VFC Index - Watershed (Plan)

Program:	Watershed
IDEM Document Type:	Plan
Document Date:	12/29/2005
Security Group:	Public
Project Name:	Cool Creek WMP
Plan Type:	Watershed Management Plan
HUC Code:	05120201 Upper White
Sponsor:	Hamilton County Surveyors Office
Contract #:	4-139
County:	Hamilton
Cross Reference ID:	16183153
Comments:	

Additional WMP Information

Checklist:	2003 Checklist
Grant type:	319
Fiscal Year:	2004
IDEM Approval Date:	12/29/2005
EPA Approval Date:	
Project Manager:	Sky Schelle

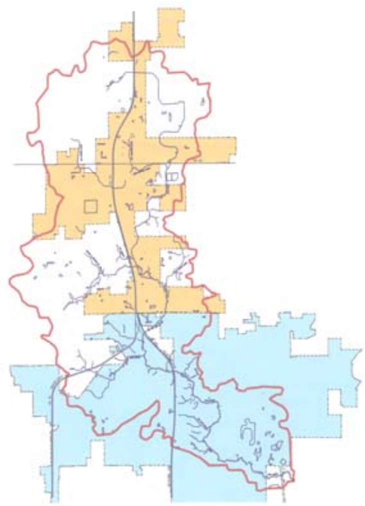
Hamilton County

City of Carmel

Town of Westfield

IDEM Section 319 Report

Cool Creek Watershed Management Plan



November 2003
Updated December 2005

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PREFACE

Planning efforts for the Cool Creek Watershed Management Plan began in 2001, when Hamilton County, the Town of Westfield, and the City of Carmel agreed to jointly fund a study of the Cool Creek watershed. Clark Dietz, Inc. was retained by Hamilton County (the lead agency) to conduct the necessary engineering analyses and develop the plan with input from watershed stakeholders. Planning efforts began in September 2001 and were completed in November 2003.

Subsequent to the completion of the original Cool Creek Watershed Management Plan, Hamilton County applied to the Indiana Department of Environmental Management (IDEM) for a Section 319 Nonpoint Source Program Grant. The purpose of the grant application was to update the Cool Creek Watershed Management Plan to make it compliant with Section 319 requirements to reduce nonpoint source pollution. The grant was approved by IDEM in 2004 and a Contract for Services was formally approved by the State of Indiana on December 29, 2004. On January 24, 2005, Clark Dietz was retained by Hamilton County to provide the additi9onal enhancements to the Cool Creek Watershed Management Plan.

This document is an update to the original November 2003 Watershed Management Plan, containing the additional Section 319 requirements. A new Chapter 9.0 has been added titled “Section 319 Updates to the Cool Creek Watershed Management Plan.” A new Appendix H, containing various exhibits from the Section 319 update project, has also been added.

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND AND PURPOSE

The Cool Creek Watershed drains significant portions of the City of Carmel and the Town of Westfield. The watershed and corporate boundaries for Carmel and Westfield are illustrated in Figure 1-1. The watershed drains approximately 23.7 square miles, with its headwaters near its headwaters near 199th Street. Cool Creek flows south and southeasterly, discharging into the White River south of 116th Street. Tributaries include Hot Lick Creek, Little Cool Creek, Highway Run, Mary Wilson Drain, Osborn & Collins #2 Drain, H. G. Kenyon Drain, and Anna Kendall Drain. US 31 and SR 431 run through the middle portion of the watershed. The Westfield portion of the watershed contains both urbanized areas as well as significant tracts of undeveloped land (primarily agricultural). The Carmel portion of the watershed is fully urbanized. Portions of the watershed lie in unincorporated Hamilton County, but are subject to potential annexation in the future.

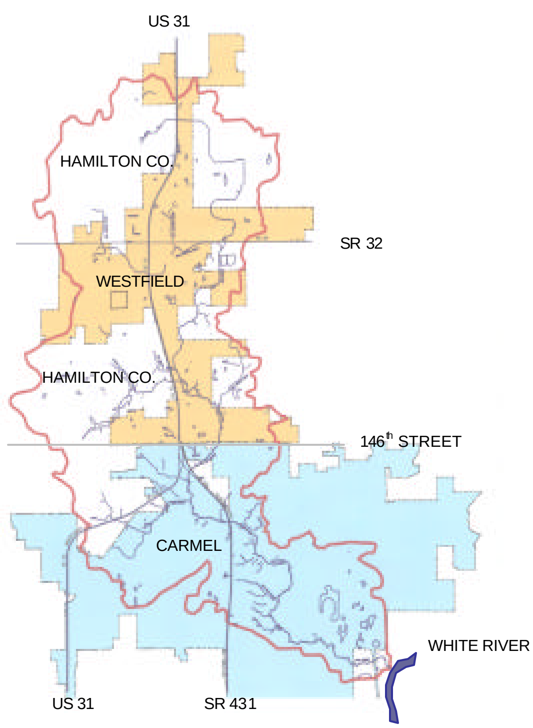


Figure 1-1 – Cool Creek Watershed

Recently, there has been growing interest and concern regarding stormwater design and management practices and their effectiveness in controlling the quantity *and quality* of stormwater runoff. This issue is of special concern given rapid growth in the Westfield area and pending requirements from the United States Environmental Protection Agency (US EPA) and the Indiana Department of Environmental Management (IDEM).

New federal regulations promulgated by the US EPA and administered by IDEM require Hamilton County, Carmel, and Westfield (and other communities throughout the country) to improve the quality of stormwater runoff. Stormwater runoff is a leading source of stream impairment due to pollutants that collect on parking lots, streets, highways, commercial, industrial and residential areas and wash off during rain events. These new regulations will require communities to educate and involve the public on stormwater quality issues, minimize erosion from construction sites, improve the long-term quality of stormwater being discharged from new developments, and develop effective municipal housekeeping operations to minimize stormwater pollution.

Hamilton County (through the County Surveyors Office), Westfield and Carmel entered into an agreement in 2001 to complete a thorough evaluation of stormwater management in the watershed. Clark Dietz, Inc. was retained to develop a Cool Creek Watershed Management Plan that includes recommendations to correct existing stormwater problems and prevent future problems from occurring as the watershed continues to develop.

A "Watershed Management Plan" can mean many things to different stakeholders, so it is important to identify scope of work for this plan. The focus of the study was on stormwater issues on the main channel of Cool Creek and its major tributaries. There are other isolated stormwater problem areas in the watershed (referred to in this report as "neighborhood" problem areas). Though some of these problem areas were identified (as part of staff interviews and public input) and located on problem area maps, detailed analysis and solution development for these areas was beyond the scope of this project.

This project also included an evaluation of water quality issues in the watershed, including a general review of the condition of the riparian corridor, a stream water quality sampling program, an evaluation of streambank erosion problems, a review of water quality violations (NPDES permit related), and an assessment of best management practices (BMPs) in the watershed. Detailed wetland delineations or ratings, biodiversity surveys, or other ecological evaluations were beyond the scope of this project, but may be considered in the future.

1.2 PROJECT SCOPE

Given the above background and purpose, the following is a summary of the scope of work for the project:

Inventory and Problem Identification	Existing information was gathered and evaluated. Sources included previous reports and studies, interviews with staff, meetings with developers, public meetings, and field reconnaissance. This information was used to compile a problem area map and identify areas for additional analysis and solution development.
Problem Analysis	Hydrologic and hydraulic computer models were developed to analyze identified problems and evaluate improvement alternatives. A stormwater quality evaluation was also performed under this task.
Solution Development	Alternative solutions were developed and evaluated. Solutions included bridge and culvert replacements, streambank stabilization projects, regional detention facilities, and land use policy modifications.

Recommendations and Implementation	This work task included recommending capital and maintenance projects, modifications to stormwater management practices, and identifying costs and implementation issues.
Watershed Management Plan Report	This work element involved compiling the above information into this report.

1.3 REPORT ORGANIZATION

This report has been organized to follow the scope of services in the order shown above. The remaining chapters of this report present the following information:

Chapter 2 Inventory	Summarizes maps, plans, reports, ordinances, standards, and other information used in completing the project.
Chapter 3 Problem Identification	Describes how problem areas were identified. Also presents the problems that were selected for detailed analysis and solution development.
Chapter 4 Water Quality Evaluation	Describes the general condition of the riparian corridor along Cool Creek, discusses wetlands in the watershed and along the stream, identifies potential pollutant sources in the watershed, and presents the stream sampling program and results. This chapter also includes a general description of how this watershed plan may be useful to Carmel, Westfield and Hamilton County and complying with upcoming stormwater quality regulations (NPDES Phase II, or Rule 13).
Chapter 5 Hydrologic Analysis	Describes the hydrologic model development and analysis results. Includes an evaluation of the effectiveness of current detention requirements in controlling stormwater on an overall watershed basis.
Chapter 6 Hydraulic Analysis	Describes the hydraulic models that were developed to evaluate solutions to stream related problems. Also includes floodplain mapping of previously unmapped tributaries.
Chapter 7 Solution Development	Presents solutions to the various problems that were identified through the problem identification and hydrologic/hydraulic analyses. Solutions were developed for stream flooding problems, streambank problems, and selected "neighborhood" problems.
Chapter 8 Recommendations, Implementation, and Funding	Summarizes recommendations, implementation issues, and funding options for the various categories of improvement projects.

2.0 INVENTORY

2.1 INTRODUCTION

Multiple sources of information were collected and analyzed to provide baseline data for the project. This chapter briefly summarizes data sources and their relevance to this study. These sources consisted of maps and plans, previous reports and studies, ordinances and standards, and other regulatory information.

2.2 MAPS AND PLANS

2.2.1 GIS Maps

Hamilton County has a comprehensive Geographic Information System (GIS) that was used extensively on the project. Data from the GIS is available to the public at the County's web page http://www.co.hamilton.in.us/gis. Figure 2-1 is an excerpt from the Hamilton County GIS.

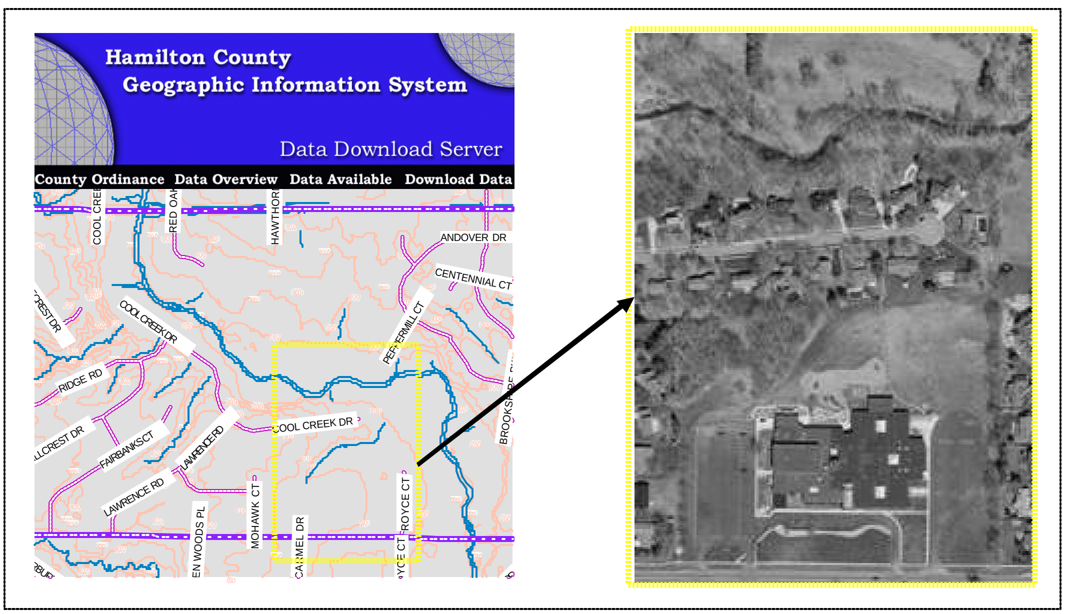


Figure 2-1
Hamilton County GIS Excerpt

The GIS contains several layers of information including the transportation system (highways, primary roads, minor roads, railroads); drainage system (drainage structures, regulated drains, streams, ponds); planimetric features (building outlines, fences, walls); topography (2' and 10' contour intervals); soils types; and political and survey boundaries. High resolution aerial photography is also available in the GIS. The GIS was updated in the fall of 2002 and was incorporated into this study.

The GIS was used to delineate watersheds and subbasins, identify land use for hydrologic modeling, analyze drainage features, identify the extent of the riparian corridor and stream buffers, and provide base mapping for figures and exhibits in this report.

2.2.2 USGS Quadrangle Maps

USGS maps (1" = 2000') were used to complement and verify the GIS topographic maps in performing watershed and subbasin delineation. Four quadrangle maps provide coverage of the entire Cool Creek watershed:

- Carmel, 1988 (5' contour interval)
- Westfield, 1992 (10' contour interval)
- Noblesville, 1992 (10' contour interval)
- Fishers, 1998 (5' contour interval)

2.2.3 National Wetland Inventory Maps

The National Wetland Inventory Maps are provided by the U. S. Department of Interior, Fish and Wildlife Service. The maps, last updated in 1989 and 1990, are provided on copies of the above mentioned USGS maps (see Figure 2-2 for an excerpt of the map along the lower reach of Cool Creek before it discharges into the White River). These maps provide the general location and extent of wetlands. Detailed delineation or assessment of the quality of wetlands in the watershed was beyond the scope of this project; however, they were included on the stream inventory maps (Chapter 3) in order to bring attention to their presence in the watershed. Final verification of the wetland boundaries should be performed by a licensed Wetland Consultant prior to approval of site plans adjacent to these areas.

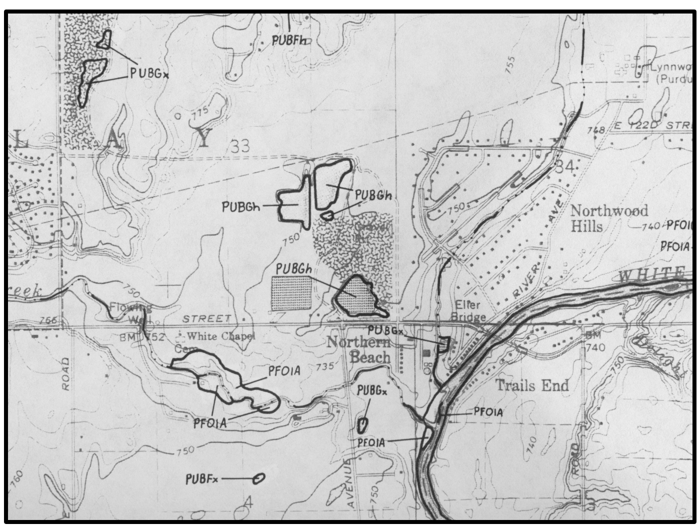


Figure 2-2
National Wetland Inventory Map Excerpt

Wetlands provide valuable functions including filtering pollutants in stormwater, providing habitat for wildlife, recharging groundwater, and providing natural flood storage. Wetlands are protected under the Federal Clean Water Act and require special permits from the U.S. Army Corps of Engineers (Section 404 permit) and IDEM (Section 401 Water Quality Certification).

Wetland regulations in Indiana (and many other states) are currently in a state of fluctuation due to a ruling in January of 2001 by the U.S. Supreme Court. In this ruling, the Court ruled against the U.S. Army Corps of Engineers and its authority to regulate certain isolated wetlands that are not adjacent to waters of the United States. Indiana has historically protected the state's waters, which include wetlands, by applying the Section 401 Water Quality Certification program in conjunction with the Section 404 U.S. Army Corps of Engineers permit program. IDEM is currently regulating isolated wetlands (those that no longer fall under Section 404 jurisdiction) through the use of NPDES permits, until a state wetland permit program is established and effective.

In order to better enforce compliance with wetland regulations and to protect their existence in future growth areas, it is recommended that wetland areas be added to the County GIS. The County will benefit from having this information readily available during the site plan review process. Furthermore, easy access to this information could be considered a Stormwater Best Management Practice (BMP) and could be used to comply with NPDES Phase II regulations.

Wetlands are scattered throughout the Cool Creek watershed though many are along the stream floodplains. The most commonly found wetland is classified as PFO1A, which stands for *Palustrine Forested Broad-Leaved Deciduous, Temporarily Flooded* wetlands. "Palustrine" comes from the Latin word "palus" or marsh. Wetlands within this category include inland marshes and swamps as well as bogs, fens, tundra and floodplains. In the Cool Creek watershed, most of the PFO1A wetlands are the floodplain type. Though all wetlands are valuable, regulatory agencies such as IDEM place a higher value on forested wetlands as compared to a small isolated wetland in a farm field. Forested wetlands provide shade to streams which in turn improves habitat for fish and wildlife.

The second most frequent type of wetland found in the watershed is Palustrine Emergent (shown as a PEMA, PEMB, PEMC, etc.). The letters following the PEM designation further describe the frequency of inundation. Emergent wetlands (sometimes known as marshes) are usually dominated by grass-like plants such as cattails, sedges or bulrush, which are rooted in bottom sediments, but "emerge" above the surface of the water.

Significant wetland areas along the Cool Creek Corridor are illustrated on the Stream Inventory Maps (Section 3.7 of Chapter 3).

2.2.4 Flood Insurance Maps

Flood Insurance Rate Maps (FIRMs) depict the regulatory floodway, the 100-year and 500-year floodplain boundary, base flood elevations, cross-section locations and other related information. During the course of this project, updated FIRM maps were being prepared for the County by others. Draft updated FIRMs were obtained from the County in the fall of 2002. The FIRMs were finalized and became effective February 19, 2003. The floodplain information in this report is based on the February 2003 updated maps. An excerpt from one of the updated FIRMs is shown on Figure 2-3.

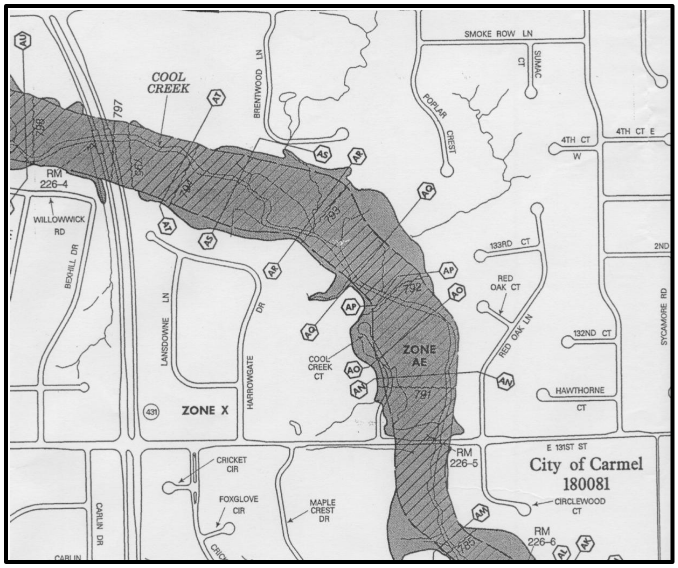


Figure 2-3
Flood Insurance Rate Map Excerpt

The flood insurance maps by themselves do not adequately illustrate the risk of flooding to buildings or other structures as they are based only on approximate topography. To better assess the flood risks and potential damages, the floodplain boundaries were re-delineated using detailed GIS-based topography with planimetric features shown. These maps are discussed Section 3.7 of Chapter 3.0.

The *floodway* is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment in order that the 100-year flood may be conveyed without substantial increases (0.1 feet or less in Indiana) in flood heights. The Indiana Department of Natural Resources (IDNR) regulates construction in the floodway. Local jurisdictions (Carmel, Westfield, and Hamilton County) regulate the portion of the floodplain outside of the floodway, referred to as the floodway *fringe*. The County has regulations prohibiting fill in the portion of the floodplain that they regulate (i.e. the floodway fringe). Carmel and Westfield currently do not have regulations that prohibit fill in the floodway fringe. This issue is discussed in more detail in Chapter 4.

A more detailed discussion of some of the problems identified from the Flood Insurance Rate Maps is included in Chapter 3.

2.2.5 Zoning Maps

Zoning maps were used to assist in identifying existing and future land use (an important variable in hydrologic analysis). Carmel has an official zoning map produced by the City of Carmel GIS for the City's Department of Community Services. The map was last modified in March 2002. Westfield also has an official zoning map (January 1997). Both the Carmel and Westfield maps list several different categories of residential, commercial, business, and other districts.

2.2.6 Aerial Photography Maps

In addition to the aerial photography maps provided with the Hamilton County GIS, paper maps of aerial photographs (spring 1997) from the State Land Office were also obtained and used on the project. While these maps are somewhat out of date in developing areas, and their resolution is not as good as the County's GIS maps, they do provide a more convenient viewable scale. The State Land Office maps are at a scale of 1" = 400' and 15 maps provide complete coverage of the watershed.

2.3 PREVIOUS REPORTS AND STUDIES

Several previous reports and studies were used in this study. The following is a summary of these documents.

2.3.1 IDNR Department Memorandum on Grassy Branch Re-Study, July 12, 2001

Grassy Branch is a tributary to Cool Creek that begins near 186th Street and flows south then east under US 31, through Westfield, and discharges into Cool Creek just south of SR 32. The entire stream is named "Grassy Branch" on USGS Quadrangle Map (Westfield). On the FEMA floodplain maps, the stream is called "Evan Kindall Drain." Locally, the stream is known as the *Anna Kendall* Drain (note difference in drain name and spelling). For this report, the stream will be referred to as the Anna Kendall Drain.

The purpose of this IDNR Department Memo was to summarize changes to the hydraulic model of the Anna Kendall Drain. The memo states that the model was updated between 1998 and September 2000 by a Christopher B. Burke Engineering, LTD (CBBEL). The model was revised to reflect changes in the upstream portion of the stream. A portion of the channel downstream from SR 32 and Oak Ridge Road was reconstructed, and an abandoned railroad crossing was removed. A complete restudy of the drain upstream of US 31 was also completed. The restudy was prompted because of a dredging project that occurred in 1998, upstream of SR 32 that resulted in the channel bottom being lowered approximately 4 feet. IDNR made some changes to the CBBEL models. These changes included minor revisions in flows, starting water surface elevations, and channel roughness coefficients. The final IDNR model was used in analyses performed in this study. The results of the Grassy Branch Re-Study were also incorporated into the February 2003 updated FIRMs.

2.3.2 Hydraulic Report for Village Farms Wilfong, July 10, 1996

This report, prepared by Weihe Engineers, Inc., analyzed the performance of a lake and dam at the Village Farms subdivision. The lake is the upstream-most of a series of two lakes that drain a tributary of the Osborn & Collins #2 Drain in unincorporated Hamilton County, west of Oak Ridge Road and north of 146th Street. This lake, which was designed as a Class 'B' dam structure in 1980, provides runoff control for approximately one square mile. The lake was originally 12.7 acres, but was increased by 3.44 acres, for a total surface area of 16.14 acres. The software used to perform the analysis is not identified in the report though it is clear that SCS methodology was used. The report indicates that the 100-year flow would be reduced from 1000 cfs to 87 cfs. This basin was analyzed independently of the hydrologic model in this study. The results of our hydrologic analysis are quite different than those reported in the Village Farms Wilfong report (see Chapter 5, Section 5.5.2).

2.3.3 Countryside Overall System Drainage Report, August 1, 2001

This report, prepared by Stoeppelwerth and Associates, analyzed the detention basin system provided for the Countryside residential subdivision in Washington Township in unincorporated Hamilton County. The subdivision is located in west of Oak Ridge Road and north of 161st Street and drains into the H. G. Kenyon Drain. The total site consists of 483 acres, though only the eastern portion of the development is in the Cool Creek watershed. The ponds were designed according to current Hamilton County stormwater standards.

2.3.4 Soil Survey of Hamilton County, Indiana, U. S. Department of Agriculture Soil Conservation Service, November 1978

The Soil Survey of Hamilton County was used, in conjunction with aerial photographs and zoning maps, to determine runoff Curve Numbers (CNs) for the hydrologic analysis. These soils designations are also provided on the County's GIS. Along the Cool Creek soils are mostly classified as Shoals-Genesee (Sh, Ge). The Shoals series of soils consists of deep, somewhat poorly drained, moderately permeable soils on floodplains. The Genesee series are adjacent to Shoals and consist of deep, well drained, moderately permeable soils on floodplains.

The upper portion of the watershed consists of Crosby and Brookston (Cr, Br) soils (about 50/50 distribution). The Crosby series consists of deep, somewhat poorly drained, slowly permeable soils on glacial till plains. The Brookston series consists of deep, very poorly drained, moderately permeable soils on glacial till plains and are generally near Crosby soils. Crosby soils are better drained and are in a higher position than Brookston soils. The lower portion of the watershed, closer to the White River, has more Miami series soils (Mm). The Miami series consists of deep, well drained soils on till plains and have loose sand and gravelly sand in the underlying material.

Soil types are used to help determine runoff CNs through the identification of hydrologic soil groups. Soils are classified into four groups – A, B, C, or D, depending on their minimum infiltration rate. The groups are summarized below (Source: TR-55, Urban Hydrology for Small Watersheds, SCS, June 1986).

Group A	Low runoff potential and high infiltration rates even when thoroughly wetted. Consist of deep, well to excessively drained sands or gravels. Infiltration rate greater than 0.30 in/hr. Low runoff potential.
Group B	Moderate infiltration rates when thoroughly wetted. Consist of moderately deep to deep, moderately well to well drained soils. Infiltration rate of 0.15 to 0.30 in/hr. Low/Medium runoff potential.
Group C	Low infiltration rates when thoroughly wetted. Soils impede downward movement of water. Infiltration rate of 0.05 to 0.15 in/hr. Medium/High runoff potential.
Group D	Soils have high runoff potential and very low infiltration rates. Clay soils with high swelling potential and a permanent high water table. Infiltration rate of 0.00 to 0.05 in/hr. High runoff potential.

In the Cool Creek watershed, the Genesee and Miami soils are Group B, while the Crosby and Shoal soils are Group C. Brookston soils are listed as B/D with B for locations that are drained and D for areas that are undrained. Conversations with Hamilton County Soil and Water Conservation District indicate that these soils often respond like Group D soils due to soil compaction that often accompanies development.

2.3.5 Flood Insurance Studies

Flood Insurance Studies (FIS) for Carmel, Westfield, and Hamilton County were obtained and reviewed. As mentioned previously, these studies were updated during the course of this project; however, resulting flood flows and stages are generally consistent with the previous studies. The FIS reports list peak discharges and corresponding flood profiles for 10-, 50-, 100-, and 500-year recurrence interval storm events.

A summary of 100-year peak discharges for Cool Creek and its tributaries is provided in Table 2-1. Peak flows for Cool Creek range from 6000 cfs at the mouth to 1200 cfs at 186th Street. The hydrologic modeling completed for this project resulted in flows that were generally within 20 percent of those published in the FIS.

Table 2-1
Flood Insurance Study – 100-year Flow Summary

Location	Drainage Area (sq. mi.)	100-year peak flow (cfs)
Cool Creek		
At mouth	23.7	6000
Below Hot Lick Creek	20.5	5400
Below Highway Run	15.8	4300
At 146th Street	13.8	3720
Below Anna Kendall Drain	7.2	2420
Above Anna Kendall Drain	3.9	1550
At East 186th Street	2.8	1200
Hot Lick Creek		
At mouth	0.4	540
Anna Kendall Drain		
At mouth	3.3	2400
Above Bowman Drain	2.3	1050
At US 31	2.0	940

2.4 OTHER INFORMATION FROM REGULATORY AGENCIES

Other information obtained from regulatory agencies included:

- Hydrologic/Hydraulic Models
- IDNR Permits
- IDEM Rule 5 and 6 Permits
- INDOT Information on US 31

2.4.1 Hydrologic/Hydraulic Models

Existing hydrologic/hydraulic models were obtained from IDNR. The models included:

- HEC-1 model of the Cool Creek Watershed
- HEC-2 model of Cool Creek (to 186th Street)
- HEC-2 model of Upper Cool Creek (upstream from 186th Street)
- HEC-2 model of Little Cool Creek
- E-431 (hydraulic) models of Hot Lick Creek and Grassy Branch (Anna Kendall Drain)
- HEC-RAS model of the upper portion of Grassy Branch (Anna Kendall Drain)

The HEC-1 model (software developed by U. S. Army Corps of Engineers) is a hydrologic model that simulates the rainfall runoff process and generates hydrographs for various storm events. The HEC-1 model of the Cool Creek was used by IDNR to assist in developing Coordinating Discharges for the stream. The IDNR model is more generalized than the detailed hydrologic model developed for this project.

The HEC-2 models (software developed by U. S. Army Corps of Engineers) simulate stream hydraulics and predict peak flood stages for various storm events. The IDNR models were converted to HEC-RAS (a newer release of HEC-2 with a graphical user interface) and were used to analyze problems and develop solutions in the Cool Creek watershed. The E-431 models are older hydraulic models that are no longer supported by the model developer (U. S. Geological Survey).

2.4.2 IDNR Permits

IDNR regulates construction activity or land alteration in mapped floodways and also issues any changes to floodway maps (called Letter of Map Amendments or Revisions). Information on floodway permits can be found at IDNR's web site:

http://www.state.in.us/dnr/water/permits/index.html.

Permits issued in the Cool Creek watershed total 102 (82 on Cool Creek; 6 on Little Cool Creek; and 14 on Grassy Branch/Anna Kendall Drain). The approximate distribution by permit type is as follows:

44%	Utility related (storm outfalls, water main crossings, etc.)
24%	Stream crossings (bridge replacements, new bridges/culverts, bridge repair, etc.)
11%	Fill activities (tennis courts, parking lots, etc.)
10%	Miscellaneous grading and excavation
6%	Excavation for ponds
5%	Streambank stabilization

A summary listing of the IDNR permits is provided in Appendix A.

2.4.3 IDEM Rule 5 and Rule 6 Enforcement

IDEM regulates stormwater runoff from construction sites and certain industrial activities. Rule 5 is a general permit that requires erosion and sediment controls for all construction sites that disturb more than five acres. This threshold recently dropped to sites disturbing more than one acre. Rule 6 governs stormwater runoff from certain industrial sites (ones that are more likely to cause stormwater runoff pollution).

The IDEM database was reviewed to determine if there were any enforcement actions regarding Rule 5 and Rule 6 (and other regulations) in the Cool Creek watershed. Information on IDEM enforcement is found at http://www.in.gov/serv/idem/oe. Two "Notice of Violations" were issued in the watershed. One in 1997 for a residential subdivision development that failed to submit a Notice of Intent (NOI) to comply with Rule 5 and one in 2001 for a commercial development that failed to submit an NOI, did not have its erosion and sediment control plan approved prior to construction, and had erosion control measures that were not properly installed and maintained. Both of these cases appear to have been resolved without Agreed Orders or civil penalties. No Rule 6 violations were found.

A water quality violation (unrelated to Rule 5 or Rule 6) occurred in April of 1999 for a private water utility (Hamilton Western Utilities, Inc.) that was found to be discharging water treatment plant backwash into a tributary of Cool Creek. This water treatment plant, located at 1140 Greyhound Pass, is no longer used since the new River Road water plant was put on line. The violation was settled with an Agreed Order and an assessed civil penalty of $4,250.

2.4.4 INDOT Information on US 31

The Indiana Department of Transportation (INDOT) is currently undertaking a study on improvements to US 31 between I-465 and SR 38 (12.5 miles). Information on the project can be found at http://www.us31indiana.com/. The purpose of this project is to reduce congestion for the US 31 corridor; improve the level of safety for motorists; and provide for reliable and efficient movement of commerce and regional travel. This project will essentially upgrade US 31 to Interstate standards by removing all at-grade intersections and uncontrolled access points.

A "US 31 Preliminary Alternatives Analysis and Screen Report" (Parsons Transportation Group, July 2002) narrows upgrade options down to two alternatives shown as Alts F and G in the Figure 2-4. Alt F generally follows the existing US 31 corridor while Alt G swings to the east of Westfield north of 161st Street. A Draft Environmental Impact Statement is expected to be released in 2003 for public comment.

Alts F and G would disturb 4 and 9 acres of wetlands and 38 and 54 acres of floodplains, respectively. Alt F would have 12 stream crossings involving 5170 feet of stream and Alt G would have 11 crossings involving 4715 feet of stream. As this project moves forward, impacts to water quality and quantity should be carefully evaluated and mitigated as needed.

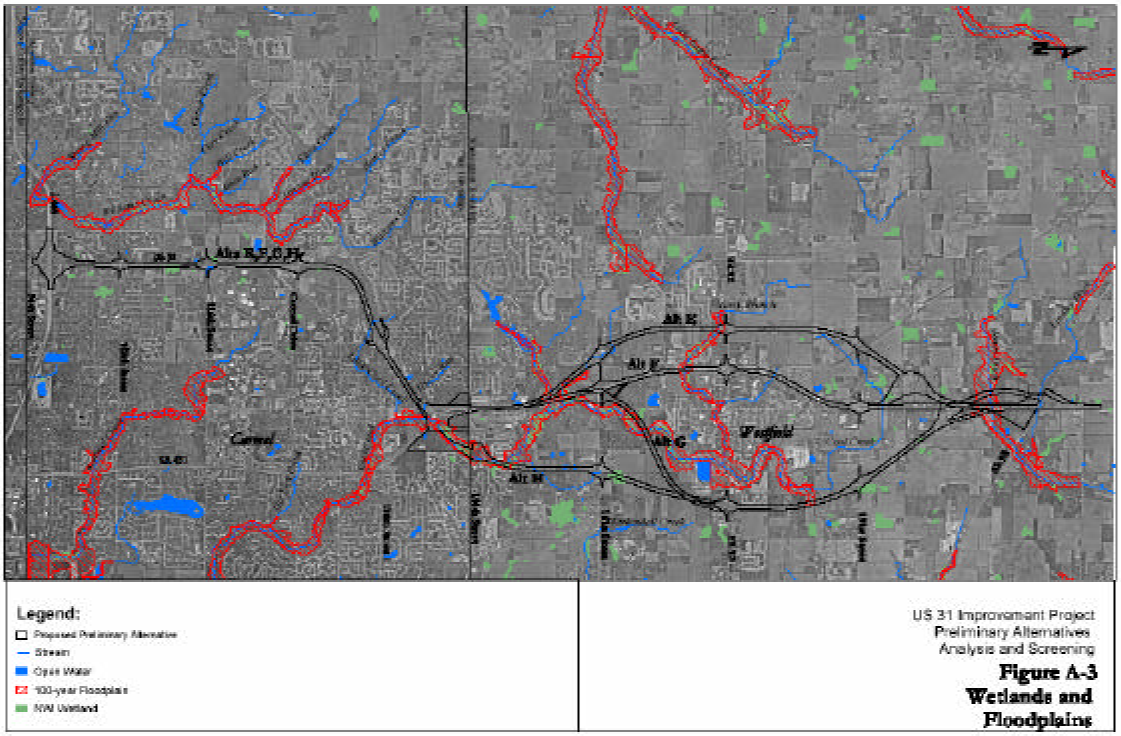


Figure 2-4
Excerpt from US 31 Improvement Report

2.5 ORDINANCES AND STANDARDS

Hamilton County, Westfield, and Carmel ordinances and site design standards were reviewed as they pertain to stormwater management. Carmel and Westfield both follow the Hamilton County standards, which is a key advantage in terms of providing consistent stormwater management controls in the different jurisdictions in the watershed.

Local site design standards require developers to provide detention facilities (ponds) that temporarily restrict increased stormwater runoff resulting from new impervious surfaces (e.g. roadways, sidewalks, rooftops) that are constructed in new developments. Ponds must be designed to limit stormwater discharge for both large and small storms. Developers are currently required to construct detention ponds that collect water from their respective developments and restrict the peak discharge to a magnitude below the pre-development condition. Chapter 5 – Hydrologic Analysis includes an evaluation of the effectiveness of current detention requirements on peak flow control.

Many ponds in new developments have a permanent pool of water that remains after a storm event. These ponds (often referred to as wet ponds) provide some water quality benefit. However, design standards for these types of ponds need to be upgraded to provide better water quality enhancement performance and protect downstream channels.

Hamilton County also has an ordinance that prohibits fill in the floodplain of any drainageway. This is a proactive requirement in that it preserves natural flood storage and also protects water quality. Carmel and Westfield (and many other communities in Hamilton County) allow development within the floodplain, provided that it meets certain standards to prevent flooding.

3.0 PROBLEM IDENTIFICATION

3.1 INTRODUCTION

Stormwater problems were identified from several sources, including staff interviews, developer input, previous reports/studies, and field investigations. This information was compiled and summarized on a Stormwater Problem Map. A selected group of projects were identified for detailed hydrologic/hydraulic analysis (Chapters 5 and 6) and solution development (Chapter 7). The following sections summarize the problem identification process.

3.2 INTERVIEWS

Interviews were completed with staff from Hamilton County, Carmel, and Westfield. The purpose of the interviews was to obtain knowledge of both general and specific problem areas. Specific problem areas were annotated on work maps. More general input is summarized as follows:

- The entire stream is in need of maintenance to address erosion, log jams and beaver dams.
- Most of the streams upstream from 146th Street are regulated drains. The Anna Kendall Drain is the only regulated drain on a maintenance assessment.
- There have been several petitions to re-construct the regulated drain down to 146th Street.
- Several bridges in the watershed have been replaced or plan to be replaced.
- Many reported problems are on private property.
- Anna Kendall Drain is one of the more problematic tributaries in terms of flooding concerns. Portions of the drain have been reconstructed. The culvert at the abandoned railroad on the drain serves as a control structure to store flood waters. This structure should remain.
- Impacts from the planned upgrades to US 31 should be considered and mitigated.
- Carmel and Westfield should consider additional ordinance language to protect floodplains.

Input on potential problem areas or watershed concerns was also obtained from the Hamilton County Soil and Water Conservation District. Input is summarized as follows:

- Concern with Creek being too close to Grassy Branch Road north of State Road 32. There a general safety concerns and limitations on future expansion.
- Land east of US 31 and between 151st street and SR 32 is wooded with rolling hills. Concern that as this land is developed there will be a high potential for sedimentation of Cool Creek and the hydrology of the watershed will change significantly.
- From 126th Street to SR 431 there are homes that back up to steep slopes. This area is generally stable but if the channel were to start eroding, there could be homes and property harmed.
- Significant sediment has been deposited on the south side of the 116th street bridge and needs to be cleaned out for that structure to have full capacity.
- Cool Creek south and north of 116th street is widening and eroding.
- Soils along much of Cool Creek are terrace or floodplain soil. These soils lack the texture, strength, and glacial till that upland soils possess to resist bank erosion.

- Criteria for a riparian corridor should be established for Cool Creek. Programs are available to assist landowners and new developments should be required to establish the buffers.
- Focus should be placed on maintaining the floodplain and not allowing construction even in the fringe. Corridor repair should also be stressed, which is being addressed by new ordinances that Hamilton County has passed.
- There is a need for an established system for construction site inspection. Site visits need to be more frequent.
- Need for a reduced nutrient program (lawns/clippings)

3.3 DEVELOPER INPUT

On October 30, 2002, a meeting was held at the Hamilton County Surveyors Office to obtain input from the development community on stormwater issues affecting the Cool Creek watershed. One of the key drivers of the study was the concern with stormwater impacts resulting from new development, particularly with the upper watershed (Westfield) developing and the lower watershed (Carmel) being already fully developed. Topics covered at the meeting included:

- Overview and purpose of the Cool Creek Watershed Plan
- Existing stormwater problems in the watershed
- Effectiveness of stormwater runoff controls associated with new development
- Regional detention facilities
- Rule 13 requirements and impacts to new development

Key feedback from representatives of the development community included:

- Regional on-line detention has become very difficult to implement because of environmental permitting issues.
- Regional detention for areas less than one square mile can work; however detention basin configurations are often dictated by other engineering issues (need for earthwork fill, limitations on conveyance facility sizes, etc.)
- If regional basins are constructed, credit should be given towards open space requirements.
- If the communities or the County want a particular regional detention basin site, the development community should know this early on so it can be accommodated in the development process.
- Development restrictions in the floodplain should be re-considered in areas of very wide, shallow floodplains.
- Street widths and parking space requirements should be considered when looking at the non-structural aspects of upcoming water quality requirements.

A summary of detailed discussion with the development community representatives is provided in Appendix B.

3.4 PUBLIC INPUT

Public input was obtained through two public meetings held in the spring of 2002, one in Westfield and one in Carmel. A total of approximately 70 people attended the meetings. A copy of the presentation handout and meeting summaries is provided in Appendix C. Each meeting included introductions, a presentation on the scope of the project, and a description of findings to date. After the presentation and question and answer session, work maps were available for residents to identify specific problem areas. Key input and areas of concern are summarized as follows:

- Several residents expressed concern with filling or development taking place within the floodplain.
- A general desire was expressed to maintain the aesthetic value of the creek, including preservation of riparian areas.
- Concerns about water quality were discussed. Residents showed interest in continued sampling and monitoring of the quality of water in the creek. Comments were expressed that we should strive to improve the water quality, not just maintain it.
- Concern was expressed regarding the amount of native plant growth residing in the riparian areas adjacent to the creek and the invasion of non-native plants. It was suggested that a bio-diversity assessment of the creek/watershed system be considered.
- General concern was expressed regarding blockages in the creek.
- Interest was expressed to have information available on the Internet
- There were some questions regarding the future expansion of US 31 and its impact on the watershed.
- Residents displayed interest in performing channel clean out, erosion control, streambank stabilization, and general creek maintenance.
- Residents showed interest in Rule 5 compliance (erosion control) within the watershed.

3.5 PROBLEMS IDENTIFIED IN PREVIOUS STUDIES AND REPORTS

The primary source used in problem identification was the Flood Insurance Studies for Hamilton County, Westfield, and Carmel. These reports, along with the accompanying floodplain/floodway maps and the hydrologic/hydraulic analyses performed in this study, were used to identify flooding problems such as roadway overtopping or other structures at risk from flooding. A summary of stream related flooding in the three jurisdictions in the watershed is as follows:

Carmel

- Cool Creek – No roadway overtopping problems along the main Cool Creek channel
- Hot Lick Creek – Overtopping at Carmel Drive during 10-year event (creates about 3 feet of backwater)
- Highway Run – Overtopping at Walter Street and Walter Court during 25-year and greater events.
- Highway Run – Overtopping at Thornberry Drive during 25-year and greater events.

Westfield

- Cool Creek – E. 151st Street overtopping during 10-year event
- Cool Creek – Oak Road just overtopped during 100-year event
- Cool Creek – S. Union Street/Westfield Boulevard overtopping or nearly overtopping during 10-year event (at two stream crossing locations)
- Cool Creek – Private Drive overtopped during 10-year event
- Cool Creek – Oak Road just overtopped during 10-year event

- Cool Creek – 171st Street almost overtopped during 10-year event
- Anna Kendall Drain – Four (4) Private Drives overtopped during 10-year event.
- Anna Kendall Drain – Gurley Street and Cherry Street overtopped during 50-year event
- Anna Kendall Drain – Park Street overtopped during 10-year event
- Anna Kendall Drain – Abandoned railroad embankment overtopped during 10-year event
- J. M. Thompson Drain – W. Jersey Street overtopped during 10-year event

Hamilton County Unincorporated Areas

- H. G. Kenyon Drain – Two private gravel drive crossings with small culverts overtop during even small storms
- Mary Wilson Drain – 151st Street overtopped during 10-year event
- Mary Wilson Drain – One private drive overtopped during the 10-year event.

As highlighted above, conveyance problems at stream crossings are more pronounced in Westfield, with several undersized bridges and culverts on both Cool Creek and Anna Kendall Drain. Flooding problems along Cool Creek in Carmel is not a major problem. Erosion is more of a concern along Cool Creek in Carmel.

3.6 FIELD RECONNAISSANCE

A field reconnaissance of Cool Creek and its major tributaries was performed during the spring of 2002. The purpose of the field reconnaissance was to:

- Assess the general condition of the riparian corridor
- Photograph and note areas with erosion problems
- Note areas with log jams or debris build up
- Measure and record location and size of storm sewer outfalls
- Check outfalls for evidence of scour
- Note any illegal dumping of trash
- Photograph and note flood prone areas

The following photographs illustrate the types of problems that were recorded.

Debris Jam and Streambank Erosion

Unknown Leachate

Culvert in Need of Sediment Cleanout

Culvert Pipe Collapse and Erosion

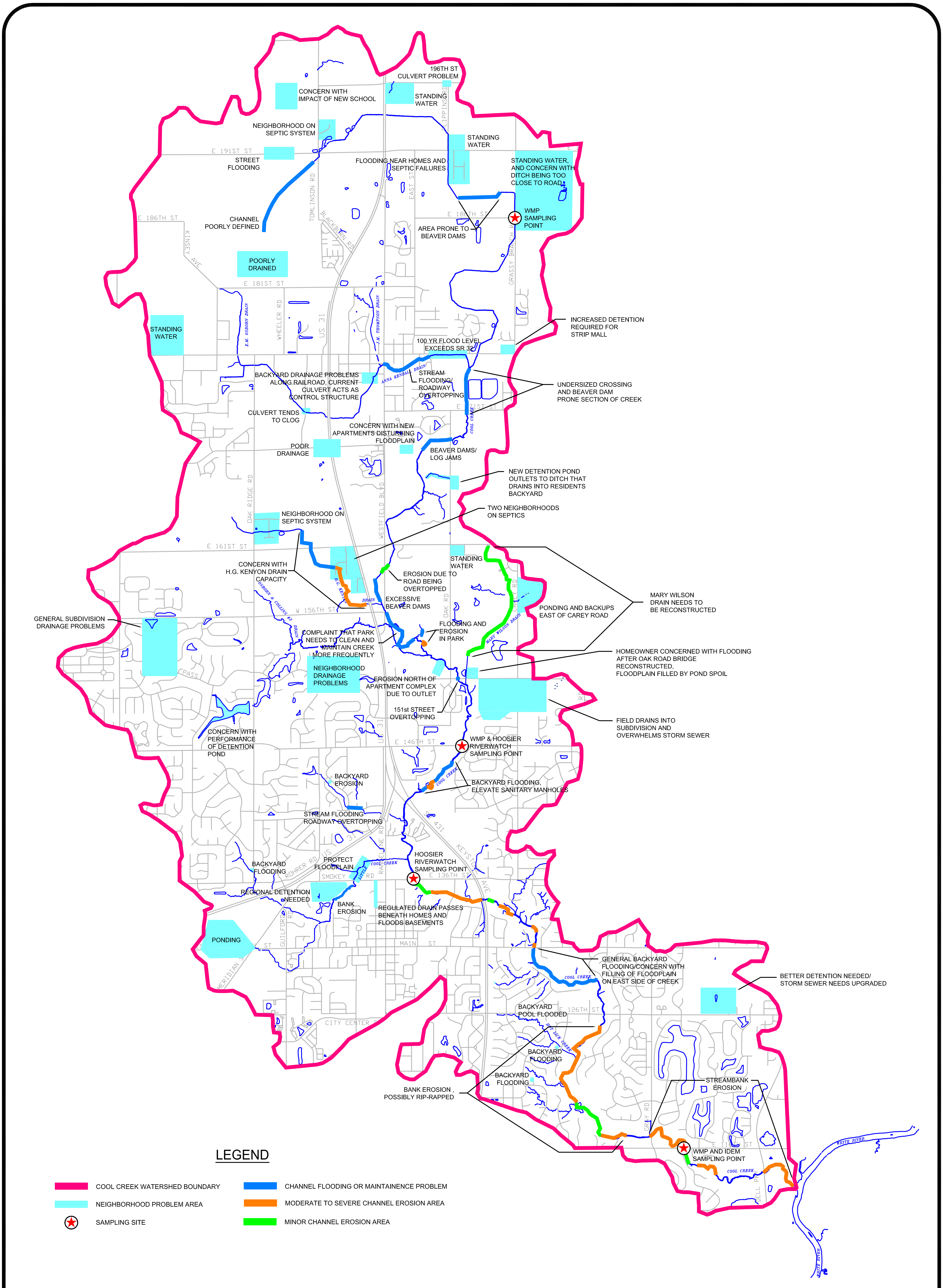
3.7 PROBLEM AREA MAP

Problem area information obtained from the various sources is summarized on the Problem Area Map, provided in Figure 3-1. The map shows the areas of channel erosion, localized flooding problem areas (neighborhood areas), and stream reaches with reported flooding problems, and other problems or concerns reported through the interviews and public meetings.

A second set of more detailed maps was also prepared and transmitted separately from this report. This map set, titled "Cool Creek Stream Inventory Maps", is comprised of 13 sheets (24" x 36") covering the main Cool Creek channel and floodplain. This map set provides a baseline condition inventory from which to compare and assess future watershed conditions. The maps show the following information:

- 100-year base flood elevation reference marks
- 100-year floodplain delineation
- Structures located in the floodplain
- Cross-section locations from the Flood Insurance Study hydraulic models
- Approximate wetland locations from the National Wetland Inventory Maps
- Location and size of stormwater outfalls
- Photographs of channel erosion, debris blockage and other areas of interest

Selected problem areas were targeted for more detailed analysis and solution development. These areas are presented in Chapter 7.



COOL CREEK WATERSHED MANAGEMENT PLAN

FIGURE 3-1
PROBLEM AREA MAP

4.0 WATER QUALITY EVALUATION

4.1 INTRODUCTION

A water quality evaluation was performed as part of the Cool Creek Watershed Management Plan. This task included a review of the general condition of the riparian corridor, an evaluation of floodplain development issues in the watershed, and water quality sampling at selected locations in the watershed, and a general overview of pending stormwater quality related regulations.

4.2 RIPARIAN CORRIDOR EVALUATION

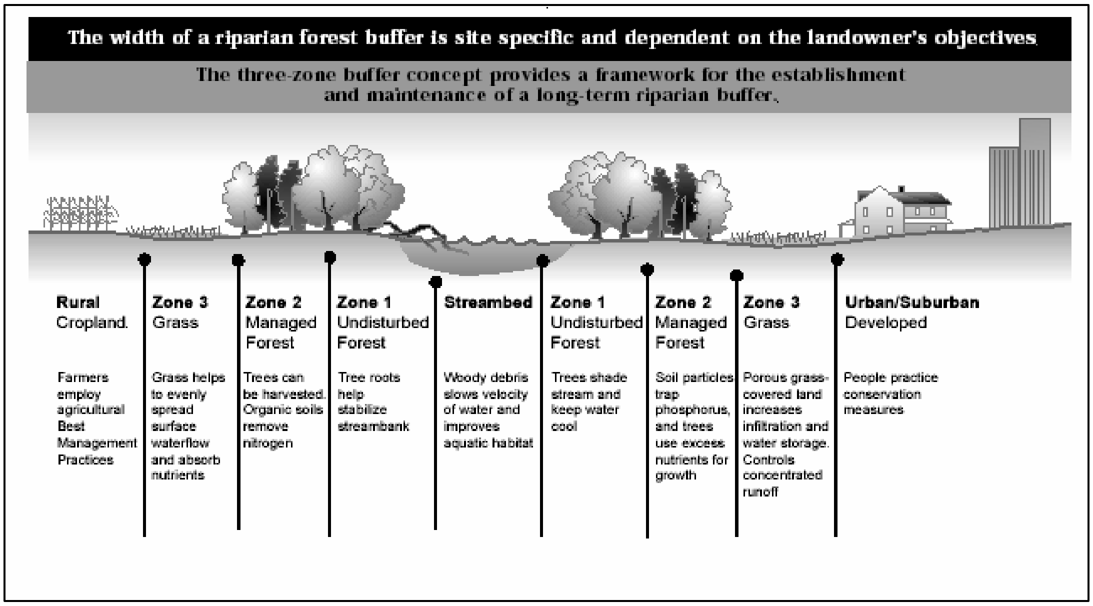
The term riparian refers to anything connected with or immediately adjacent to the banks of a stream or other body of water. A riparian forest buffer encompasses the area from the streambank to the area of trees, shrubs, and herbaceous vegetation located upslope from the body of water. Buffers are established and managed to reduce the impact of adjacent land use. A buffer serves several important functions: it preserves the stream's natural characteristics, protects water quality, and improves habitat for plants and animals on land and in the water.

For a good portion of its main stem, Cool Creek has a healthy riparian forested buffer. From the mouth at the White River upstream to 116th Street, the stream corridor is forested. Between 116th Street and 126th Street, Cool Creek runs through a golf course. There are some forested areas along the creek in this reach, but not to the extent seen in other reaches. Upstream of 126th Street to approximately SR 32 there are healthy riparian buffers, though there are segments with limited forest cover.

Upstream of SR 32, Cool Creek has limited riparian vegetation and is farmed to the edge of the stream. Several segments of Cool Creek have been channelized and straightened. The photographs below illustrate the difference in riparian vegetation for the lower and upper reaches of Cool Creek. As the agricultural tracts in the upper watershed are developed, stream buffers should be considered. Figure 4-1 shows an illustration of the various zones and benefits of a properly planned riparian buffer.

Forested riparian buffer along Cool Creek east of SR 431

No riparian buffer – Cool Creek south of 191st Street



Source: University of Maryland, Cooperative Extension

Figure 4-1
Riparian Forest Buffer Illustration

4.3 FLOODPLAIN DEVELOPMENT

Floodplain development concerns tie directly to preservation of the riparian buffers along Cool Creek (and its tributaries). Filling of floodplains can cause loss of flood storage and riparian habitat. As noted previously, Hamilton County has an ordinance that prohibits filling of land in the floodplains of its regulated drains. It would be appropriate for Carmel and Westfield to adopt similar policies for floodplains under their jurisdiction. This would provide a uniform policy and would help preserve existing riparian buffers. Many communities have adopted buffer ordinances to protect headwater streams where floodplains are often narrow and floodplain protection alone may not adequately protect buffer systems. This management practice would also help comply with IDEM water quality regulations.

4.4 WATER QUALITY SAMPLING

Stream sampling was performed at three locations in the watershed: 186th Street, 146th Street, and 116th Street. The 186th Street sampling point captures mostly agricultural runoff. The 146th Street sampling point includes runoff from most of the Town of Westfield. The 116th Street sampling point includes 98 percent of the watershed.

Two wet weather events (03-25-02 and 8-19-02) and two dry weather events (06-21-02 and 09-09-02) were selected for the water quality sampling. The total rainfall during the two wet weather events was approximately 0.7 inches (3-25-02 event) and 2.9 inches (8-19-02 event).

Samples were collected by Clark Dietz staff and were delivered with appropriate chain of custody to Test America, Inc. for laboratory analysis. Samples were analyzed in accordance with EPA standard methods. Grab samples analyzed for the following parameters:

- Biochemical Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Chromium, Hexavalent
- Cyanide
- Nitrogen (Ammonia, Kjeldahl, Nitrate, Organic, Total)
- Oil & Grease
- Ph
- Phenol
- Phosphorus (Dissolved and Total)
- Solids (Suspended and Dissolved)
- Fecal Coliform
- Fecal Streptococcus
- E. Coli
- Metals

Table 4-1 summarizes the results of the sampling program. Complete reports from the testing laboratory can be found in Appendix D. The highlighted values in Table 4-1 represent sample results that were somewhat elevated as compared to national averages. The following is an evaluation and interpretation of some of the specific parameters that were tested in the Cool Creek watershed. Several references were used in interpretation of the sampling data:

- Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPS, Metropolitan Washington Council of Governments, July 1987.
- Urbanization and Water Quality: A Guide to Protecting the Urban Environment, Terrene Institute, March 1994.
- Polluted Urban Runoff: A Source of Concern, University of Wisconsin-Extension, 1997.
- Watershed Protection Techniques Vol. 3, No. 1, Microbes and Urban Watersheds: Concentrations, Sources, & Pathways, Center for Watershed Protection, April 1999.
- Stormwater Magazine: The Journal for Surface Water Quality Professionals, The ABCs of Water-Quality Assessment in Georgia, March/April 2002.
- National Management Measures to Control Nonpoint Source Pollution from Urban Areas – Draft, U. S. Environmental Protection Agency, July 2002.

4.4.1 Oxygen Demand (BOD and COD)

BOD and COD levels were found at levels below national averages. BOD and COD are measures of the amount of oxygen used by macroinvertebrates and bacteria in processing organic matter in streams. Organic matter comes from both natural and human sources. Natural sources include riparian vegetation like leaves falling in the stream. Human sources might include sewage, pet wastes, nutrients from fertilizers, and litter. High BOD levels result in low dissolved oxygen in streams, which in turn degrades water quality and lowers diversity of aquatic organisms. Typically, BOD levels from 3 to 5 mg/l are considered moderately clean. Levels below 3 mg/l are considered very clean.

TABLE 4-1
STREAM SAMPLING RESULTS
COOL CREEK WATERSHED MANAGEMENT PLAN

Parameter		Typical Wet Weather Values Reported in Literature	116th Street Crossing				146th Steet Crossing				186th Street Crossing			
			Dry Weather		Wet Weather		Dry Weather		Wet Weather		Dry Weather		Wet Weather	
			06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02
BOD	mg/L	12(1)	<5	<5	5.1	5.5	<5	<5	5	6.9	<5	<5	5	5.4
COD	mg/L	91(1)	<10	<10	10	59	<10	9.8	10	81	<10	11	10	32
Nitrogen, Kjelhdahl	mg/L	2.35(1)	0.56	0.3	2.3	3.0	0.84	0.54	2.1	3.6	0.73	0.69	1.1	2.1
Nitrogen, Nitrate	mg/L	0.96(1)	0.65	0.47	0.9	0.69	0.85	0.16	1.2	0.81	**1.8**	0.65	**2.2**	1.2
Nitrogen, Ammonia	mg/L	0.26 - 1.1(2)	<0.10	<0.10	0.88	0.14	<0.10	<0.10	**5.1**	0.16	<0.10	<0.10	**4.3**	0.29
Nitrogen, Total	mg/L	3.31(1)	1.2	0.77	3.2	3.7	1.7	0.7	3.3	4.4	2.5	1.3	3.3	3.3
Nitrogen, Organic	mg/L	1.25(3)	0.56	0.3	1.4	2.9	0.84	0.49	<0.10	3.4	0.73	0.66	<0.10	1.8
Phosphorus, Dissolved	mg/L	0.16(1)	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.21	0.067	0.07	<0.05	0.28
Suspended Solids	mg/L	100(4)	<5	<5	120	**490**	<5	<5	61	**580**	<5	10	11	160
Dissolved Solids	mg/L	N/R	440	530	280	120	390	430	290	210	360	490	390	140
E coli	/100 mL	11,000(5)	170	>1600	900	1600	220	>1600	300	1600	170	>1600	900	>1600
Fecal Streptococcus	/100 mL	35,000(5)	13	3	120	920	12	<1	240	960	5	4	<10	1700
Chromium, Hex	mg/L	0.007(6)	0.01	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Phenol	mg/L	0.008 - 0.115(6)	0.012	0.022	<0.01	0.025	<0.01	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	0.018
Copper	mg/L	0.047(1)	<0.02	<0.02	<0.02	0.033	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02	<0.02
Nickel	mg/L	0.012(6)	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.176(1)	<0.05	<0.05	<0.05	0.095	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

(1) Nationwide Urban Runoff Program. 2300 monitored storms at 22 sites across the nation. US EPA 1983.
(2) Range is for newer suburban sites and older urban areas, as reported by Metropolitan Washington Council of Governments, 1987.
(3) Newer suburban sites, as reported by Metropolitan Washington Council of Governments, 1987.
(4) U. S. EPA database for general urban runoff.
(5) Center for Watershed Protection database of 34 recent urban stormwater monitoring studies, 1999.
(6) Metro Seattle as reported in Fundamental of Urban Runoff Management: Technical and Institutional Issues, Terrene Institute, 1994.
N/R = Not Reported
Cells shaded yellow with bold border indicate values somewhat elevated as compared to national averages found in the literature

The Cool Creek sampling results ranged from 5 to 6.9 mg/l during wet weather and were less than 5 during dry weather. The National average for BOD is 12 mg/l. Higher BOD levels are often associated with older, highly impervious areas with outdated combined sewers. Neither Carmel nor Westfield has combined sewers which may be why BOD levels are significantly below the national average.

4.4.2 Nutrients (Phosphorus and Nitrogen)

The average concentration of nutrients from all three sites and both storm events are somewhat higher than national averages reported in the literature, which may warrant further evaluation. Nutrients such as phosphorus and nitrogen are essential nutrients needed by all living plants and animals. Excess nutrients cause extensive algal growth which can in turn cause eutrophication, which in turn increases BOD. Phosphorus comes from several sources, including human wastes, animal wastes, industrial wastes, fertilizers, and human disturbance of land. Ammonia nitrogen is often found in areas where duck and geese excretions are high. Human sewage, caused by failing septic systems and illegal sanitary sewer cross-connections, is a source of nitrates. Fertilizers and runoff from animal feedlots and barnyards are also important sources of nitrates (and ammonia).

Water bodies with total phosphorus present at levels above 0.1 mg/l may be at risk for eutrophication. Typically, concentrations of nitrate nitrogen above 10 mg/l, ammonia nitrogen above 2 mg/l, and Kjeldahl nitrogen above 2 mg/l are a concern and may warrant actions to identify and limit inputs into the receiving streams. The Cool Creek sampling data show Kjelhdahl nitrogen was generally above 2 mg/l during wet weather. Nitrate nitrogen was generally below 2 mg/l (well below the 10 mg/l level of concern), and tended to be higher at the 186th Street sampling location. Ammonia nitrogen was high (4.3 and 5.1 mg/l at the 186th Street and 146th Street locations) during the March 25, 2002 sampling event. Early spring lawn fertilizing may be a partial explanation for this result. The August 19, 2002 sampling event showed ammonia nitrogen levels below 0.3 mg/l.

4.4.3 Sediment

The sediment sampling performed in the Cool Creek watershed showed varying results. Typical urban runoff values for total suspended solids (TSS) are around 100 mg/l. For the March 25, 2002 wet weather event, TSS concentrations were 120, 61, and 11 mg/l at 116th Street, 146th Street, and 186th Street. These values confirm higher TSS from urban areas versus cropland areas. For the August 19, 2002 event, TSS concentrations were much higher – 490 mg/l at 116th Street, 580 mg/l at 146th Street and 160 mg/l at 186th Street. It should be noted, this storm event was not a typical rainfall event, with 2.5 to 2.9 inches of rain. A typical storm event in central Indiana is about 0.65 inches.

High concentrations of suspended sediment in streams cause many adverse impacts. Suspended solids change the color of streams from nearly clear to red-brown. High turbidity causes streams to lose their ability to support diverse aquatic organisms. Suspended solids can also directly impact aquatic life in terms of clogging fish gills, reducing growth rates and decreasing resistance to disease. Excessive sediment deposited in the stream bed can prevent egg and larvae development.

The leading sources of sediment in existing urban areas are industrial sites, commercial development and freeways. But by far the highest loads of sediment come from areas under construction. Construction sites have high erosion rates and high delivery rates. Typical erosion rates for construction sites are 35 to 45 tons per acre disturbed per year compared to 1 to 10 tons per acre per year for cropland. The delivery rate of sediment is also much higher in construction sites as compared to cropland because ditches and sewers are typically constructed in the first phase of a site development project. Typically 50% to 100% of soil eroded from a construction site is delivered to a lake or stream, compared to only 3% to 10% of the soil from cropland delivered to lakes or stream. This fact illustrates the importance of properly planned, installed and maintained erosion and sediment controls on construction sites.

4.4.4 Bacteria (E. Coli and Fecal Streptococcus)

Bacteria results found in the Cool Creek samples are consistent with the national averages. E. Coli levels were above standards for recreational use (235), ranging from 300 to >1600 counts/100 ml during wet weather. One of the dry weather events (9/9/02) was also well above standards with a reported value of >1600 counts/100 ml. The laboratory was unable to perform counts higher than 1600 due to sample size limitations. Literature on national averages reports a mean E. Coli value of approximately 11,000 counts/100 ml.

Bacteria are indicators of the presence of fecal wastes in surface waters. Escherichia coli (E. Coli) is in the coliform family of bacteria. Fecal streptococci (also known as Entercocci) are another bacteria group found in feces. Coliform bacteria are only an indicator of a potential public health risk, and not an actual cause of disease. Coliform bacteria are also used by most states as a standard for drinking water, shellfish consumption or water contact recreation. Indiana uses E. Coli as its standard (235 counts/100 ml for water contact recreational use of a stream).

The Center for Watershed Protection (see reference previously listed) developed a database of 34 more recent monitoring studies for bacteria. For E. Coli, the group mean was reported to be almost 11,000 counts/100 ml. Nearly every individual stormwater runoff sample exceeded bacteria standards. Bacteria sources in urban watersheds include human sources and non-human sources. Human sources include those caused by combined and sanitary sewer overflows, illegal sanitary connections to storm drains, transient dumping of wastewater, and failing septic systems. Most bacteria present in stormwater runoff are generally assumed to be of non-human origin, unless there are inappropriate human sewage discharges present in an urban watershed. Non-human sources include dogs, cats, raccoons, rats, beaver, geese, ducks, pigeons and other animals. Dogs in particular are often found to be a major source of coliform bacteria. Several studies have found dogs to be the primary source of fecal coliforms in urban watersheds. Dogs have also been found to be significant hosts for Giardia, Salmonella, and other pathogens. Geese, ducks, and gulls are also speculated to be a major bacterial source in urban areas, particularly at lakes and stormwater ponds where large resident populations become established. Relatively little data is available to quantify whether geese and ducks are a major source. Livestock can also still be a major source of bacteria, particularly those areas of the urban fringe that have horse pastures or “hobby” farms. These types of land uses exist in the upper reaches of the Cool Creek watershed.

The Center for Watershed Protection publication lists four conclusions as a result of their research on microbes in urban watershed: 1.) It is exceptionally difficult to maintain beneficial uses of water in the face of even low levels of watershed development, given the almost automatic violation of bacterial water quality standards during wet and dry weather. 2.) Bacteria levels in urban stormwater are so high that watershed practices would need to be exceptionally efficient (99% removal rate) to meet standards during wet weather. 3.) A lot of “detective work” would be needed to narrow down the lengthy list of potential bacteria suspects. 4.) There is little understanding about the actual relationship between bacterial indicators and the risk to public health in urban watersheds.

4.4.5 Trace Metals

Copper, nickel, and zinc were found above detection limits at the 116th Street sampling location for the August 19, 2002 sampling event. Copper was also found at the 146th Street location during this event. The concentrations for copper and zinc were below averages reported in the literature for typical urban runoff. Nickel was found above detection limits at the 116th Street location during the August 19, 2002 sampling event. Chromium was also found above detection limits at the 116th Street location and the 186th Street location for this event. Nickel and chromium were above typical values reported in the literature.

Trace metals can be a concern because of their toxic effects on aquatic life, and their potential to contaminate drinking water supplies. Sources of metals include roofing materials, downspouts, galvanized pipes, metal plating, paints, wood preservatives, catalytic converters, brake linings, and tires. The most common metals found in urban runoff are lead (has been declining since unleaded gas has been implemented), cadmium, copper, and zinc. The primary source of many metals in urban runoff is vehicle traffic. Concentrations of zinc, cadmium, chromium and lead appear to be directly correlated with the volume of traffic.

4.4.6 Organic Compounds

Phenol is an organic compound that is a main chemical component of oil. Sources of phenol include oil spill, runoff carrying oil from streets, and other oil related activities. Phenol was detected in both dry and wet weather sampling events. The concentration was consistent with urban runoff values reported in the literature.

4.4.7 Summary of Sampling Results

The following observations and conclusions can be made from the sampling of Cool Creek:

- The constituents and concentrations of pollutants found in Cool Creek are generally comparable to urban and urbanizing watersheds across the country.
- Nutrients appear to be somewhat higher than national averages. This could be the result of excess fertilizer use coupled with agricultural runoff from the upper watershed. Public education regarding proper lawn care may be an appropriate follow up activity.
- Suspended solids were very high for one of the sampled events, though this was an atypical storm event. Proper erosion and sediment control on construction sites, in addition to streambank restoration, will help to control suspended solids levels.
- Bacteria levels exceed those required for recreational contact. This finding was expected as nearly all urban watersheds have bacteria counts that greatly exceed health standards for swimming. Efforts should be made to track and reduce human sources of bacteria that may result from failing septic systems, illegal sanitary sewer connections, and other sources. Public education on proper disposal of pet waste would also be a best management practice to help reduce bacteria levels.
- Other management practices, such as enhanced stormwater management practices, will further reduce stormwater runoff pollution into Cool Creek and its tributaries.

4.5 PHASE II NPDES STORMWATER REGULATIONS

In the late 1980s and early 1990s, federal regulations were promulgated (through the US Environmental Protection Agency (EPA) requiring municipalities to develop programs to reduce pollutants in stormwater runoff. The initial regulation applied only to communities with a population of 100,000 or larger (called Phase I communities). In 1999, a federal regulation was passed that addresses Phase II communities (those with populations greater than 10,000). Hamilton County, Carmel, and Westfield will all be regulated under this program.

IDEM is responsible for enforcement of the Phase II stormwater program in Indiana. On August 6, 2003, the final regulation became effective as 327 IAC 15-13 and titled "Rule 13 - Storm Water Run-Off Associated with Municipal Separate Storm Sewer System Conveyances." A Notice of Intent (NOI) letter and other associated initial application documents were due to IDEM by November 4, 2003. The Rule 13 regulation is to be implemented through six minimum control measures, summarized in Table 4-2 below.

Table 4-2
Rule 13 Six Minimum Control Measures Summary

Public Education and Outreach	Distributing educational materials and performing outreach to inform citizens about the impacts polluted stormwater runoff discharges can have on water quality.
Public Participation and Involvement	Providing opportunities for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen involvement.
Illicit Discharge Detection and Elimination	Developing and implementing a plan to detect and eliminate illicit discharges to the storm sewer system. Includes developing a storm sewer system map and informing the community about hazards associated with illicit discharges and improper disposal of waste.
Construction Site Runoff Control	Developing, implementing, and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land.
Post-Construction Runoff Control	Developing, implementing, and enforcing a program to address discharges of post-construction stormwater runoff from new development and redevelopment areas. Applicable controls could include preventative actions such as protecting sensitive areas or the use of structural BMPs such as wet ponds or constructed wetlands.
Pollution Prevention/Good Housekeeping	Developing and implementing a program with the goal of preventing or reducing pollutant runoff from municipal operations. (e.g., regular street sweeping, reduction in the use of pesticides or street salt, or frequent catch-basin cleaning).

Rule 13 requires the development of a comprehensive written document called a Stormwater Quality Management Plan (SWQMP). The SWQMP is divided into three parts:

Part A: Initial Application (due along with the NOI by November 4, 2003)

- Listing of entities covered by the permit
- Schedule of activities
- Proposed budget allocation and summary of identified funding sources

Part B: Baseline Characterization and Report (due within 180 days from receivership date of NOI)

- An investigation of land use and assessment of any stormwater BMP locations
- Identification of known sensitive water areas
- A review of known existing and available monitoring data of area receiving waters
- Identification of areas causing or likely to cause pollutant problems
- Assessment of BMP effectiveness

Part C: Program Implementation (due within 365 days from receivership date of NOI)

- Initial evaluation of the stormwater program
- Detailed program description for each minimum control measure
- Timetable for program implementation milestones
- Schedule for on-going characterization of receiving waters
- Narrative and mapped description of the boundaries covered by permit
- Estimate of the linear feet of open ditch or pipe
- Summary of the types of BMPs that will be allowed in developing areas
- Narrative or tabular summary of post-installation performance standards for BMPs
- Summary of the current and projected stormwater budget and funding sources
- Summary of measurable goals for each minimum control measure

All three entities in the Cool Creek watershed have submitted Notice of Intent (NOI) letters and Part A of the SWQMP, with Hamilton County and the City of Carmel being co-permittees. *The Cool Creek Watershed Management Plan will be useful in support of Rule 13 application and implementation efforts.*

The water quality sampling program, the riparian corridor evaluation, streambank erosion assessment and other data collected on this project is directly applicable to development of the Part B: Baseline Characterization and Report requirement. Recommendations in Chapter 7 regarding changes to stormwater detention requirements and land use and planning are directly applicable to post-construction runoff control requirements.

5.0 HYDROLOGIC ANALYSIS

5.1 INTRODUCTION

Hydrologic analysis of the Cool Creek watershed was performed to assist in problem identification and develop solutions and recommendations. The hydrologic computer model HEC-HMS (U. S. Army Corps of Engineers, Hydrologic Engineering Center – Hydrologic Modeling System, Version 2.2.1) was used to perform the peak stormwater runoff analysis. HEC-HMS is a physically based storm event simulation model capable of simulating runoff from various land uses and soil types, combining subbasin hydrographs, and routing flow through storage and conveyance facilities. Flows from the HEC-HMS model were used as inputs to the hydraulic analyses of the stream system (Chapter 6).

A second hydrologic model, XP-SWMM, was used to analyze potential off-line regional detention facilities. XP-SWMM is a dynamic (unsteady) flow model that performs both hydrologic and hydraulic analyses and can more accurately account for unsteady flow conditions associated with off-line detention facilities. The following sections describe the model development, evaluation results, and conclusions.

5.2 HEC-HMS MODEL DEVELOPMENT

HEC-HMS model development requires delineation of subbasins within the watershed, determining land use and runoff characteristics, and determining how subbasins are combined and routed downstream. The remainder of the HEC-HMS model input is divided into a series of operations. Each operation computes land surface runoff from a subbasin, combines two or more hydrographs, or performs flood routing through a channel reach or reservoir. Each operation produces a flow hydrograph as its output. Hydrographs can be added together (combined) to represent the confluence of two streams. The model graphical user interface and example of results are shown in Figure 5-1 below.

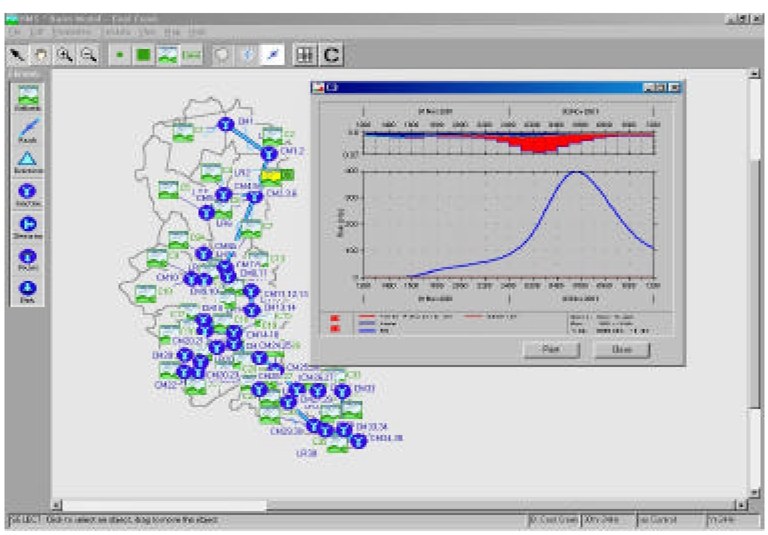


Figure 5-1 – HEC-HMS Model Graphical Interface

The following sections describe the design rainfall data, subbasin parameters, routing of subbasin flows, and model calibration for the watershed. A copy of the HEC-HMS summary output for the 2-, 10, 25-, 50-, and 100-year rainfall events (24-hour duration storm) is provided in Appendix E.

5.2.1 Design Rainfall

The watershed analyses focused on system performance for synthetic (predetermined) rainfall events. A design storm event is defined by precipitation depth, duration, and time distribution. Precipitation depths for various storm durations were obtained from "Bulletin 71 - Rainfall Frequency Atlas of the Midwest" (Midwestern Climate Center and Illinois State Water Survey, 1992). Time distributions (called Huff curves) were used as published in the above referenced Bulletin 71. These "Huff curves" distribute rainfall over the duration of the storm. Different curves (referred to as quartiles) are used for different duration storms. Storms less than 6 hours in duration use the first quartile distribution. Storms with durations of 6 to 12 hours use the second quartile distribution. Storms with durations greater than 12 hours but less than or equal to 24 hours use the third quartile distribution. A fourth quartile distribution is also available for storm durations greater than 24 hours; however, storms longer than 24 hours are not typically used in urban stormwater management analyses. Tables 5-1 and 5-2 list design rainfall depths and distributions.

5.2.2 Subbasin Parameters

The Cool Creek watershed was subdivided into 36 individual subbasins using critical analysis points as subbasin break points. Subbasin delineation was performed using the 2-foot contours in the Hamilton County GIS.

Stormwater runoff from each subbasin was computed using the Soil Conservation Service (SCS) curve number method available in HEC-HMS. Required parameters include subbasin area, curve number, and basin lag time. The time of concentration for each subbasin was estimated using the SCS TR-55 method. Calculations were based on distance, surface characteristics, slope, and velocity of flow from the most remote point in the subbasin to the subbasin outlet. The time of concentration, measured in hours, was converted to the subbasin lag time using the HEC-HMS recommended factor of 0.6.

Subbasin curve numbers were determined using a weighted average of curve numbers assigned to individual sub-areas of homogeneous land use and soil types. Existing conditions land use data was obtained from GIS maps and aerial photos. Future land use data was determined for undeveloped areas from zoning maps. Soil types were obtained from the SCS soil survey discussed in Chapter 2. The individual curve numbers for each land use and soil were selected from tables in SCS Technical Release 55, Urban Hydrology for Small Watersheds, 1986. Subbasin parameters are summarized in Table 5-3. Subbasins locations are shown on Figure 5-2.

5.2.3 Routings

A key feature of the HEC-HMS model is its capability to route stormwater runoff hydrographs through various drainage system components such as detention basins, culverts, and channel reaches. Appropriate flow routings enhance the accuracy of the representation of the watershed response to storm events by incorporating the attenuation of peak flows and time delay of hydrographs which occur as a flood wave travels through the storm system. Both detention pond storage and channel routings were utilized in the Cool Creek watershed HEC-HMS model.

Table 5-1
Design Rainfall Depths

Storm Duration (hours)	Rainfall Depth by Recurrence Interval (inches)					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	1.37	1.71	2.00	2.43	2.80	3.21
3	1.87	2.33	2.72	3.30	3.81	4.28
6	2.19	2.73	3.19	3.87	4.46	5.13
12	2.54	3.17	3.70	4.49	5.18	5.95
24	2.92	3.64	4.25	5.16	5.95	6.84

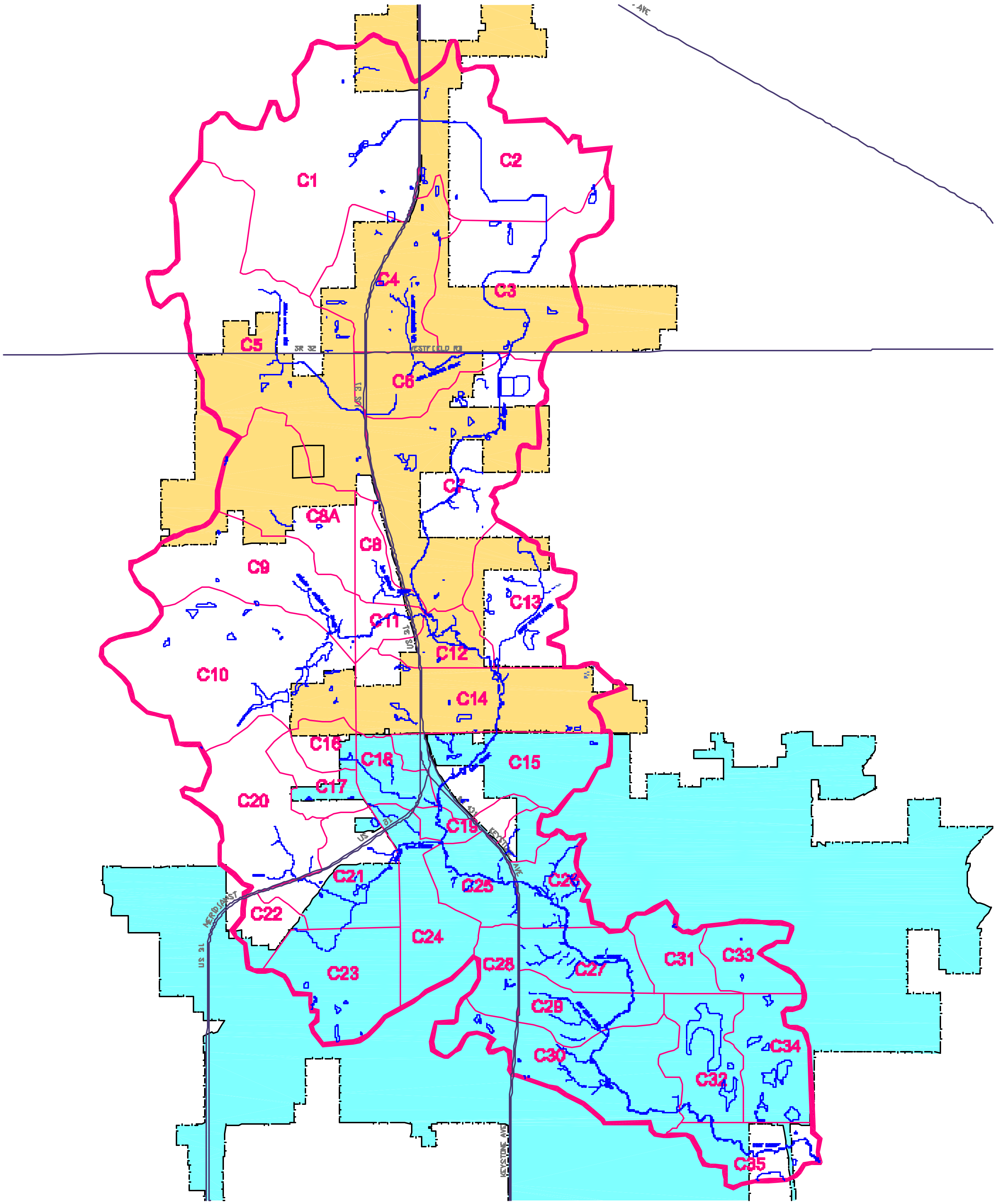
Table 5-2
Design Rainfall Time Distributions

Cumulative Storm Time (%)	Cumulative Storm Rain (%)			
	First Quartile*	Second Quartile	Third Quartile**	Fourth Quartile
5	12	3	2	2
10	25	6	5	4
15	38	10	8	7
20	51	14	12	9
25	62	21	14	11
30	69	30	17	13
35	74	40	20	15
40	78	52	23	18
45	81	63	27	21
50	84	72	33	24
55	86	78	42	27
60	88	93	55	30
65	90	87	69	34
70	92	90	79	40
75	94	92	86	47
80	95	94	91	57
85	96	96	94	74
90	97	97	96	88
95	98	98	98	95
100	100	100	100	100

* First quartile was used in flow computations for smaller tributaries.
** Third quartile was used to compute flows in Cool Creek.

Table 5-3
Subbasin Hydrologic Parameters

Subbasin	Area (sq. mi.)	Time of Concentration (hrs)	Lag Time (hrs)	Curve Number
C1	1.88	3.33	2.00	81
C2	1.18	4.94	2.96	81
C3	1.14	4.04	2.42	80
C4	0.89	2.88	1.73	80
C5	1.95	4.47	2.68	75
C6	0.40	3.07	1.84	77
C7	1.62	4.55	2.73	79
C8	0.18	1.28	0.77	70
C8A	0.67	2.76	1.66	81
C9	0.86	3.12	1.87	81
C10	1.48	2.14	1.28	78
C11	0.17	1.42	0.85	73
C12	0.26	2.39	1.43	66
C13	0.63	2.18	1.31	78
C14	0.87	1.49	0.89	84
C15	0.77	2.58	1.55	73
C16	0.19	1.11	0.67	82
C17	0.24	1.70	1.02	82
C18	0.21	1.36	0.82	79
C19	0.15	1.19	0.71	81
C20	0.78	2.56	1.54	81
C21	0.58	2.08	1.25	82
C22	0.19	0.98	0.59	81
C23	0.65	3.06	1.84	83
C24	0.52	1.90	1.14	74
C25	0.48	2.31	1.39	80
C26	0.35	1.05	0.63	71
C27	0.43	2.72	1.63	75
C28	0.24	1.06	0.64	82
C29	0.36	1.12	0.67	72
C30	0.97	2.00	1.20	75
C31	0.30	1.75	1.05	75
C32	0.53	1.76	1.06	78
C33	0.30	1.09	0.66	73
C34	0.46	2.41	1.45	80
C35	0.50	2.14	1.28	74



NOT TO SCALE

Subbasin Boundary
Cool Creek Watershed Boundary
Westfield Corporate Limits
Carmel Corporate Limits

Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 5-2
Subbasin Map

5.3 XP-SWMM MODEL DEVELOPMENT

XP-SWMM2000 (Version 8.5), produced by XP Software Inc. is used for free surface open channel and closed conduit flow modeling and for modeling pressure flow networks. The model is based on the EPA Stormwater Management Model (SWMM), which has been in continuous use since approximately 1970. XP-SWMM offers a graphical user interface and detailed model output.

XP-SWMM2000 was used on the Cool Creek watershed project to simulate and evaluate the impact of off-line detention facilities. Off-line facilities were analyzed because on-line basins can create more negative environmental impacts and require a dam safety permit (for drainage areas greater than one square mile). Dam safety issues significantly increase the cost of design, construction, and maintenance of a detention facility. Off-line facilities are more complex to analyze; hence the XP-SWMM2000 model was utilized.

Off-line facilities require a side-channel diversion weir to divert channel flow into the basin when flows in the natural channel begin to rise during a storm event. A restricted outlet is created at the downstream end of the off-line basin to temporarily store flow and reduce downstream flow rates and velocities. XP-SWMM is capable of analyzing the unsteady flow components associated with the interface between the channel, diversion weir, storage facility, and outlet pipe. Figure 5-3 illustrates the XP-SWMM interface for the off-line storage facility modeling.

In this XP-SWMM analysis, an upstream hydrograph is generated using the same hydrologic methodology utilized by the HEC-HMS model. The hydrograph is routed through links that represent the natural stream channel of Cool Creek. A side channel weir is represented along the channel. Flow is diverted into the off-line detention basin storage node. The outflow from the detention basin is restricted, in this case by an orifice controlled structure. Flow is conveyed back to the natural stream channel via a conduit. This hydraulic system is controlled by differentials in water surface elevations between the pond and the channel. Flow will divert into the off-line basin until it is full, in which case flow would bypass the facility and continue downstream via the natural channel. Outflow from the off-line basin will flow back to the natural stream as the hydraulic gradeline in the natural channel subsides.

The location, size, effectiveness, and cost of recommended regional off-line detention storage facilities are summarized in Chapter 7.

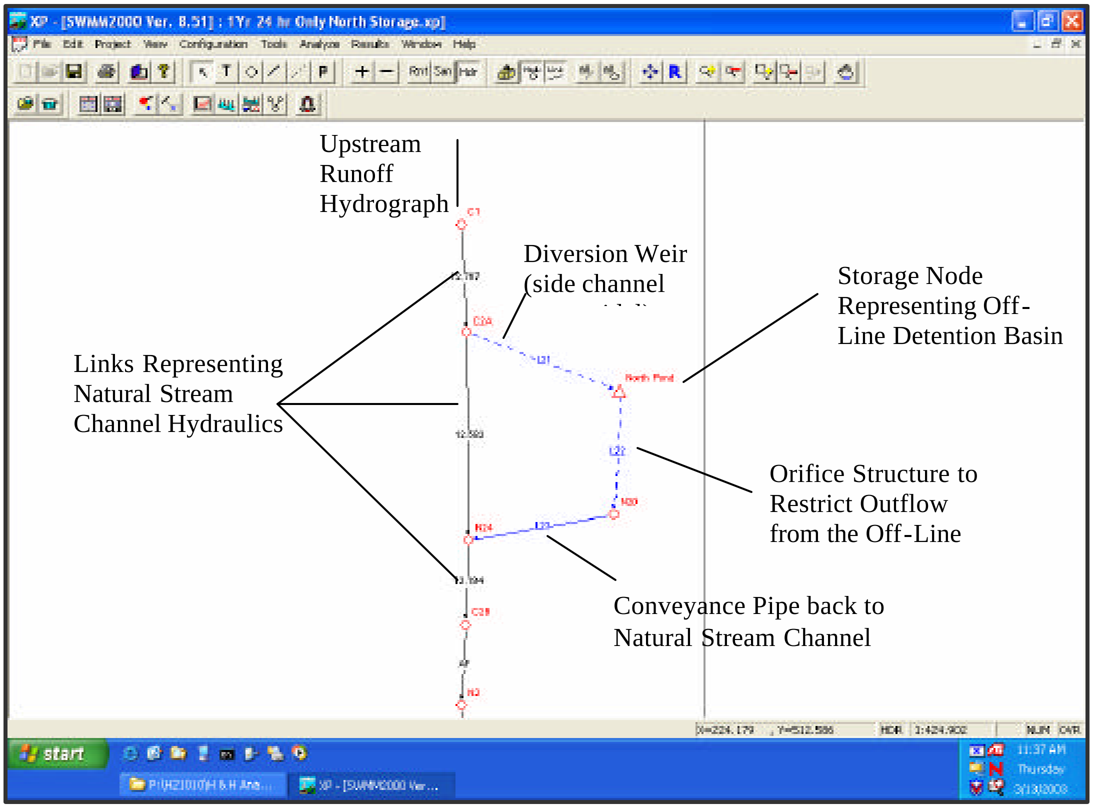


Figure 5-3
XP-SWMM Representation of Off-Line Detention Basin

5.4 MODEL CALIBRATION/VERIFICATION

Hydrologic model calibration/verification was performed by comparison to other analyses or methods and comparing predicted results to general field observations. Detailed comparison of computed hydrographs to gauged stream flow data was not possible because there are no stream gauging stations (and associated rain gauging network) in the Cool Creek watershed. The HEC-HMS model computed flows were compared to those listed in the Flood Insurance Study. The Flood Insurance Study flows were based partly on previous HEC-1 modeling of Cool Creek watershed by IDNR (note: HEC-1 is the predecessor of HEC-HMS). Table 5-4 summarizes the comparison of HEC-HMS model results to previous analyses by IDNR and to the Flood Insurance Studies.

The comparison shows the HEC-HMS model results to be comparable to the IDNR and FIS results, though somewhat lower for the 10-year and higher for the 100-year events. The HEC-HMS model has a more detailed representation of the watershed (36 subbasins) as compared to the IDNR HEC-1 model (10 subbasins). Also, the HEC-HMS model considered an existing regional detention facility on a tributary of the Osborn & Collins # 2 Drain. The IDNR model did not consider this facility as it is privately owned. IDNR will only consider existing storage facilities if they are owned, operated, and maintained by a public entity.

Table 5-4
HEC-HMS Model Results Comparison to IDNR and FIS Results

Location Along Cool Creek	10-Year Storm (cfs)			100-Year Storm (cfs)		
	HEC-HMS	IDNR HEC-1	FIS	HEC-HMS	IDNR HEC-1	FIS
At Mouth at White River	2690	3508	3000	5078	5409	6000
At 116th Street	2601	3394	2700	4892	5223	5400
At Little Cool Creek Confluence	2310	2883	2220	4597	4336	4300
At 146th Street	1842	N/A	2425	3977	N/A	3720
At Osborn & Collins # 2 Confluence	1692	2116	N/A	3732	3244	N/A
At Anna Kendall Confluence/SR 32	1152	1493	1280	2448	2394	2420

The HEC-HMS model also computes flows consistent with observed field conditions for smaller storm events. The HEC-HMS model predicts that Cool Creek would be out of its normal channel banks along its lower reaches in Carmel for the 1-year storm (about 2.5 inches over 24 hours). This modeled condition is consistent with observations to 2-inch and greater storm events that occurred over the course of the project when Cool Creek was observed to be out of its channel banks.

Overall, the HEC-HMS model produces reasonable results consistent with IDNR analyses and with observed field conditions. Additional calibration would require installation of either permanent or temporary stream gauging stations. The County is considering entering into an agreement with the USGS to install and maintain a permanent gauging station on Cool Creek and sharing the cost with Carmel and Westfield. USGS has indicated a new station would cost $5,000 for initial installation and $10,200 annually for maintenance of the station.

5.5 EVALUATION RESULTS

The HEC-HMS flow results were used as inputs to the hydraulic analysis and to develop solutions to flooding problems (Chapters 6 and 7). The model was also used to evaluate the effectiveness of current stormwater detention requirements and existing regional storage facilities in the watershed.

5.5.1 Current Stormwater Detention Requirements

The hydrologic model was used to simulate the cumulative effects of future development in the watershed and evaluate the appropriateness of current stormwater management requirements. Current detention standards require control of 100-year and 10-year storms. For a given site, the 100-year post-development peak rate of runoff must be restricted to the 10-year pre-development peak rate. The 10-year post-development flow must be restricted to the 2-year pre-development peak rate.

The effectiveness of this policy was evaluated by using future land use runoff curve numbers in undeveloped or partially developed subbasins. Storage routing routines were input at the downstream end of these subbasins to represent current detention requirements (control of the 100-year and 10-year post-development flows to 10-year and 2-year pre-development rates, respectively).

The results of this analysis are illustrated in Figure 5-4 which compares existing conditions (blue) and "full build-out" conditions with current detention standards (magenta). The flow vs. time graphs (hydrographs) represent the 100-year and the 1-year storms (24-hour duration) and are located at 146th Street.

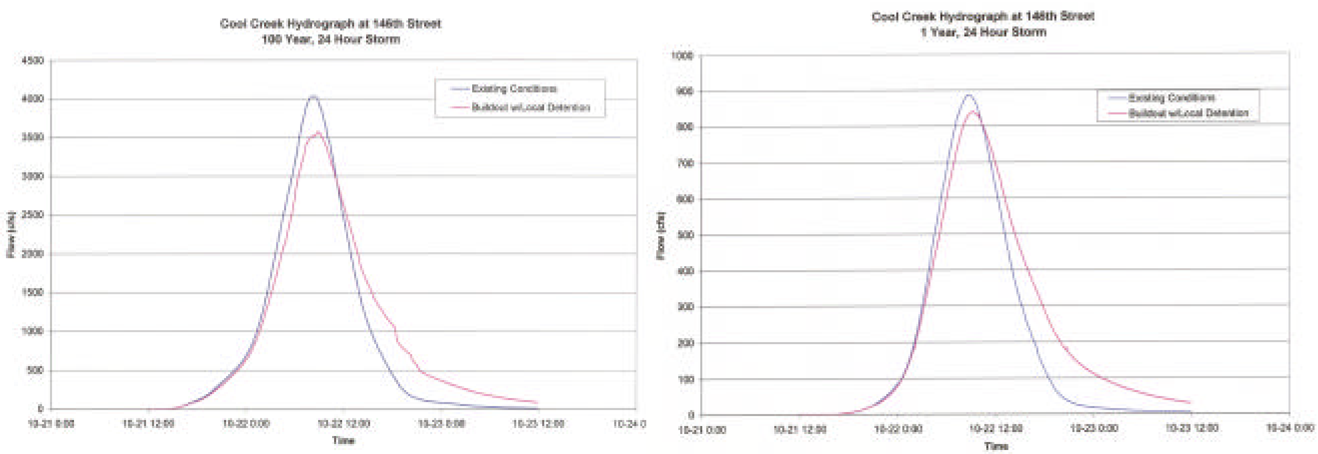


Figure 5-4
Hydrologic Impact of Future Development

The hydrologic analysis shows that current detention standards will be effective in controlling peak flow rates and corresponding flood elevations. However, these hydrographs also illustrate the impact of urbanization on the *volume* and *duration* of stormwater runoff. Under developed conditions, peak flow is reduced but it takes longer for flows to recede.

Urbanization can alter the geometry and stability of stream channels. Larger and more frequent discharges that accompany watershed development cause downstream channels to enlarge, by widening, downcutting, or a combination of both. This is occurring in the lower reaches of Cool Creek. Recommended changes to the current detention standards to help address water quality and channel erosion are included in Section 7.8 of Chapter 7.

5.5.2 Existing Regional Detention Facilities

Two existing regional detention facilities were evaluated as part of the hydrologic analysis. The first is the Village Farms Subdivision lake and dam and the second is storage area created by an undersized culvert at an abandoned railroad embankment on the Anna Kendall Drain.

Village Farms Lake and Dam

The Village Farms Subdivision lake and dam is an engineered on-line stormwater detention facility. The dam was constructed in 1979 – 1980 as a Class 'B' structure. The tributary drainage area is approximately one square mile. The surface area of the lake was increased from 12.7 acres to 16.14 acres in 1996. A hydraulic report was prepared by Weihe Engineers, Inc. in July 1996 to evaluate the hydraulics of the lake enlargement. The hydrologic/hydraulic analysis was completed for large storms only (100-year through the Probably Maximum Precipitation event). The report presents the following results (a 6-hour duration storm was used in the analysis):

Frequency	Inflow (cfs)	Outflow (cfs)	Stage
100-year	1000.7	87.1	877.56
200-year	1394.5	218.0	878.98
300-year	1521.9	300.3	879.18
400-year	1633.3	376.5	879.34
500-year	1712.8	437.3	879.46
½ PMP*	3472.0	2471.5	881.92
PMP*	7112.0	---	Overtop Dam

** PMP: Probable Maximum Precipitation*

The 1996 analysis appears to overestimate the effectiveness of this lake in controlling flood flows in that it accounts for storage that is actually not available. The normal permanent pool elevation for the lake is 873.80 feet. The stage-storage-discharge relationship shown in the 1996 report identifies storage below the normal pool, starting at an elevation of 862 feet and providing approximately 95 acre-feet at the normal pool elevation of 873.80 feet. Unless the lake was completely drained down to elevation 862.0 feet (presumably the bottom of the excavated pond) before a storm event this storage would not be available to attenuate peak inflows. The runoff curve number of 92 used in the 1996 report was much higher than the curve number of 78 computed in this project. A curve number of 92 is appropriate for a highly impervious urbanized commercial/ business district. The zoning map for Westfield – Washington Township shows this area as being zoned single family residential, low density, which is more consistent with a CN of 78. Also the time of concentration in the 1996 analysis was much shorter than in the current HEC-HMS analysis.

Using a curve number of 78, a longer time of concentration, and only accounting for storage above the permanent pool, the HEC-HMS model predicts the following flow reductions for the 2-, 10- and 100-year storm events:

Storm Event (6-hr duration)	Peak Inflow (cfs)	Peak Outflow (cfs)	Percent Reduction	Storage (ac-ft)
2-year	151	55	64%	25
10-year	291	81	72%	49
100-year	610	256	58%	97

The HEC-HMS analysis shows that the Village Farm lake and dam provides significant flood control benefits.

Anna Kendall Drain

A 48-inch culvert under an abandoned railroad embankment creates a significant impoundment area upstream (south) of Park Street on the Anna Kendall Drain. The drainage area at this point is approximately 2 square miles. Although there is significant volume in the impoundment area (approximately 80 acre-ft), an existing breach in the embankment limits the amount of flow that can be stored. Improvements at this location are needed to restore and maintain the flood control benefits of this storage area. The effectiveness of the storage area and specific improvements needed are presented in Section 7.7.3 of Chapter 7.

5.6 SUMMARY AND CONCLUSIONS

A hydrologic analysis of the Cool Creek watershed was completed using the hydrologic computer model HEC-HMS. A second model, XP-SWMM2000, was used to supplement the HEC-HMS model in analyzing proposed off-line regional detention basins. The following conclusions were formed as a result of the hydrologic analysis.

- Existing stormwater detention standards will effectively control peak flows and localized flooding as the watershed continues to develop, especially for larger storm events. However, the volume and duration of flow will increase, especially for the smaller more frequent storm events. This may lead to additional streambank erosion. Modifying detention pond design requirements to provide an extended detention time for the 1-year or "first flush" storm will help reduce erosion and improve water quality.

- Two existing regional detention facilities in the watershed provide significant flood control benefits, though the Anna Kendall storage area is currently ineffective due to a breach in the embankment.

- Additional regional detention facilities in the upper reaches of Cool Creek (discussed in detail in Chapter 7) will provide additional flood control benefits and help reduce downstream channel erosion.

6.0 HYDRAULIC ANALYSIS

6.1 INTRODUCTION

Hydraulic analyses were performed on Cool Creek and its major tributaries to identify existing problem areas, identify floodplain limits for unmapped tributaries, and to develop solutions to stream related flooding areas. The analyses were performed using HEC-RAS (U. S. Army Corps of Engineers, Hydrologic Engineering Center – River Analysis System, version 3.0.1, March 2001).

The following sections provide an overview of HEC-RAS, the analysis using the existing FIS models, summarizes the development and analysis results of the new HEC-RAS models of the unmapped tributary, and the results of the floodplain mapping.

6.2 HEC-RAS OVERVIEW

HEC-RAS is an integrated package of hydraulic analysis programs and a Graphical User Interface (GUI). The system is capable of performing steady flow water surface profile calculations (note: a recent release of HEC-RAS also includes provisions for unsteady flow analysis).

A HEC-RAS "Project" is a set of data files associated with a stream system. The data files for a typical project include plan data, geometric data, and flow data. Plan data defines the geometry and flow data that are to be used, a description and identifier for the model run, and other simulation options. Geometric data consist of stream cross-section data and hydraulic structure data (bridges, culverts, weirs, etc.). Channel and floodplain roughness coefficients (n-values), ineffective flow areas, and levees can also be specified in geometric data. Flow data includes the number of profiles to be calculated and the peak flow data for each stream reach and profile (i.e. 2-year, 10-year, 100-year).

HEC-RAS results can be viewed in both tabular and graphical form. Figure 6-1 illustrates several of the graphical user interface elements.

6.3 HEC-RAS MODEL DEVELOPMENT

6.3.1 Existing FIS Model – Conversion to HEC-RAS

The existing HEC-2 Flood Insurance Study models obtained from IDNR (Section 2.4.1 of Chapter 2) were converted to HEC-RAS models using the *import routine* provided with HEC-RAS. Importing a HEC-2 data set usually requires some modifications to the data, particularly at bridges and culverts, as the bridge routines in HEC-RAS are more detailed than HEC-2. The HEC-RAS model output was very close to the original HEC-2 flood elevations.

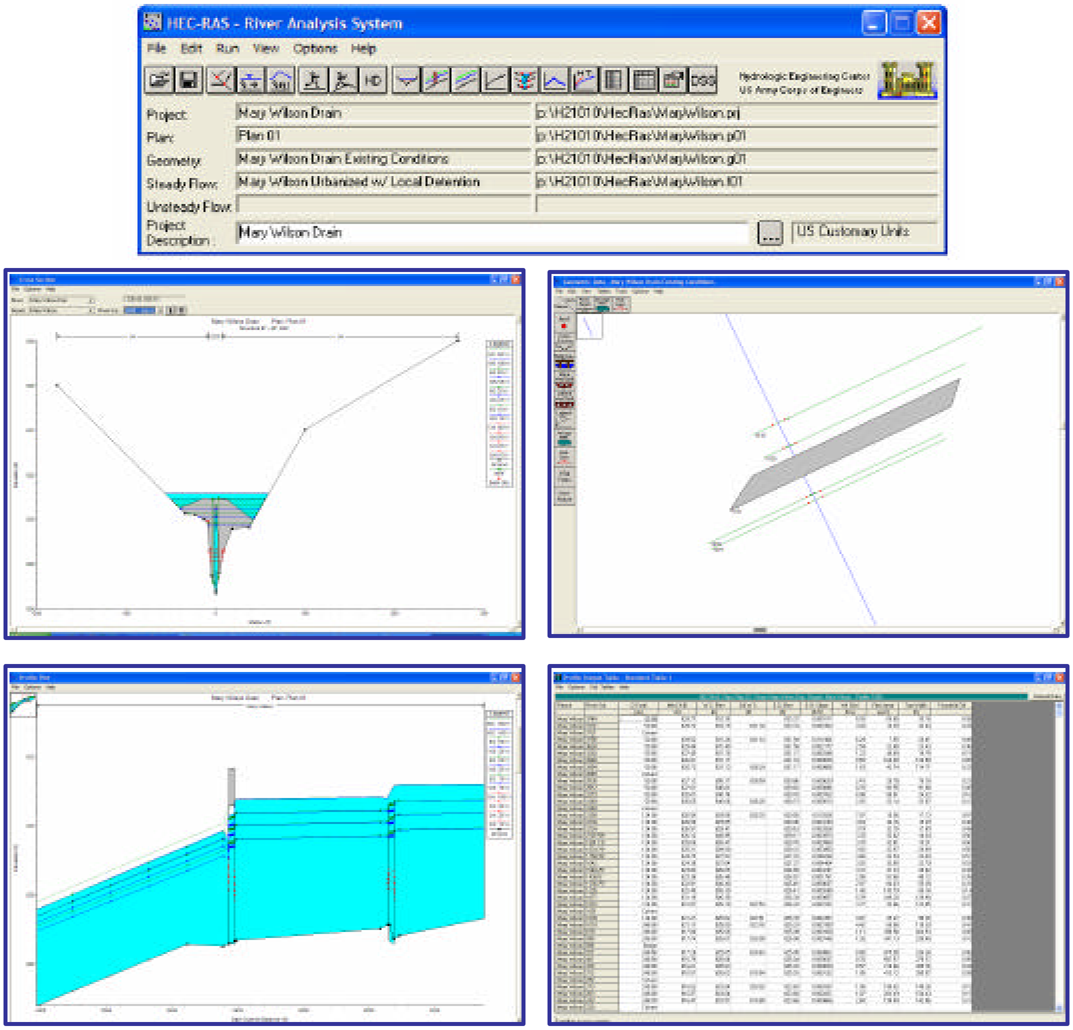


Figure 6-1
HEC-RAS Graphical User Interface

6.3.2 New HEC-RAS Models

New HEC-RAS models were developed for four minor tributaries that have not previously been analyzed:

- Mary Wilson Drain
- H.G. Kenyon Drain
- J.M. Thompson Drain
- Highway Run

Field surveying of the four unmapped tributaries was completed in April 2002. Surveys were based on benchmark information provided by the Hamilton County Surveyor's Office. Table 6-1 summarizes the number of cross-sections and hydraulic structures surveyed on each tributary.

Table 6-1
Hydraulic Survey Summary

Stream	Number of Cross-Sections	Number of Structures
Mary Wilson Drain	18	8
H.G. Kenyon Drain	28	9
J.M. Thompson Drain	12	3
Highway Run	21	10

A Hydraulic Survey Report was prepared and transmitted under separate cover to Hamilton County. The report includes cross-section and structure sketches, photographs of each structure, and field notes. Cross-sections were surveyed and sketched looking downstream. The cross-section sketches list the station offset (from the centerline of the channel) and corresponding elevation for each surveyed point on the cross-section. Structure sketches included station and elevation data along with measurements for culvert size or bridge waterway opening size, pier configuration and size, rail configuration and size, roadway elevation and width, wing wall size and configuration, and other information as applicable.

The above geometry data was input into the HEC-RAS model for each tributary. A copy of the HEC-RAS input and output is provided in Appendix F. Peak flows were computed from the HEC-HMS model (Chapter 5) and input into the HEC-RAS models at locations summarized in Table 6-2. The 3-hour duration storm produced the highest peak flows which were used as inputs to the HEC-RAS models.

Table 6-2
100-Year Flow Summary – New HEC-RAS Models

Stream	Distance Above Mouth (feet)	100-Year Flow (cfs)
Mary Wilson Drain	1010	392
	2350	196
	3740	80
H.G. Kenyon Drain	3307	484
	4654	300
	6864	200
	8172	104
J.M. Thompson	1403	488
	2207	350
	3221	200
Highway Run	1920	510
	2386	425
	2784	350
	4733	186

6.4 RESULTS

6.4.1 New HEC-RAS Model Results

Flood elevations for the four previously unmapped tributaries were computed using HEC-RAS. The resulting 100-year flood profiles for the Mary Wilson Drain, H.G. Kenyon Drain, J.M. Thompson Drain, and Highway Run are shown on Figures 6-2 through 6-5. The corresponding floodplain limits were also delineated on the Stream Inventory Maps (Section 3.7 of Chapter 3).

Mary Wilson Drain

The lower reaches of Mary Wilson Drain are impacted by backwater from Cool Creek. The backwater results in overtopping of 151st Street. There are six private drive culvert crossings upstream of 151st Street. Five of these drives are overtopped during the 100-year storm event. The floodplain is generally narrow and there are no buildings or structures in the floodplain.

H.G. Kenyon Drain

H.G. Kenyon drain has limited roadway overtopping problems. A private drive upstream of US 31 and two private drives downstream of Oak Ridge Road are overtopped during the 100-year storm event. The floodplain is generally narrow, but widens somewhat downstream of Oak Ridge Road where the channel is poorly defined. There may be a building in the floodplain between Oak Ridge Road and Montrose Lane.

J.M. Thompson Drain

The first stream crossing on the J.M. Thompson Drain (Jersey Street) is impacted by backwater from the Anna Kendall Drain. The other two stream crossings on this drain (Main Street and Catherine Drive) can safely pass the 100-year storm event. However, the Main Street culvert creates significant headwater, resulting in a wide upstream floodplain. Six structures along the lower end of J.M. Thompson Drain are flooded by the backwater from Anna Kendall Drain. Numerous structures upstream of Main Street are within the 100-year floodplain.

Highway Run

The US 31 culvert creates significant headwater during the 100-year storm. This headwater impacts the culverts in the vicinity of Walter Street and Walter Court. Five stream crossings of the Highway Run are overtopped during the 100-year event, four in the vicinity of Walter Street and Walter Court, including Thornberry Drive. Rohrer Drive is also overtopped during the 100-year event. There are numerous buildings in the 100-year floodplain, especially downstream of Walter Court.

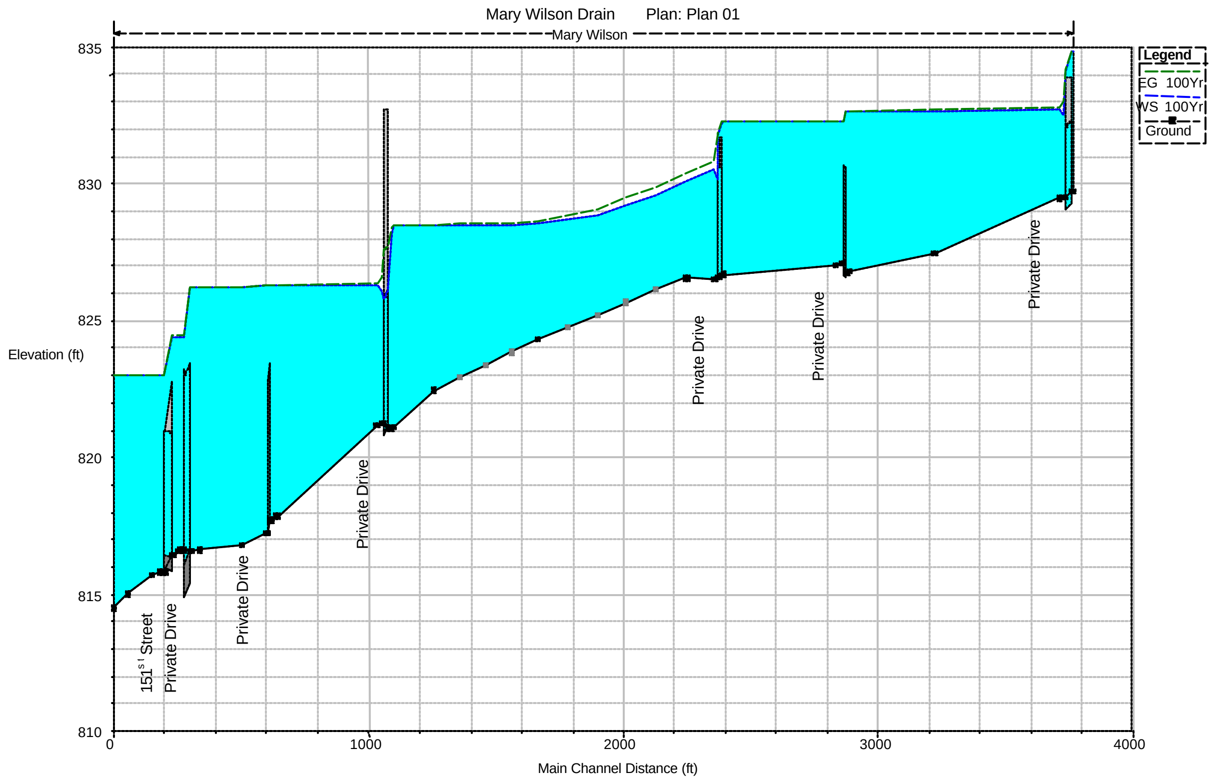


Figure 6-2
Mary Wilson Drain – 100-year Flood Profile

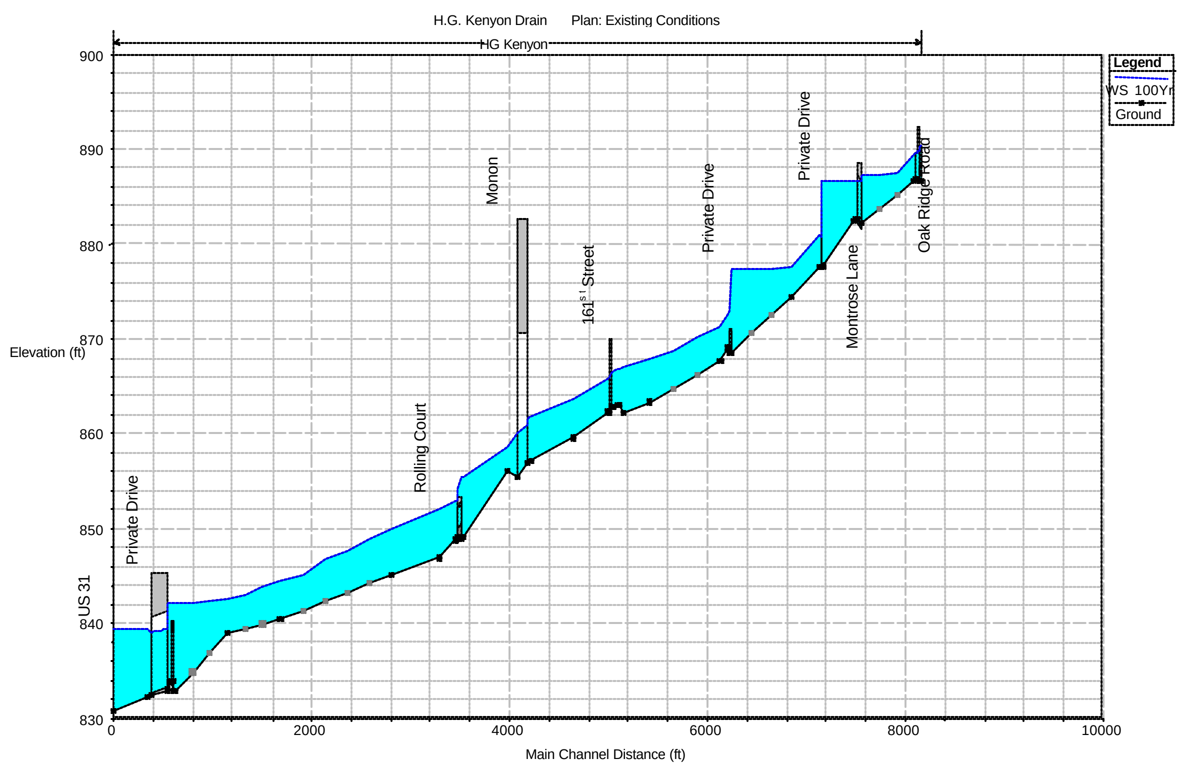


Figure 6-3
H.G. Kenyon Drain – 100-year Flood Profile

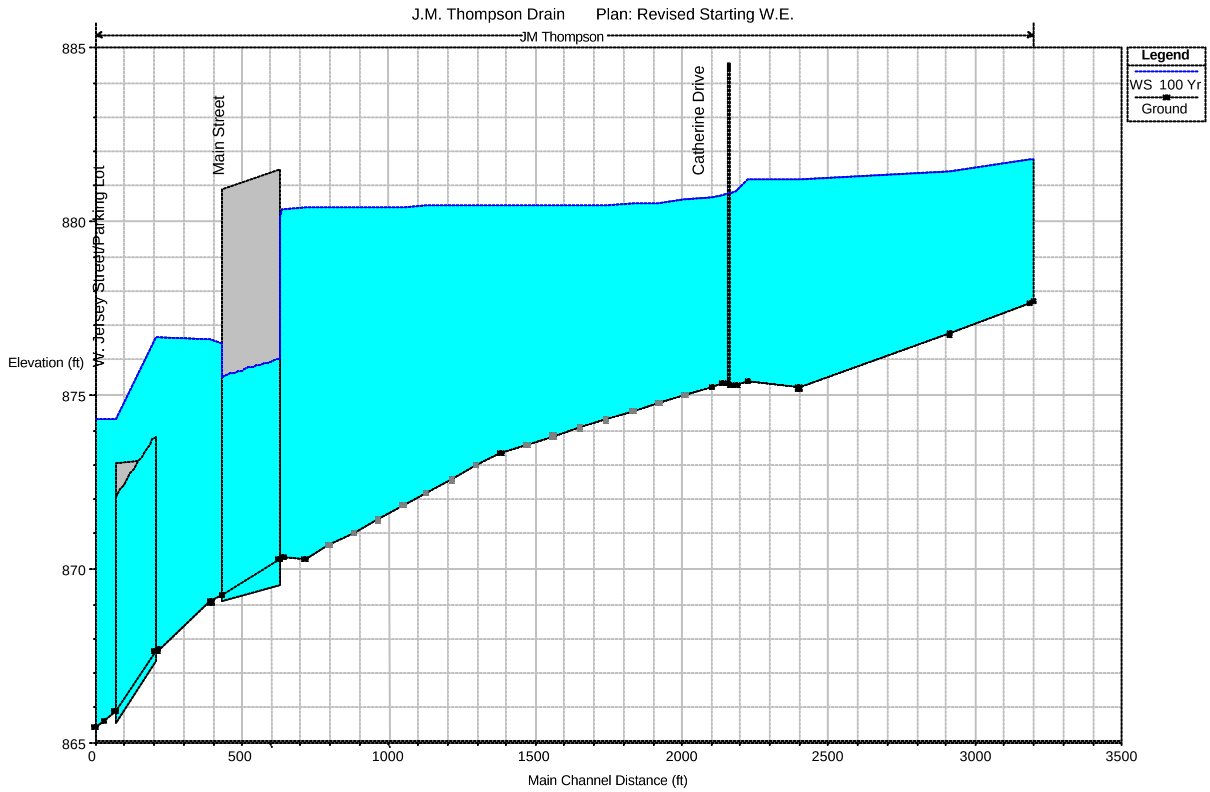


Figure 6-4
J.M. Thompson Drain – 100-year Flood Profile

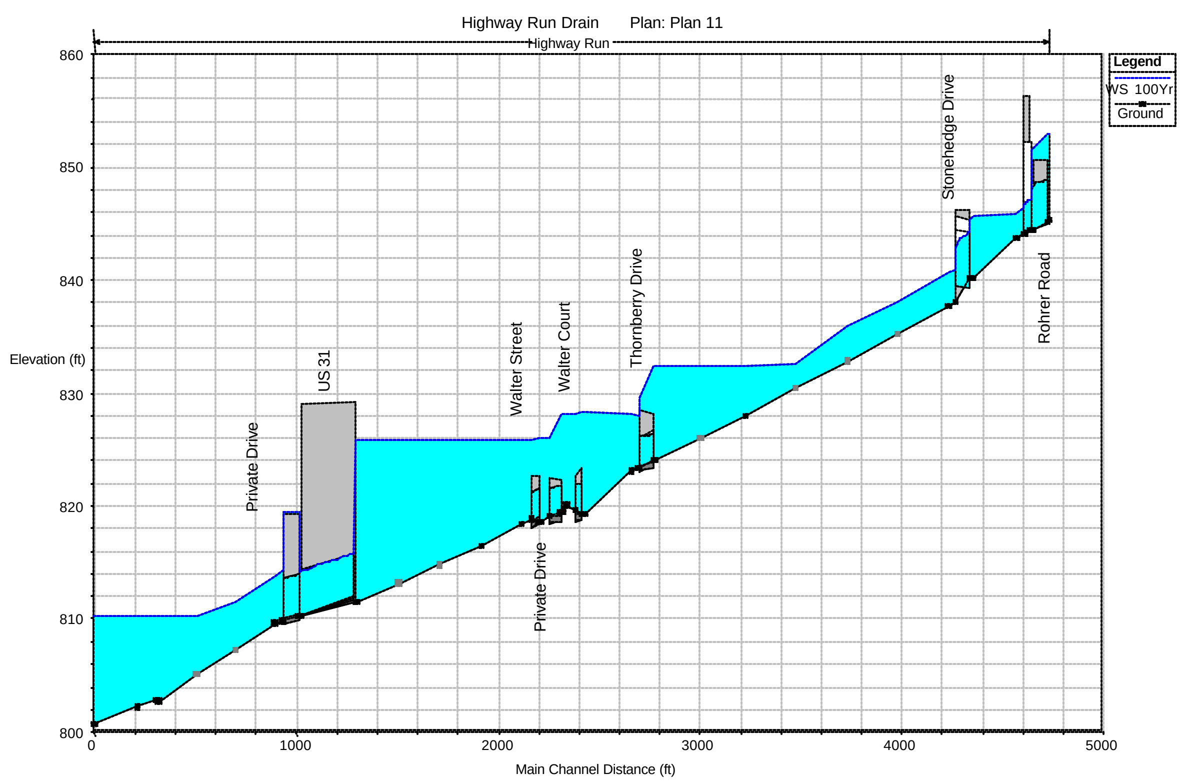


Figure 6-5
Highway Run Drain – 100-year Flood Profile

6.4.2 Existing FIS Model Results

The existing FIS HEC-RAS models (converted from HEC-2) provided model results nearly identical to the flood profiles contained in the Flood Insurance Study reports for Hamilton County, Westfield, and Carmel. The models predict the following roadway overtopping problems areas during the 100-year event.

Cool Creek

- E. 151st Street
- Oak Road
- S. Union Street/Westfield Boulevard
- Private Drive
- Oak Road
- 171st Street

Hot Lick Creek

- Carmel Drive

Anna Kendall Drain

- Four private drives
- Gurley Street
- Cherry Street
- Park Street
- Abandoned railroad embankment

The above results show that conveyance problems are much more pronounced in Westfield. Both Cool Creek and Anna Kendall Drain have several roadway crossings that would be overtopped during significant rainfall events.

A review of the Stream Inventory Maps shows some buildings in the 100-year floodplain of Cool Creek. Most are in the lower portion of the stream, downstream of 116th Street. There are approximately 12 building structures in the floodplain along Cool Creek downstream of Hazel Dell Parkway. This reach of Cool Creek is in the 100-year backwater area of the White River. Four buildings in the vicinity of 116th Street are in the floodplain. Other locations along Cool Creek with isolated buildings or structures in the floodplain are south of 136th Street, north of 151st Street, near 156th Street, and east of Grassy Branch Road. Anna Kendall Drain, along SR 32, has isolated buildings in the floodplain.

6.5 SUMMARY AND CONCLUSIONS

Hydraulic analyses were performed on Cool Creek and its major tributaries utilizing previously developed and new models developed during this project. The models were used to identify roadway overtopping and structures in floodplains. The models were also used to develop solutions to selected problem areas (Chapter 7). The hydraulic analyses lead to the following conclusions:

- The lower reaches of Cool Creek (in the City of Carmel) have limited flooding problems. No roadways are overtopped and limited structures are in the floodplain. Major upstream regional flood control facilities would provide limited benefit. Continued enforcement of the County's detention policy will effectively control 100-year discharges in the future.

- Stream related flooding is more pronounced in Westfield where several roadways along Cool Creek, Anna Kendall Drain, J.M. Thompson Drain and Highway Run are overtopped. Conveyance and/or storage solutions should be considered in these areas.

7.0 SOLUTION DEVELOPMENT

7.1 INTRODUCTION

7.1.1 Introduction to Solution Development

The solutions presented in this section were developed to address multiple needs within the Cool Creek watershed. These needs include:

- Flood control at major roadway crossings
- Neighborhood (local roadway) flood control
- Streambank erosion control
- Regional detention needs
- Land use and planning

Solutions were *not* considered for the following problems:

- Flooding at private crossings
- Flooding at bridges currently being replaced or under consideration for replacement in the near future
- Structures that meet currently-accepted stormwater design guidelines and do not negatively impact the 100-year floodplain

7.1.2 Upper Reaches versus Lower Reaches – Overview of Proposed Solutions

Upper Reaches:

Reduce peak flows during more frequent (i.e. 1-year and 2-year) rainfall events by constructing new and retrofitting existing detention basins. Although these detention facilities may not serve as flood control devices, they will serve as water quality enhancement features, providing the following benefits:

- Reducing sediment, nutrients, and metals in stormwater runoff
- Reducing flow rates resulting from more frequent storm events, thus reducing the erosive forces on downstream open channels
- Providing habitat for aquatic and non-aquatic species
- Reserving open space in the watershed for public access, recreation, and education

Provide adequate conveyance at major roadway crossings. Based on available hydraulic information, there are more severe conveyance problems in the upper reaches of Cool Creek and its immediate tributaries. Replacing inadequate bridges and culverts will help to enhance public safety by reducing the likelihood of roadway overtopping during major storm events and reduce floodplain impacts on property owners.

Lower Reaches:

Many downstream reaches of Cool Creek currently experience severe erosion problems. This is largely due to the following:

- ***Aggregate effects of development in the upstream portions of the Cool Creek watershed.*** Higher peak flows occur more frequently and subject channel streambanks to excessive erosive forces. Numerous detention ponds have been constructed in the watershed. These ponds provide effective peak flow control for larger storm events, but do not adequately restrict flow rates for more frequent (i.e. 1-year and 2-year recurrence interval) storm events. These more frequent rainfall events generally dictate the tendency for channel erosion.

- ***Development at or near existing channels.*** Manmade features, such as residential structures, retaining walls, patios, foot bridges, and decks have been constructed within the floodplain and result in flow restrictions, higher velocities, and promote downstream streambank erosion.

Construction near channel (right side of photo) constricts flood waters and promotes downstream erosion. Landscape debris (left side of photo) prevents the efficient flow of water and traps additional debris, creating a dam.

The proposed improvements to the Cool Creek watershed will be an important first step in reducing nuisance flooding, preventing flooding at major roadways, and reducing streambank erosion. Land use planning within the entire Cool Creek watershed should be implemented to minimize the impacts of development on stormwater pollution, erosion potential, and flooding potential. This will help to ensure a positive return on the capital investments recommended in this section (see discussion on recommended land use and planning policies in Section 7.8).

7.2 DESIGN CRITERIA AND CONSTRAINTS

7.2.1 Erosion Prevention

Channel erosion is a key factor in water quality degradation and presents numerous problems for stormwater infrastructure. The absence of vegetation along channel banks, when combined with high flow velocities, results in channel deepening, widening, and incision. This process is accelerated in areas of rapid land development, due to changing flow patterns, increased sediment from construction activities, and inadequate culverts and bridges. The long-term quality of Cool Creek will be improved by reducing steambank erosion. Erosion prevention can consist of the following methods:

- Streambank stabilization of severely eroded areas (Section 7.6)
- Hydrologic modification using regional detention (Section 7.7)
- Monitoring and long-term maintenance of moderately eroded areas
- Modifying the detention policy to better control and detain runoff from the 1-year and 2-year storms (Section 7.8)

Numerous erosion areas exist along the entire reach of the Cool Creek and its tributaries. The cost to repair each identified erosion area would be prohibitive. As such, it was necessary to classify each erosion area as minor, moderate, or severe. This classification allowed the separation of erosion areas posing the greatest threat to public safety and private property from those areas not needing immediate attention.

Severe erosion areas consisted of specific channel segments with evidence of any or all of the following:

- Deep, undercut channel banks
- Absence of vegetation along entire eroded bank
- Steep bank slope (exceeding 1:1 ratio and approaching vertical)
- Close proximity of manmade structures

Seven separate severe erosion sites have been identified in the Cool Creek watershed. Of these sites, five are along the Cool Creek. Two sites are located on tributaries. These sites are discussed in more detail in Section 7.6.

Minor and moderate erosion areas showed initial signs of channel undercutting and loss of vegetation. These areas have been identified on the Cool Creek Inventory Maps and should be monitored in the future for any negative physical changes.

HEC-RAS v. 3.0 was used to estimate peak flow velocities for seven (7) individual sites experiencing *severe erosion* (using HEC-2 data from the most recent Cool Creek Flood Insurance Study, supplemented with GIS contour data). As discussed in Section 7.6, the calculated velocities have been used to develop recommendations for streambank improvements for each identified area. Peak flow velocities resulting from the *10-year* recurrence interval storm were used to evaluate each erosion area and to determine appropriate erosion prevention measures.

7.2.2 Flood Control

Numerous flood-prone areas have been identified through past resident complaints, FEMA floodplain maps, and independent hydraulic analysis. Many of the flood-prone areas are caused by private driveway crossings and are located in remote, undeveloped portions of the watershed. Proposed flood control solutions have been prepared only for major public roadways and other public rights-of-way with significant known flooding problems.

Neighborhood Flooding. Typical municipal standards were employed for solution development in identified neighborhood flooding areas. Culverts, storm sewer pipes, and open channels were designed to convey the runoff generated from a 10-year recurrence interval rainfall event. In developing the proposed solutions for neighborhood flooding areas, it was assumed that access to private property could be secured through permanent and/or temporary construction easements.

The proposed solutions were developed using HEC-RAS and HY8 (HY8 is a culvert analysis program). GIS data were used to determine approximate site characteristics and identify potential construction limitations.

Roadway (Bridge) Overtopping. INDOT design standards were employed for bridges identified as flood-prone. The hydraulic capacities of 151st Street and 171st Street bridges (each at Cool Creek) and Cherry Street, Gurley Street, and Park Street (each at Anna Kendall Drain) were analyzed for both the 25-year and 100-year recurrence interval rainfall events. INDOT standards specify that a bridge with an Average Daily Traffic (ADT) count between 1,000 and 3,000 shall convey stormwater runoff generated from a 25-year recurrence interval rainfall event without roadway flooding. *The above crossings should fall within the referenced ADT range.* For a 100-year event, the upstream hydraulic grade line shall be less than or equal to 0.10 feet above that under existing conditions. The proposed modifications for the above crossings, with the exception of Gurley Street (ADT < 1,000), were based on these criteria.

HEC-RAS v. 3.0 was used to develop a hydraulic model for the existing and proposed bridge geometries. Existing bridge geometries and cross-sectional data for Cool Creek were based on the pending 2003 update of the Flood Insurance Study (HEC-2 model). Cross-sectional and roadway crossing geometries for the Anna Kendall Drain were based on approximations developed using the GIS contour and roadway elevation data.

Excessive Hydraulic Restrictions at Roadway Crossings. The US 31 crossing (Highway Run), the SR 32 (Main Street) crossing (J.M. Thompson Drain), and several culverts in the vicinity of Walter Street/Walter Court (Highway Run) create significant headwater, resulting in wide floodplains upstream of each location, affecting numerous residential structures. HEC-RAS was used to determine necessary culvert replacements that would lower the 100-year water surface elevations upstream of selected culverts along the Highway Run and J.M. Thompson Drain. Although these culverts do no overtop during the 100-year event, they result in significant upstream flooding. As such, their replacement is recommended.

7.3 COST ESTIMATING APPROACH

This section describes the basis for determining estimated costs for the proposed solutions. At the end of this section is a summary of the estimated costs for each proposed improvement. These cost estimates are based on typical construction bids for similar work and information available from governmental sources.

7.3.1 Streambank Restoration

Streambank restoration costs vary widely, largely due to the numerous materials and construction techniques currently available. The United States Environmental Protection Agency (USEPA) and the Natural Resource Conservation Service (NRCS) provide useful information on typical costs for streambank restoration work. Unit prices were based on guidance from these sources and available bid history on similar pay items. Estimated restoration costs were adjusted to account for specific site characteristics, such as channel depth, estimated flow velocities and site accessibility/mobilization.

7.3.2 Storm Sewers and Appurtenances

Storm sewer estimates were based on bid tabulations for similar construction work. Adjustments were made for specific site characteristics and site accessibility.

7.3.3 Pavement Re-grading and Bridge/Culvert Removal and Replacement

Pavement re-grading and bridge removal/replacement costs were based on bid tabulations for similar construction work. Cost estimates for bridge/culvert replacement include additional costs for soil testing, structural analysis, excavation, pavement restoration, riprap, boring/jacking (if necessary) and general site restoration.

7.3.4 Detention Facilities

Detention pond construction cost estimates were based on published ranges available from the USEPA and other sources.

The estimated cost to retrofit the detention basin upstream of the Conrail Railroad (Anna Kendall Drain) was modified to reflect additional costs required to satisfy the Indiana DNR *General Guidelines for New Dams and Improvements to Existing Dams in Indiana*.

The detention pond cost estimates do *not* include land acquisition costs, unless specifically noted.

7.3.5 Construction Contingency

A construction contingency of twenty (20) percent was added to each construction estimate to account for unforeseeable site specific items that cannot be identified at the conceptual design level.

7.3.6 Non-Construction Costs

Each proposed improvement will require field survey, detailed site condition analysis, design report preparation, regulatory permitting, plan and specification preparation, and construction administration. Legal and administrative costs are also typically included on proposed improvement projects. For each proposed solution, it was estimated that an additional twenty (20) percent would be required for these non-construction costs. Land acquisition costs were assumed to be $15,000 per acre, unless the land was generally not conducive to development, in which case it was assumed to be $5,000 per acre.

Table 7-1 contains a summary of cost estimates for the proposed improvements in the Cool Creek watershed. Detailed costs estimates can be found in Appendix G. Additional discussion on the proposed improvements follows in Sections 7.4 through 7.7 of this chapter.

Table 7-1
Proposed Improvements Cost Summary

Project Description	***Total Project Cost***
151st Street Roadway Modification	$10,000
171st Street Roadway Modification/Bridge Replacement	$700,000
Gurley Street Bridge Replacement	$280,000
Cherry Street Bridge Replacement	$340,000
Carmel Drive (Hot Lick Creek)	$90,000
Swimming Pool Inundation (Hot Lick Creek)	$10,000
Private Drive Culvert Replacement @ US 31 (Highway Run)	$100,000
US 31 Culvert Replacement (Highway Run)	$700,000
Walter St., Private Drive, Walter Ct. Culvert Replacements (Highway Run)	$200,000
Thornberry Drive Culvert Replacement (Highway Run)	$80,000
SR 32 (Main Street) Culvert Replacement (J.M. Thompson Drain)	$310,000
Streambank Erosion D/S of Stonehedge Drive (Highway Run)	$5,000
Streambank Erosion D/S of Rolling Court (H.G. Kenyon)	$15,000
Streambank Erosion U/S of Confluence with White River	$300,000
Streambank Erosion D/S of Gray Road	$75,000
Streambank Erosion Near Hot Lick Creek Confluence	$125,000
Streambank Erosion U/S of 131st Street	$20,000
Streambank Erosion U/S of Keystone Avenue	$30,000
171st Street Regional Stormwater Detention Pond	$2,600,000
Grassy Branch Road Regional Stormwater Detention Pond	$1,800,000
Anna Kendall In-Line Detention Pond Retrofit	$700,000
TOTAL	**$8,490,000**

7.4 STREAM FLOODING/ROADWAY OVERTOPPING SOLUTIONS

The HEC-RAS backwater analysis confirmed that several roadway crossings within the Cool Creek watershed are either: 1) not adequate to meet current INDOT hydraulic requirements; or 2) creating significant headwater during the 100-year storm, resulting in the flooding of residential structures. These crossings are:

- 151st Street (Cool Creek)
- 171st Street (Cool Creek)
- Cherry Street (Anna Kendall)
- Gurley Street (Anna Kendall)
- W. Jersey (J.M. Thompson)
- SR 32 (Main Street) (J.M. Thompson)
- US 31 and Adjacent Private Crossing (Highway Run)
- Walter Street, Walter Court, and Adjacent Private Crossing (Highway Run)
- Thornberry Drive (Highway Run)

The proposed solutions for each crossing are discussed in detail as follows:

7.4.1 E. 151st Street (Cool Creek)

Under existing conditions, 151st Street would be flooded during significant storm events. As the roadway elevation is low relative to the channel elevation, overtopping occurs during storm events less than the 25-year recurrence interval magnitude. As such, the crossing does not meet current INDOT hydraulic standards.

151st Street Bridge (Cool Creek)

The proposed solution consists of approximately 160 LF of roadway elevation modification. Increasing the roadway to a minimum elevation of 823.50 will provide flooding protection up to the 25-year recurrence interval rainfall event, per INDOT requirements. Figure 7-1 illustrates the proposed extents of the roadway modification **(note: figures are grouped together at the end of this chapter)**. The total estimated project cost for this solution is $10,000.

7.4.2 171st Street (Cool Creek)

Under existing conditions, 171st Street would be flooded during significant storm events. Similar to 151st Street, the roadway elevation is low relative to the channel elevation. However, the bridge opening is small at 171st street, adding to the hydraulic restriction. Overtopping occurs during storm events less than the 25-year recurrence interval magnitude. As such, the crossing does not meet current INDOT hydraulic standards.

171st Street Bridge (Cool Creek)

The proposed solution consists of approximately 320 LF of roadway elevation modification and the removal and replacement of the existing bridge. Bridge replacement is necessary to prevent excessive headwaters resulting from a 100-year storm. Replacing the bridge and raising the roadway elevation will provide flooding protection up to the 25-year recurrence interval rainfall event, per INDOT requirements. Figure 7-2 illustrates the proposed improvements. The total estimated project cost for this solution is $700,000.

7.4.3 Gurley Street (Anna Kendall Drain)

Gurley Street is a minor dead-end public roadway with an average roadway width of 11 feet. The existing bridge consists of wooden abutments, 45-degree wooden wingwalls, steel deck supports and a wooden deck. The bridge is in fair to poor structural condition. Under existing conditions, the Gurley Street crossing would be overtopped during the 50-year and 100-year storm events. The overtopping occurs approximately 75 feet north of the bridge at a vertical sag in the roadway. Our independent calculations indicate that this bridge would also be overtopped during the 25-year storm event. However, as this roadway is minor it likely has an ADT well below 1,000. As such, INDOT standards would specify a 10-year storm be used as the criteria for maximum flow before roadway overtopping.

Given the structural condition of the existing bridge, it is recommended that it be replaced. The proposed solution consists of a new single-span concrete bridge. The new bridge will replace the failing wooden structure and provide additional hydraulic capacity. The proposed bridge, as depicted in Figure 7-3, would provide adequate conveyance for the 10-year storm without roadway overtopping. The total estimated project cost for this solution is $280,000.

Gurley Street (Anna Kendall)

7.4.4 Cherry Street (Anna Kendall Drain)

Cherry Street is a 2-lane local roadway with a rectangular concrete bridge opening. The bridge opening area at Cherry Street is smaller than nearby bridges, including Gurley, Union, and Park Streets. Under existing conditions, the Cherry Street crossing would be overtopped during the 50-year and 100-year storm events. This crossing creates a significant hydraulic restriction in the Anna Kendall Drain, raising the 100-year water surface elevation by approximately three (3) feet. Replacing this bridge would provide significant improvements to the upstream floodplain and would help to lower the 100-year floodplain elevation in the downstream reach of the J.M. Thompson Drain.

Cherry Street (Anna Kendall Drain)

The proposed solution consists of a new single-span concrete bridge. The new bridge will replace the current small opening area and will provide adequate hydraulic capacity at the crossing. The proposed bridge, as depicted in Figure 7-4, would provide adequate conveyance for the 25-year storm without roadway overtopping. Furthermore, the hydraulic grade line would be lowered significantly through this reach of drain, helping to alleviate flooding problems upstream of Cherry Street. The total estimated project cost for this solution is $340,000.

7.4.5 W. Jersey Street and SR 32 (Main Street) (J.M. Thompson Drain)

This crossing is impacted by the backwater effects caused by the Anna Kendall Drain, immediately downstream of W. Jersey Street. The proposed improvements to the Cherry Street will help to lower the 100-year floodplain approximately 0.6 feet near the mouth of the J.M. Thompson Drain. However, this is a low-lying area and would nonetheless be subject to flooding during a 100-year recurrence interval rainfall event.

W. Jersey Street Culvert (J.M. Thompson Drain)

Upstream of Main St. (J.M. Thompson Drain)

Replacing the culvert at W. Jersey Street would not have a significant hydraulic impact, given the high tailwater created by the Anna Kendall Drain. As such, it is recommended that no improvements be made at this location.

The Main Street (SR 32) crossing, immediately upstream (north) of W. Jersey Street, creates a significant hydraulic restriction during the 100-year storm, causing flooding in upstream residential areas. In order to reduce flooding potential upstream of SR 32, it will be necessary to replace the existing CMP arch culvert at Main Street with a 12’ x 8’ box culvert, as illustrated in Figure 7-5. The total estimated construction cost to replace this culvert is $310,000.

7.4.6 US 31 and Adjacent Private Drive (Highway Run)

The US 31 crossing, in the lower reaches of the Highway Run, creates a severe hydraulic restriction. Furthermore, the private drive immediately downstream of US 31 creates an additional hydraulic restriction. The resulting headwaters impact the Walter Street/Walter Court neighborhood, causing widespread flooding during a 100-year storm. As such, it will be necessary to replace both culverts in order to lower the 100-year floodplain to a reasonable level.

US 31 Culvert (Highway Run)

The proposed culvert replacements, as depicted in Figure 7-6, will consist of replacing the twin 5' x 4' box culverts (private crossing) with a 10' x 6' box culvert and adding a 60" RCP culvert next to the existing box culverts under US 31. It was assumed that boring and jacking would be necessary at US 31, given the depth of the culvert and traffic volumes. The culvert replacements will help to relieve flooding potential upstream and will reduce flow velocities downstream of US 31. The total estimated construction cost to replace both culverts is $800,000.

7.4.7 Walter Street, Private Drive, and Walter Court (Highway Run)

Three adjacent stream crossings, beginning at the Walter Drive (downstream) crossing and ending at the Walter Court (upstream) crossing, are overtopped during the 10-year storm. The existing crossings, each consisting of triple CMP arch culverts, are partially filled with sediment and do not provide adequate flow conveyance. Replacing each crossing with a single 12' x 4' box culvert, in conjunction with minor channel reshaping, would provide adequate conveyance for the 10-year storm without roadway overtopping. The proposed impr ovements are illustrated in Figure 7-7. The total estimated construction cost to replace both culverts is $200,000.

Private Drive along Walter Street (Highway Run)

Walter Street (Highway Run)

7.4.8 Thornberry Drive (Highway Run)

The Thornberry Drive culvert does not adequately convey the 10-year recurrence interval rainfall event. This is partially due to the hydraulic restriction created by the Walter Street/Court culverts (described above in Section 7.4.7). Replacing the three culverts as described in Section 7.4.7 and replacing the existing Thornberry Drive culverts with a 11' x 3.5' box culvert (see Figure 7-8) will provide adequate conveyance for the 10-year storm. The total estimated construction cost to replace the Thornberry Drive crossing is $80,000.

Thornberry Drive (Highway Run)

7.5 NEIGHBORHOOD PROBLEM SOLUTIONS

7.5.1 Carmel Drive Overtopping (Hot Lick Creek)

The existing twin 48-inch concrete pipes do not provide adequate conveyance for a 10-year recurrence interval rainfall event. Nearby residential structures would be vulnerable to flood waters resulting from roadway overtopping. As such, it will be necessary to replace the existing culverts such that a 10-year storm flow can be adequately conveyed without roadway overtopping.

Carmel Drive (Hot Lick Creek)

The proposed solution consists of 120 lineal feet of a 4-foot rise by 10-foot span reinforced concrete box culvert with 45-degree wingwalls at each end. This improvement will reduce the 10-year peak water surface elevation at Carmel Street by approximately 0.6 feet, approximately 0.4 feet below the roadway elevation. Peak 10-year flow velocities at the downstream end of the Carmel Drive culvert will be reduced from 9.3 feet per second (fps) to just over 5 fps.

It is also recommended to re-grade approximately 120 lineal feet of the open channel upstream of the Carmel Drive culvert so as to provide additional flow capacity and better erosion protection. This is necessary to curb channel erosion that is beginning to occur in this area. Figure 7-9 illustrates the proposed culvert replacement and channel improvement. The total estimated project cost for this solution is $90,000.

7.5.2 Swimming Pool Inundation (Hot Lick Creek)

The Hot Lick Creek meanders within close proximity to an existing swimming pool in the vicinity of 126th Street and Fairbanks Drive. The channel is currently eroding along a wooden fence located near the swimming pool. However, this erosion is *not* related to the flooding susceptibility of the swimming pool located on this parcel.

It is recommended that approximately 105 lineal feet of the channel be relocated, as shown in Figure 7-10, to direct flow away from the existing residential property. Although this will help to prevent erosion along the existing fence, it will *not* affect the hydraulic capacity of the channel and will *not* prevent occasional flooding of the swimming pool area. Any channel relocation should be performed with careful consideration of existing conditions. The existing slope, cross section, and depth of the relocated channel should match those characteristics of the existing channel. The relocated channel should be immediately restored with vegetation and proper erosion control measures. The total estimated project cost for this solution is $10,000.

The floodplain elevation through this reach of channel can only be manipulated by *extensive* channel improvements. Such improvements would be cost-prohibitive and would provide little other substantial benefits. Therefore, only the channel relocation is recommended.

7.6 STREAMBANK EROSION SOLUTIONS

Seven streambank erosion sites were selected for improvements, based on the criteria described in Section 7.2.1. The proposed improvement sites are described as follows:

- Highway Run — Downstream of Stonehedge Drive
- H.G. Kenyon Drain — Downstream of Rolling Court
- Cool Creek — Upstream of confluence with the White River
- Cool Creek — Downstream of Gray Road (at bend)
- Cool Creek — Upstream and downstream of Hot Lick Creek
- Cool Creek — Upstream of 131st Street (Main Street)
- Cool Creek — Upstream of Keystone Avenue

Proposed solutions range from minor regrading and seeding (for areas experiencing moderate flow velocities) to more intensive improvements such as riprap, geotextile fabric, woody plantings, vegetated geogrids, etc. for areas experiencing high flow velocities or containing steep channel sideslopes. Whenever possible, streambank stabilization should employ vegetative measures, so as to maintain the natural state of the channel corridor and to enhance instream water quality. In some instances of severe erosion, a more structural solution such as gabion baskets or revetment may be a more appropriate solution.

For all of the following improvement recommendations, the descriptions "left bank" and "right bank" reference the channel when looking *downstream*.

The proposed solutions described in this section are preliminary only. Upon choosing specific streambank restoration sites, detailed information will need to be collected and each site will need to be analyzed separately. Detailed information needed for a final design would be as follows:

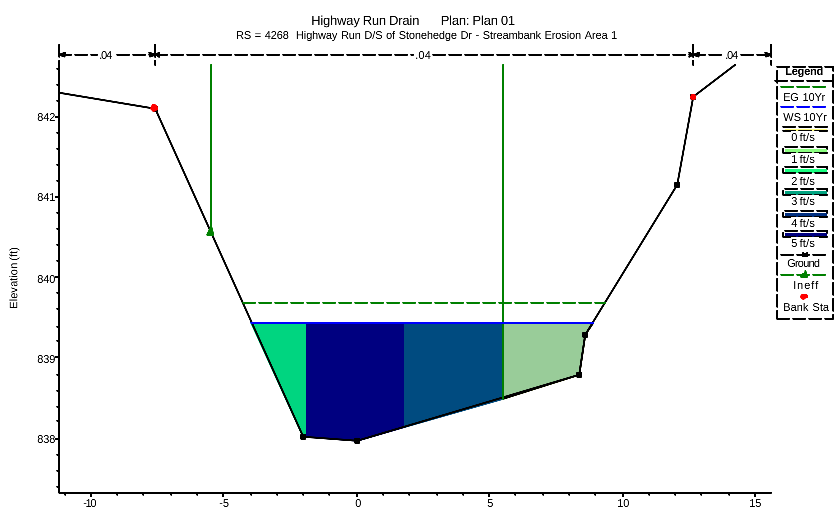
- Channel cross sections at each restoration site, including location of private features, property corners, and nearby utilities.
- Hydraulic analysis for each restoration site, including velocity calculations and shear stress calculations for more frequent (i.e. 1-year, 2-year) recurrence interval rainfall events.
- Soil analysis for each restoration site.
- Determination of land availability (i.e. easements, right-of-way, and land acquisition) for proposed grading.
- Determination of construction access points.
- Public input on proposed improvements (most important when improvements are immediately adjacent to existing homes)

The proposed solutions for each identified erosion area are discussed in detail as follows:

7.6.1 Highway Run: downstream of Stonehedge Drive

Significant streambank erosion is occurring approximately 100 lineal feet downstream of the Stonehedge Drive culvert (see Figure 7-11). Although this erosion area is isolated, it is severe. A utility pole adjacent to the channel is in danger of collapse.

Flow velocities are moderate in this area. The 10-year peak flow velocity, approximately 5 feet per second (fps), will require some vegetation reinforcement but should not require any more intensive improvements. The 10-year flow velocity distribution at this location is illustrated below.



Velocity Distribution: Highway Run downstream of Stonehedge

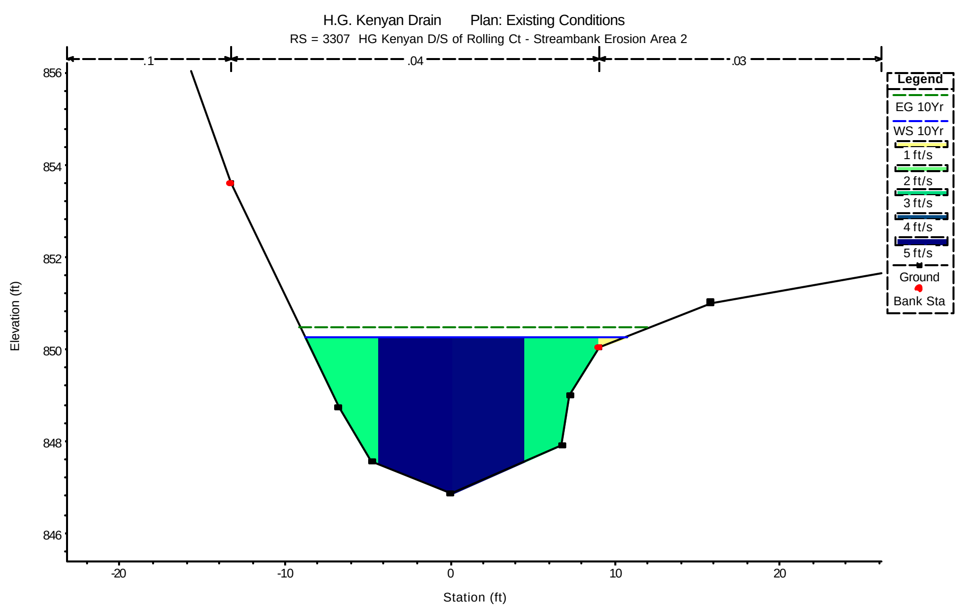
It is recommended that approximately 100 lineal feet of the Highway Run streambank be re-graded to a slope not to exceed 3:1 (horizontal:vertical). This will provide a flatter sideslope and will help to reduce flow veloc ities. The modified streambank should be reinforced with an erosion matting and grass seed specifically designed for open channels (often referred to as "ditch mix").

Some grading may be required on both sides of the channel in order to accommodate the existing utility pole. Streambank reinforcement should be implemented a minimum of *2 vertical feet* from the channel bottom.

7.6.2 H.G. Kenyon Drain: downstream of Rolling Court

Streambank erosion is occurring downstream of the Rolling Court culvert (see Figure 7-12). This erosion continues around a 90-degree bend in the channel for a total length of approximately 250 lineal feet. Although the majority of the identified erosion is occurring on the right channel bank, there is a steep bank on the left side of the channel that will be vulnerable to considerable erosion if left unchecked.

Flow velocities are moderate in this area. The 10-year peak flow velocity of approximately 5 feet per second (fps), will require some vegetation reinforcement but should not require any intensive improvements. The 10-year flow velocity distribution at this location is illustrated below.



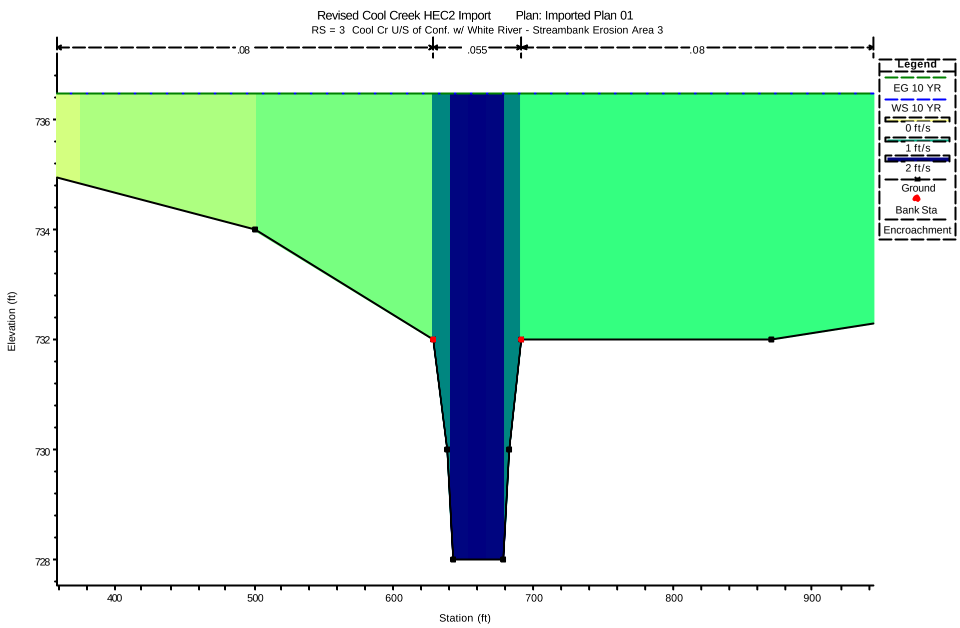
Velocity Distribution: H.G. Kenyon Drain downstream of Rolling Ct.

It is recommended that 250 lineal feet of the Highway Run streambank (right side only) be graded to a slope not exceeding 3:1 (horizontal:vertical) and reinforced with vegetative protection. This will protect the soils and increase the friction coefficient along the streambank, thus helping to reduce flow velocities. The modified streambank should be reinforced with an erosion matting and grass seed specifically designed for open channels (often referred to as "ditch mix"). The proposed improvements for this area are similar to those described in Section 7.6.1. Streambank reinforcement should be implemented a minimum of *3 vertical feet* from the channel bottom.

7.6.3 Cool Creek: upstream of confluence with the White River

Streambank erosion is occurring in the downstream reaches of the Cool Creek, immediately upstream of its confluence with the White River (see Figure 7-13). This erosion occurs over an approximate length of 1500 lineal feet. The erosion in this area is severe, with incised streambanks (near vertical sideslopes) and undercut channels.

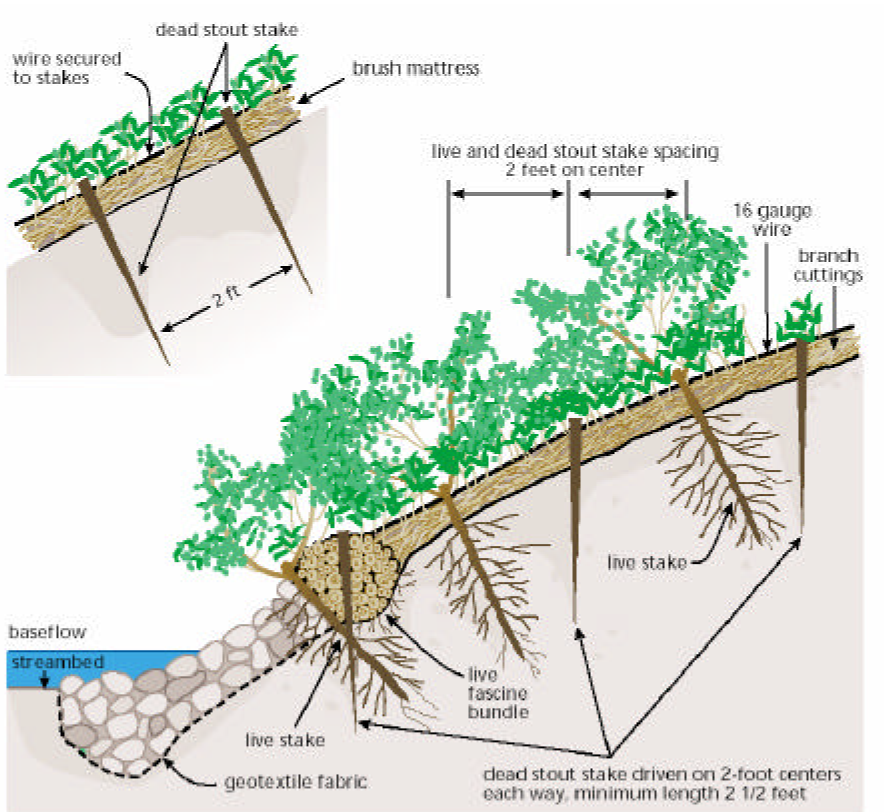
Although the 10-year peak flow velocity is low in this reach, approximately 2 fps, it is likely that more frequent storm events (i.e. 1-year and 2-year recurrence interval) have a significant impact on the channel, as the White River backwater would likely have a smaller impact on the Cool Creek and velocities would be higher. The 10-year flow velocity distribution at this location is illustrated below.



Velocity Distribution: Cool Creek upstream of the White River

Protecting this reach of the Cool Creek is critical, as any erosion in this area would be immediately transported to the White River. Erosion prevention measures at this location should be designed to withstand frequent erosive forces.

It is recommended that 1500 lineal feet of the Cool Creek streambank be re-graded to a slope not exceeding 2:1 (horizontal:vertical) and reinforced using a *brushmattress technique* as illustrated on the following page. This will help to stabilize the streambank from the channel bed to the top of bank with a combination of dense vegetation, geotextile fabric, and riprap. Streambank reinforcement should be implemented a minimum of *4 vertical feet* from the channel bottom. Gabion basket stabilization would also be a viable option at this location.



Brushmattress Technique (Source: USDA-NRCS 1996)

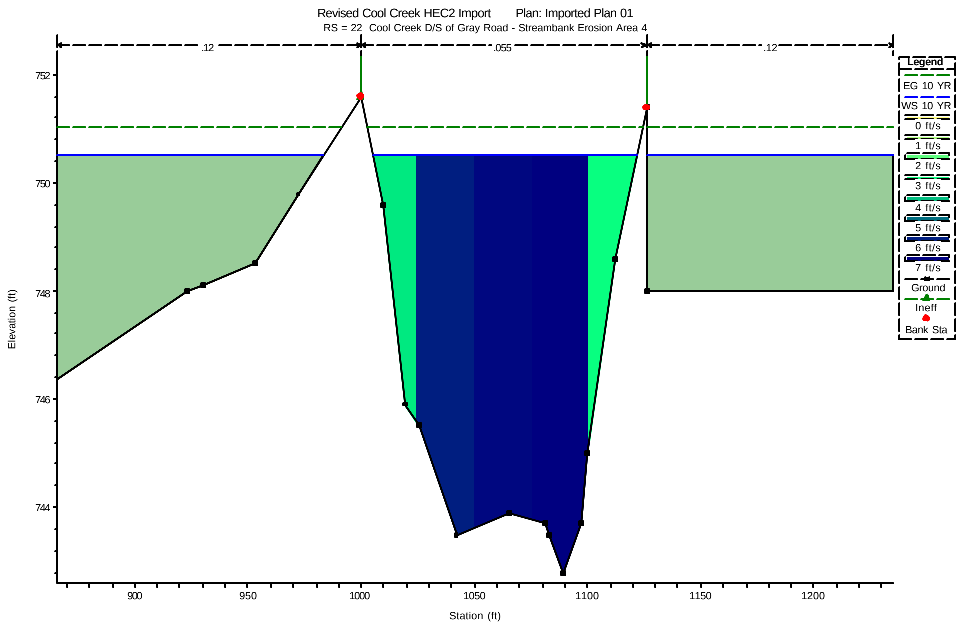
7.6.4 Cool Creek: downstream of Gray Road (at bend)

Streambank erosion is occurring in the Cool Creek downstream of Gray Road (see Figure 7-14). This erosion continues around a sharp bend in the channel for a total length of approximately 200 lineal feet. The streambank along the outside edge of the channel bend is subject to severe erosion. The 10-year peak flow velocities at this location are very high, exceeding 7 fps at the center of the channel. Flow velocities in this range will cause significant erosion in unprotected areas. The 10-year flow velocity distribution at this location is illustrated on the following page.

Protecting this reach of the Cool Creek will require significant protection along the lower portion of the main channel to combat the high flow velocities.

It is recommended that 200 lineal feet of the Cool Creek streambank be reinforced using a *vegetated geogrid* as shown in the illustrations and photographs on the following pages. This will help to stabilize the streambank from the channel bed to the top of bank with a combination of dense vegetation, geotextile fabric, and boulders.

Riprap toe protection should be installed along the toe of streambank to provide additional protection against streambank incision. The riprap toe protection should be provided using brushmattress technique previously discussed. Streambank reinforcement should be implemented a minimum of *6 vertical feet* from the channel bottom.

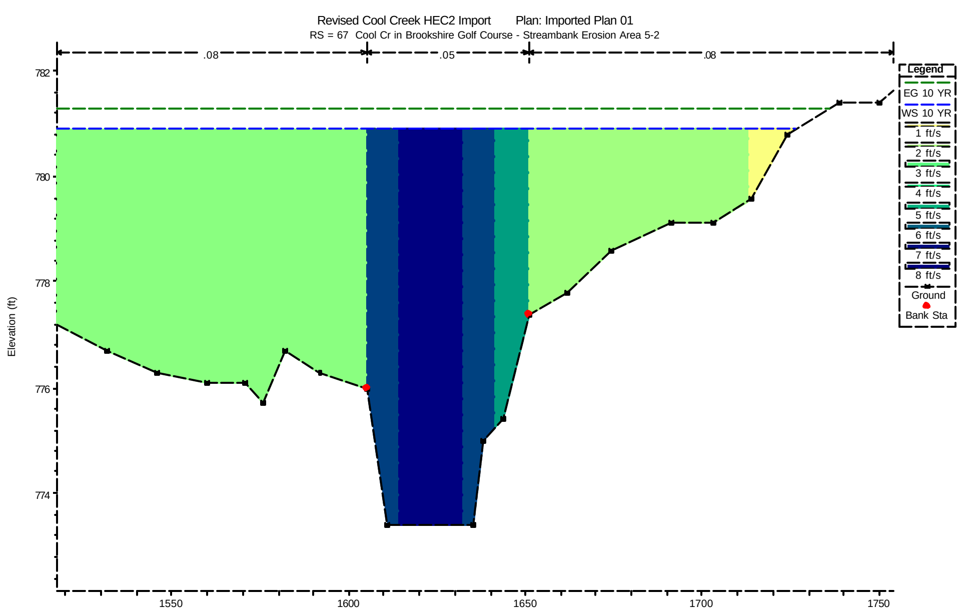


Velocity Distribution: Cool Creek downstream of Gray Road

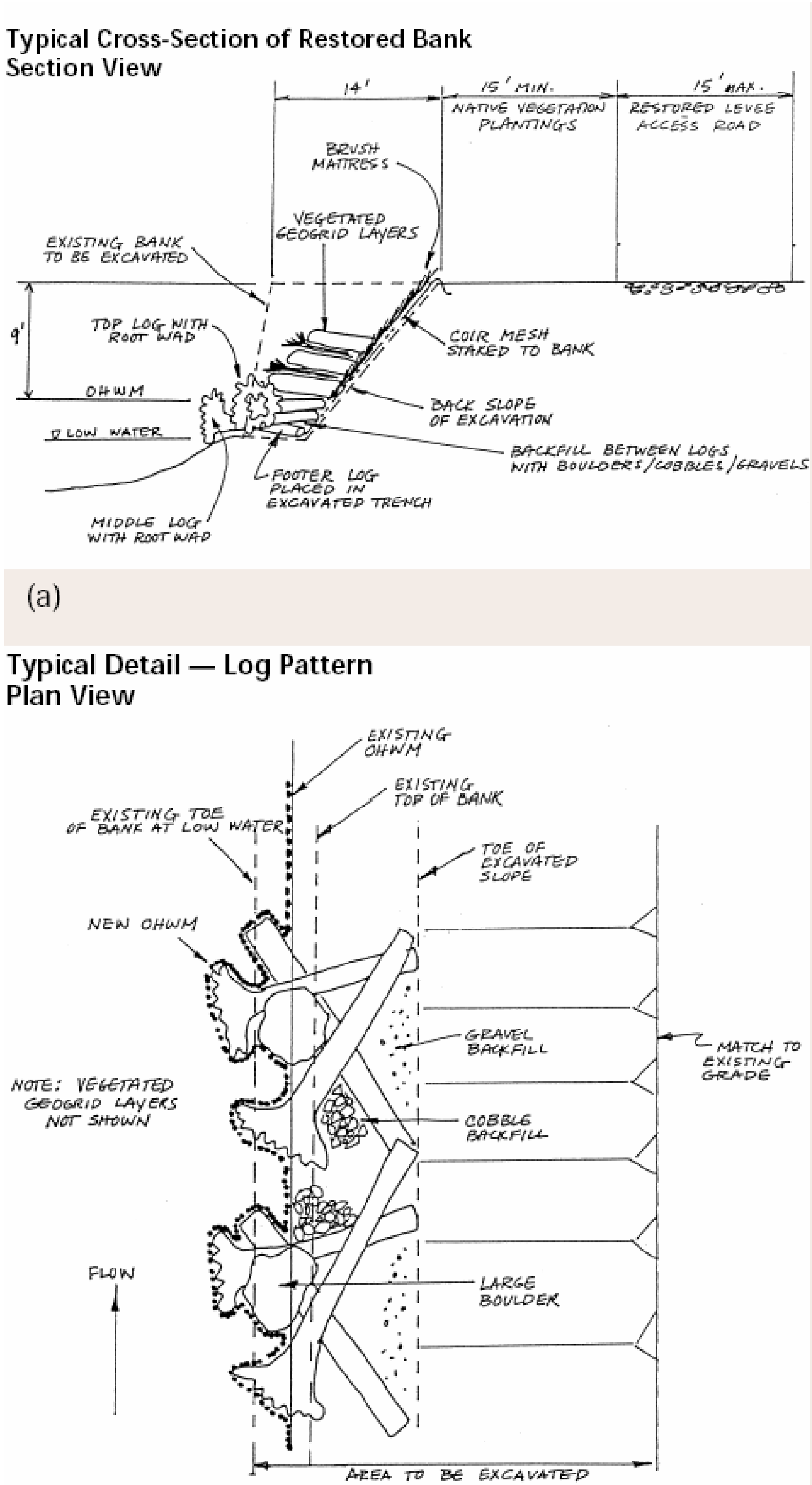
7.6.5 Cool Creek: upstream and downstream of Hot Lick Creek

Streambank erosion is occurring in the Cool Creek in the vicinity of the Hot Lick Creek, through the Brookshire Golf Course (see Figure 7-15). This erosion is severe and will likely continue to worsen unless preventative measures are taken.

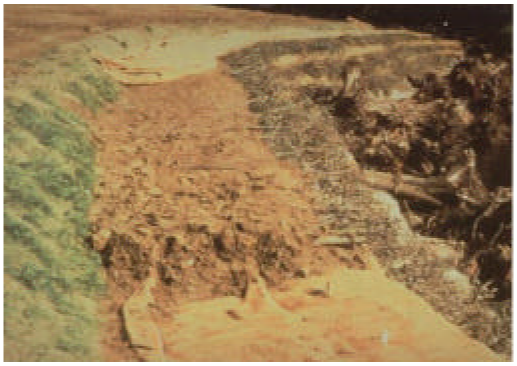
The 10-year peak flow velocities at this location are very high, exceeding 8 fps at the center of the channel. Flow velocities in this range will cause significant erosion in unprotected areas. The 10-year flow velocity distribution at this location is illustrated below.



Velocity Distribution: Cool Creek in vicinity of Hot Lick Creek



Vegetated Geogrid (Source: King County Surface Water Management Division)

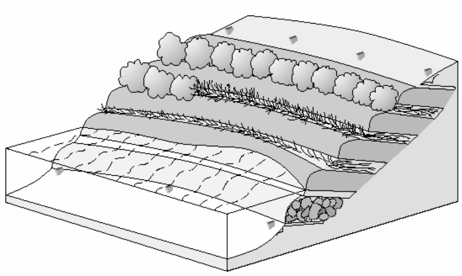


Geogrid Installation

Geogrid Post-Installation

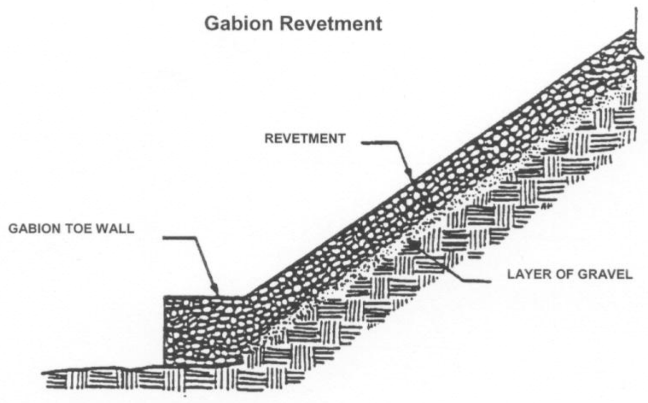
Geogrid after Complete Establishment of Vegetation

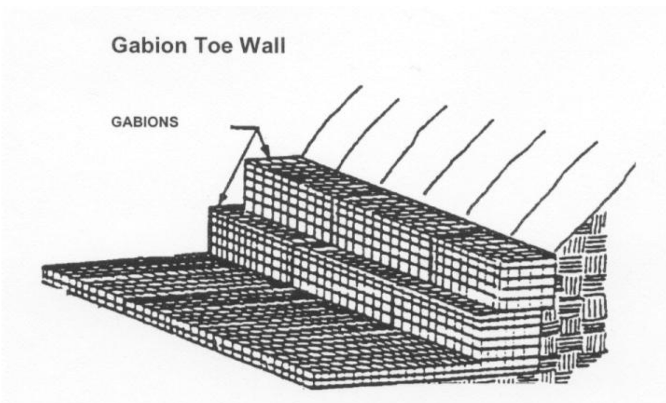
Vegetated Geogrids



Alternating layers of live branch cuttings and compacted soil with natural or synthetic geotextile materials wrapped around each soil lift to rebuild and vegetate eroded streambanks.

Vegetated Geogrids can also consist of branch cuttings and live stakes, as opposed to large diameter tree trunks, as depicted in the photos above. (Source: Federal Interagency Stream Restoration Working Group, 1998)





Source: Chattanooga Public Works Department

Example of Gabion channel bank stabilization on Cool Creek near Underwood Court in City of Carmel

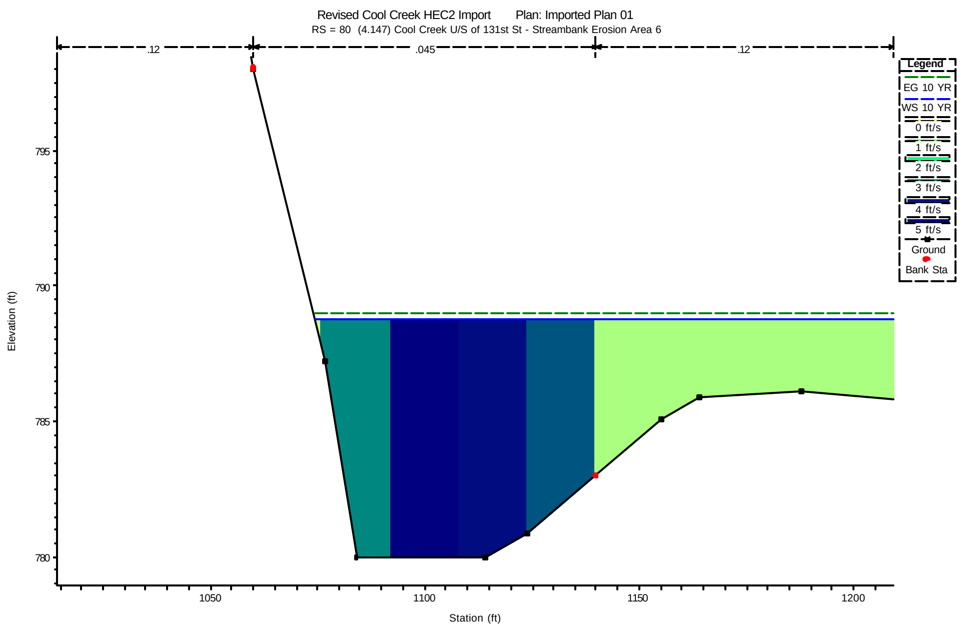
Protecting this reach of the Cool Creek will require significant protection along the lower portion of the main channel to combat the high flow velocities.

It is recommended that a total of 575 lineal feet of the Cool Creek streambank be reinforced using the *brushmattress technique* as described in Section 7.6.3. Streambank reinforcement should be implemented a minimum of *3 vertical feet* from the channel bottom.

7.6.6 Cool Creek: upstream of 131st Street (Main Street)

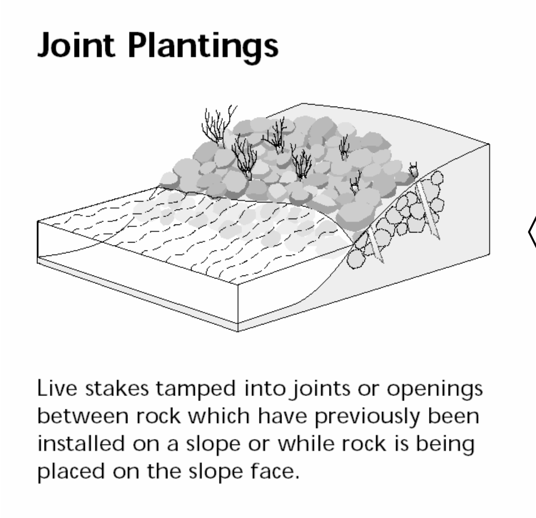
Streambank erosion is occurring in the Cool Creek immediately upstream of 131st Street (see Figure 7-16). This erosion, occurring on 150 lineal feet of the left streambank, is severe and will likely continue to worsen unless preventative measures are taken.

The 10-year peak flow velocities at this location are moderate, exceeding 5 fps at the center of the channel. Flow velocities in this range will cause continued erosion in unprotected areas. The 10-year flow velocity distribution at this location is illustrated below.



Velocity Distribution: Cool Creek upstream of 131st Street

Protecting this reach of the Cool Creek will require some regrading, slope protection, and vegetative reinforcement to protect the channel banks from continued erosion. It is recommended that 150 lineal feet of the Cool Creek streambank be re-graded to a slope not exceeding 3:1 (horizontal:vertical) and reinforced with a combination of riprap (w/geotextile fabric base) and live woody stakes (referred to as the *joint plantings* technique, see illustration on following page). The live stakes will take root along the reinforced streambank and strengthen the channel. Furthermore, the live stakes will grow and shroud the riprap with a natural vegetative cover. Streambank reinforcement should be implemented a minimum of *4 vertical feet* from the channel bottom.

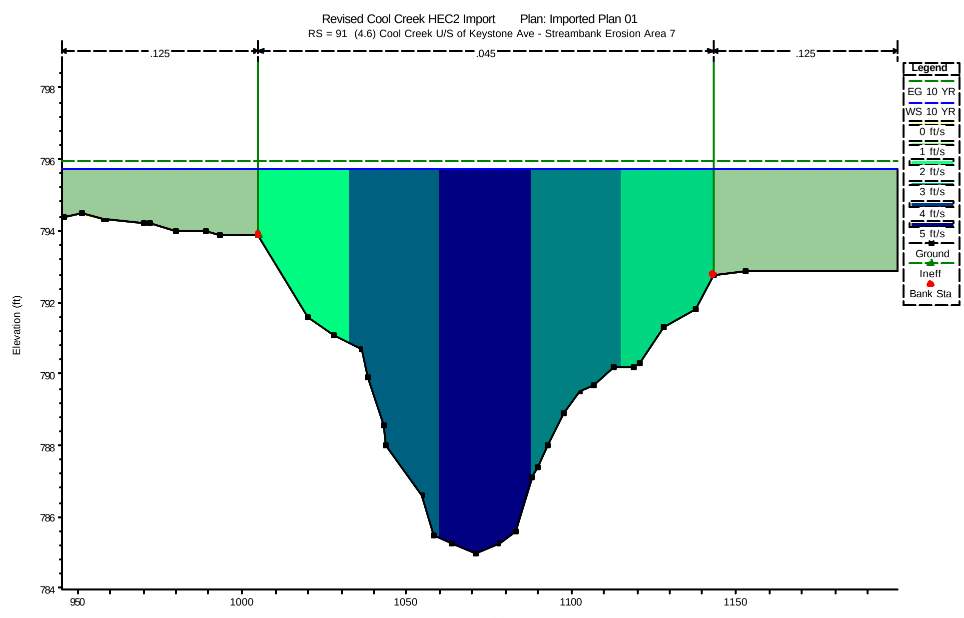


Riprap and Live Stakes (Joint Plantings)
Source: Federal Interagency Stream Restoration Working Group, 1998

7.6.7 Cool Creek: upstream of Keystone Avenue

Streambank erosion is occurring in the Cool Creek immediately upstream of Keystone Avenue (see Figure 7-17). This erosion, occurring on the right channel bank, is severe and will likely continue to worsen unless preventative measures are taken.

The 10-year peak flow velocities at this location are very moderate, exceeding 5 fps at the center of the channel. Flow velocities in this range will cause continued erosion in unprotected areas. The 10-year flow velocity distribution at this location is illustrated below.



Velocity Distribution: Cool Creek upstream of Keystone Avenue

Protecting this reach of the Cool Creek will require some regrading and vegetative reinforcement to protect the channel banks from continued erosion. It is recommended that 100 lineal feet of the Cool Creek streambank be reinforced with a combination of riprap toe protection and a *brushmattress technique* (Section 7.6.3). Streambank reinforcement should be implemented a minimum of *6 vertical feet* from the channel bottom.

7.7 REGIONAL STORMWATER DETENTION

Natural drainage channels are highly sensitive to changes in the magnitude of frequent stormwater runoff (i.e. 1-year and 2-year recurrence interval) events. Urban development, despite the presence of stormwater detention ponds, often increases the magnitude of 1-year and 2-year peak flows. This is a result of a detention pond design focus on the design (i.e. 100-year and 10-year) events. Although detention ponds typically reduce peak flow rates for larger (i.e. 100-year and 10-year) storm events, they often *increase* peak flow rates for more frequent (i.e. 1-year, 2-year) storm events and extend the overall duration of higher flow.

The hydrologic analysis completed for this project showed that major regional detention is not warranted to control the larger storms. Flooding is not a major problem in the lower watershed reaches and the existing detention policy for new development will be effective in controlling peak flows from these larger storms. However, it is recommended that regional detention facilities be constructed in the upper reaches of Cool Creek to help control the magnitude of 1-year and 2-year recurrence interval rainfall events. These facilities should be constructed “off-line” so as to maintain baseflow in the channel, avoid disrupting the existing riparian corridor, and avoid extensive dam safety requirements.

Regional stormwater detention facilities will provide the following benefits to the Cool Creek watershed:

- Reduce peak flow rates for more frequent storms
- Improve water quality by reducing concentrations of sediment, nutrients, and metals
- Increase aquatic habitat by providing wetland and open water areas
- Reduce downstream erosion potential by decreasing the magnitude and duration of the 1-year and 2-year flows, thus further reducing sediment pollution
- Maintain developable land by constructing basins in the existing 100-year floodplain (assuming this land would not be otherwise developable)

Two new regional stormwater detention facilities are recommended. The first is located immediately downstream of 171st Street and the second is located west of Grassy Branch Road. Both detention facilities are located in the upper reaches of the Cool Creek watershed and are within the existing 100-year floodplain.

An existing impoundment created by a culvert under an abandoned railroad embankment is located along the Anna Kendall Drain (immediately upstream of Park Street). This facility is in need of improvements in order to maintain the storage and associated peak flow reductions.

7.7.1 171st Street Off-Line Detention Pond (South Pond)

This detention pond would intercept diverted water immediately south (downstream) of 171st Street. A zero-slope low flow channel would direct the water through in a meandering path towards the pond outlet. Emergent and submergent wetland vegetation should be planted throughout the pond area, creating a means to filter stormwater and remove pollutants prior to discharge back into Cool Creek. The detention pond would discharge into the Cool Creek approximately 1500 channel-feet downstream of 171st Street.

The pond, illustrated in Figure 7-18, would require approximately 160,000 cubic yards of earthwork and would provide approximately 95 acre-feet of stormwater storage. The total estimated project cost for this pond is $2,600,000. Peak flows within Cool Creek could be reduced as follows:

Location	1 Year Storm (cfs)			2 Year Storm (cfs)		
	Existing Flow	Proposed Flow With 171st Street Detention	Percent Reduction	Existing Flow	Proposed Flow With 171st Street Detention	Percent Reduction
171st Street	546	254	53%	699	400	43%
146th Street	883	539	39%	1106	726	34%
131st Street	1107	825	25%	1426	1118	22%
116th Street	1156	944	18%	1497	1267	15%
Confluence	1205	998	17%	1525	1333	13%

The proposed off-line detention basin would provide substantial flow reduction up to the 2-year storm event. Storms exceeding the 2-year magnitude would inundate the detention basin. As the proposed detention ponds are intended to enhance stormwater quality and prevent channel erosion, flow attenuation was not considered for the 10-year through 100-year storm events. Existing detention ponds throughout the watershed provide storage volume for these larger rainfalls.

7.7.2 Grassy Branch Road Off-Line Detention Pond (North Pond)

This detention pond would intercept diverted water from Cool Creek approximately 1,500 feet south of 191st Street and approximately 2,500 feet west of Grassy Branch Road. The general layout and design of this detention pond will be similar to that of the 171st Street Detention Pond. The off-line detention pond would discharge back into the Cool Creek approximately 280 feet west of Grassy Branch Road (approximately 2600 channel-feet downstream of the inlet diversion).

The pond, illustrated in Figure 7-19, would require approximately 100,000 cubic yards of earthwork and will provide approximately 115 acre-feet of stormwater storage. The total estimated project cost for this pond is $1,800,000. Peak flows within Cool Creek could be reduced as follows:

Location	1 Year Storm (cfs)			2 Year Storm (cfs)		
	Existing Flow	Proposed Flow With 186th Street Detention	Percent Reduction	Existing Flow	Proposed Flow With 186th Street Detention	Percent Reduction
171st Street	546	337	65%	699	462	34%
146th Street	883	671	41%	1106	894	19%
131st Street	1107	915	26%	1426	1235	13%
116th Street	1156	989	18%	1497	1347	10%
Confluence	1205	1025	17%	1525	1395	9%

If both the 171st Street and the Grassy Branch Road detention ponds were constructed as recommended in this report, peak flows within Cool Creek would be reduced as follows:

Location	1 Year Storm (cfs)			2 Year Storm (cfs)		
	Existing Flow	Proposed Flow With 171st & 186th Street Detention	Percent Reduction	Existing Flow	Proposed Flow With 171st & 186th Street Detention	Percent Reduction
171st Street	546	192	65%	699	287	59%
146th Street	883	522	41%	1106	696	37%
131st Street	1107	819	26%	1426	1101	23%
116th Street	1156	943	18%	1497	1260	16%
Confluence	1205	998	17%	1525	1327	13%

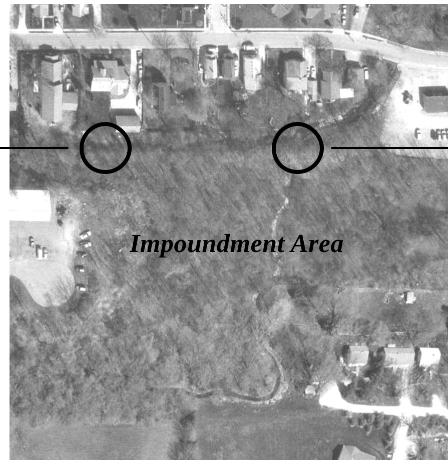
Constructing the proposed off-line detention basins would require the following activities:

- Obtain permanent easements for the pond area
- Develop planting and landscape plan for detention pond
- Remove soil material to create storage area
- Manage excess soil material
- Construct inflow weir to direct flood waters from channel to pond
- Construct discharge structure to direct water back to channel

7.7.3 In-Line Detention Pond (Anna Kendall Drain)

A 48-inch culvert under an abandoned railroad embankment creates a significant impoundment area upstream (south) of Park Street on the Anna Kendall Drain. Although there is significant volume in the impoundment area (approximately 80 acre-ft), an existing breach in the embankment limits the amount of flow that can be stored. In addition, the existing 48-inch culvert is beginning to fail and the embankment above the outlet culvert is eroding. The photographs below on the following page show the location and condition of the existing features of this impoundment.

Location of breach in abandoned railroad embankment



Location of existing 48-inch culvert outlet

Breach in abandoned railroad embankment (note deteriorated CMP, pipe in foreground appears to be a bucket or rubbish container)

Upstream end of existing 48-inch culvert outlet (note pipe section has fallen into creek and embankment is eroding above culvert)

Downstream of 48-inch culvert outlet (note how existing outlet is at a channel bend and is subject to erosion)

Looking at impoundment area from top of abandoned railroad embankment (note area is heavily forested)

The area surrounding the existing impoundment is potentially unsafe given the existing embankment breach and the location/alignment of the 48-inch outlet. Three options are available at this site:

1. Retrofit the existing impoundment structure
2. Remove the impoundment structure
3. Do nothing

Retrofit Existing Impoundment Structure

Retrofitting the existing impoundment area will require the following activities:

- Obtain permanent and construction easements for the pond area
- Investigate existing soil properties along the embankment (i.e. soil borings)
- Modify the primary detention pond outlet to discharge further downstream, past the sharp bend in the existing channel
- Construct an emergency spillway and raise the elevation of the embankment to provide adequate freeboard.
- Repair the existing breach in the embankment and upgrade other portions of the embankment as needed to satisfy IDNR Dam Safety requirements. This may require significant earthwork, up to a complete removal/replacement of the existing embankment.
- Verify that the proposed retrofit does not adversely impact the regulated 100-year floodplain.
- Obtain an IDNR permit for dam improvements.

The final item above would require significant additional expense, due to Indiana Department of Natural Resources (IDNR) requirements for new and retrofitted dams. The IDNR requires that any dam with a drainage area exceeding 1 square mile (Anna Kendall has a drainage area of 2 square miles at the impoundment) meet their design requirements. Meeting the IDNR criteria would require additional engineering/design effort, as well as higher construction costs to install dam safety features.

The proposed pond retrofit would provide approximately 80 acre-feet of stormwater storage. The estimated cost to upgrade the existing impoundment is approximately $700,000.

Retrofitting the detention storage area as described above would have the following effect on peak flows in the Anna Kendall Drain:

Location	2 Year Storm (cfs)			10 Year Storm (cfs)		
	Existing Flow	Proposed Flow With Retrofit	Percent Reduction	Existing Flow	Proposed Flow With Retrofit	Percent Reduction
Downstream of Abandoned Railroad	205	161	21%	380	215	43%

The above peak flow reductions are based on replacement of the existing 48-inch culvert with a similar sized structure. Minor flow reductions (21%) are achieved during the 2-year storm event. It may be possible to have a multi-stage outlet that provides better control flows for the 1- and 2-year storms. During the 10-year event, the impoundment nearly fills and a peak flow reduction of

43% is provided. During a 100-year storm event, the embankment would overtop and peak flow reductions would be negligible. Raising the embankment to contain the 100-year storm volume is not feasible because nearby residential structures would be flooded. IDNR dam safety requirements generally require containment of the 100-year storm. Accordingly, some relaxation in dam safety requirements would be required to make the retrofit a viable option.

Remove Embankment

The second option is to remove a portion of the existing embankment and allow the existing stream to flow unrestricted. This option would resolve the current safety concerns at the site but would also lose the flood control benefits, particularly for the 10-year storm event. The downstream 100-year flood elevations would not be increased because the existing impoundment has negligible 100-year peak flow attenuation. The estimated cost to remove a portion of the existing embankment and return the channel to an unrestricted condition is approximately $100,000.

Do Nothing

The third option, to leave the existing embankment in its current state, is not recommended. Although this involves the lowest initial cost and minimal disruption, it places downstream property owners in a potentially unsafe condition, should the embankment continue to erode and eventually fail.

Evaluation of Options

Removing the existing embankment is the most cost-effective option. However, the flood control benefits provided for the 2- through 10-year storms would be lost. We recommend that the embankment be retrofitted, *provided a compromise can be met regarding IDNR dam safety requirements*. The decision on which option to implement should be made only after the key design issues are discussed with the IDNR and their complete feedback has been received.

7.8 LAND USE AND PLANNING RECOMMENDATIONS

Land use planning and design policies, including design standards, zoning requirements, and site plan review procedures, can be modified to benefit the condition of Cool Creek and its watershed.

7.8.1 Detention Pond Design - Water Quality Volume

Many communities require detention pond designs that incorporate features to help capture pollutants in stormwater runoff. This is generally accomplished by providing a *Water Quality Volume*. The water quality volume is the storage needed to capture and treat runoff from 90% of the average annual rainfall. The *Indianapolis Drainage Design Standards and Specification Manual* (July 2001) contains a requirement for *Water Quality Volume*. This requirement provides for extended detention for the first 1 inch of rainfall. Design standards for reviewing authorities within the Cool Creek watershed should be modified to contain a similar requirement. The *Water Quality Volume* standard will help to control peak flows during more frequent storm events, reduce pollutant loadings to receiving streams, and reduce the potential for downstream channel erosion.

Properly designed and constructed stormwater ponds are generally capable of the following pollutant reductions:

Pollutant	Percent Reduction*
Total Suspended Solids	80%
Total Phosphorus	51%
Ortho-Phosphorus	65%
Total Nitrogen	33%
Nitrate and Nitrite Nitrogen	43%
Copper	57%
Zinc	66%

**Source: National Management Measure Guidance to Control Nonpoint Source Pollution from Urban Areas. U. S. EPA, Draft, July 2002*

Some communities have adopted a *Channel Protection Volume*, which provides additional storage to further reduce the potential for downstream erosion. Maryland has adopted a method that requires holding the runoff volume generated by the 1-year 24-hour duration rainfall (about 2.5 inches in Hamilton County) to be gradually released over a 12- to 24-hour period (Maryland Department of the Environment, Maryland Stormwater Design Manual, Baltimore, Maryland, Volume 1, 2000). The premise of this approach is that runoff will be stored and released so gradually that critical erosive velocities will seldom be exceeded in downstream channels. This approach should be considered given the channel erosion concerns in the watershed.

7.8.2 Stream Buffer Ordinance

Adoption of a Stream Buffer Ordinance would help to prevent development along channel corridors by setting specific limitations on development along natural channels. Often, the protected corridor is 200 to 300 feet wide. A Stream Buffer Ordinance should be adopted to provide the following benefits:

- Natural buffer on each side of channel filters urban runoff prior to discharge into the main channel
- Required setbacks prevent buildings and utilities from being constructed too close to the channel, thereby minimizing property damage due to flooding and erosion
- Promotes green space with multi-use capabilities, such as bike/walk paths, wetland areas, aquatic habitat, etc.
- Mitigates stream warming
- Promotes long-term health of the open channel, minimizing maintenance efforts

The following internet link provides model Stream Buffer Ordinance language that could be adopted, in whole or in part, to protect the Cool Creek and its tributaries.

http://www.stormwatercenter.net/Model%20Ordinances/buffer_model_ordinance.htm

7.8.3 Floodplain Protection

Floodplain development concerns tie directly to preservation of the riparian stream buffers along Cool Creek (and its tributaries). Filling of floodplains can cause loss of flood storage and riparian habitat. As noted previously, Hamilton County has an ordinance that prohibits filling of land in the floodplains of its regulated drains. It may be appropriate for Carmel and Westfield to adopt similar policies for floodplains under their jurisdiction. This would provide a uniform policy and would help preserve existing riparian buffers. Many communities have adopted buffer ordinances to protect headwater streams where floodplains are often narrow and floodplain protection alone may not adequately protect buffer systems.

7.8.4 Other Management Practices

Other recommended management practices concerning development in the Cool Creek watershed (and throughout Hamilton County) include:

- Identifying and protecting critical conservation areas (wetlands, forested areas, floodplains, riparian forest, meadow/prairie areas, etc.)
- Preserving environmentally significant areas (conservation easements, management areas, maintaining native plant species, etc.)
- Promoting urban forestry (decreases runoff, mitigates stream warming)
- Encouraging waterbody and natural drainage protection when siting developments (cluster zoning, other zoning options, urban growth boundaries, etc.)
- Utilizing sound site planning practices
- Utilizing other structural and non-structural Best Management Practices as appropriate, (e.g. porous pavement, sand filters, infiltration practices, water quality swales, manufactured BMPs, vegetated filter strips, bioretention areas, etc.)

The above issues will need to be considered for all urbanized areas of the County as part of stormwater quality regulations promulgated by IDEM (Rule 13).

7.9 SUMMARY OF IMPROVEMENT NEEDS

The following is a summary of the recommended solutions to problem areas in the Cool Creek watershed.

7.9.1 Stream Flooding/Roadway Overtopping Solutions

- E. 151st Street (Cool Creek) – Modify approximately 160 LF of roadway elevation ($10,000)
- E. 171st Street (Cool Creek) – Modify 320 LF of roadway elevation and replace existing bridge ($700,000)
- Gurley Street (Anna Kendall Drain) – Replace existing bridge ($280,000)
- Cherry Street (Anna Kendall Drain) – Replace existing bridge ($340,000)
- SR 32 (Main Street) (J. M. Thompson Drain) – Replace existing culvert ($310,000)
- US 31 and Adjacent Private Drive (Highway Run) – Culvert replacement/addition ($800,000)
- Walter Street, Private Drive, and Walter Court (Highway Run) – Replace three (3) existing culverts and reshape channel ($200,000)
- Thornberry Drive (Highway Run) – Replace existing culvert ($80,000)

7.9.2 Neighborhood Solutions

- Carmel Drive (Hot Lick Creek) – Replace existing twin culverts with new box culvert and install erosion control measures along creek upstream of Carmel Drive ($90,000)
- Hot Lick Creek Channel Improvement – Re-grade existing channel away from nearby residential structure ($10,000)

7.9.3 Streambank Erosion Solutions

- Highway Run, downstream of Stonehedge Drive – Re-grade approximately 100 LF of streambank, reinforce with erosion matting and vegetation ($5,000)
- H. G. Kenyon Drain, downstream of Rolling Court – Re-grade approximately 250 LF of streambank, reinforce with erosion matting and vegetation ($15,000)
- Cool Creek, upstream of confluence with the White River – Re-grade approximately 1500 LF of Cool Creek streambank, reinforce using brushmattress technique ($300,000)
- Cool Creek, downstream of Gray Road – Reinforce 200 LF of streambank using vegetated geogrid and riprap toe protection ($75,000)
- Cool Creek, upstream and downstream of Hot Lick Creek – Reinforce 575 LF of streambank using brushmattress technique ($125,000)
- Cool Creek, upstream of 131st Street – Re-grade approximately 150 LF of Cool Creek streambank and reinforce with combination of riprap and live woody stakes ($20,000)
- Cool Creek, upstream of Keystone Avenue – Re-grade approximately 100 LF of streambank using a combination of riprap toe protection and brushmattress technique ($30,000)

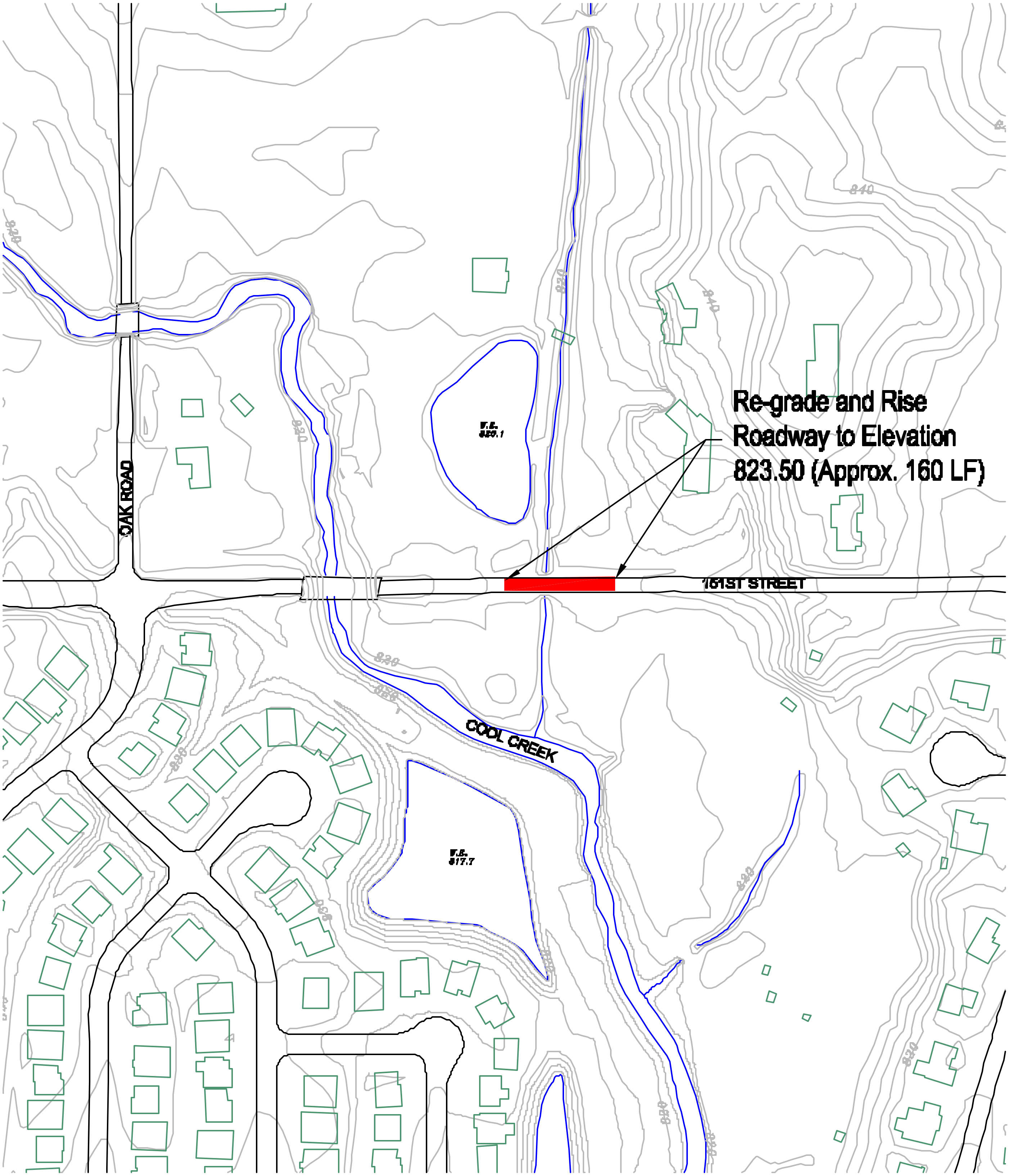
7.9.4 Regional Stormwater Detention Solutions

- 171st Street Off-Line Detention Pond – construct a 95 acre-ft detention basin with a 1800 foot long meandering low flow channel and emergent and submergent wetland vegetation planted throughout the pond area ($2,600,000)
- Grassy Branch Road Off-Line Detention Pond – construct a 115 acre-ft detention basin with a 2600 foot long meandering low flow channel and emergent and submergent wetland vegetation planted throughout the pond area ($1,800,000)
- Anna Kendall In-Line Detention Pond – repair breach in existing embankment, upgrade embankment, and install new control structure and emergency spillway to provide approximately 80 acre-feet of flood storage ($700,000)

7.9.5 Improvements Cost Summary

The costs of the proposed improvements are summarized as follows:

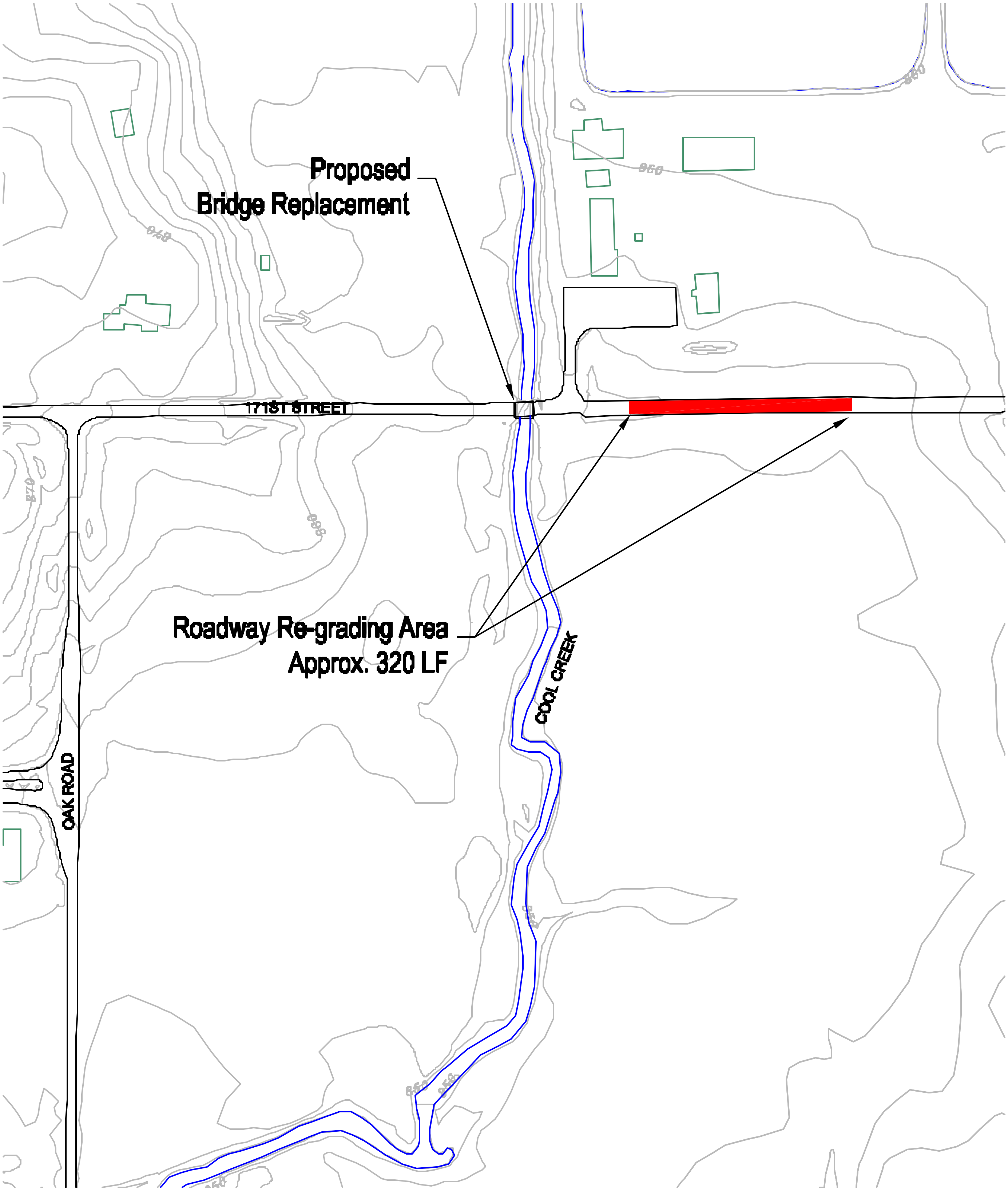
Stream Flooding/Roadway Overtopping Solutions	$2,720,000
Neighborhood Solutions	$100,000
Streambank Erosion Solutions	$570,000
Regional Detention Solutions	$5,100,000
Total of All Proposed Solutions	**$8,490,000**



Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-1
151st Street
Stream Flooding/Roadway Overtopping

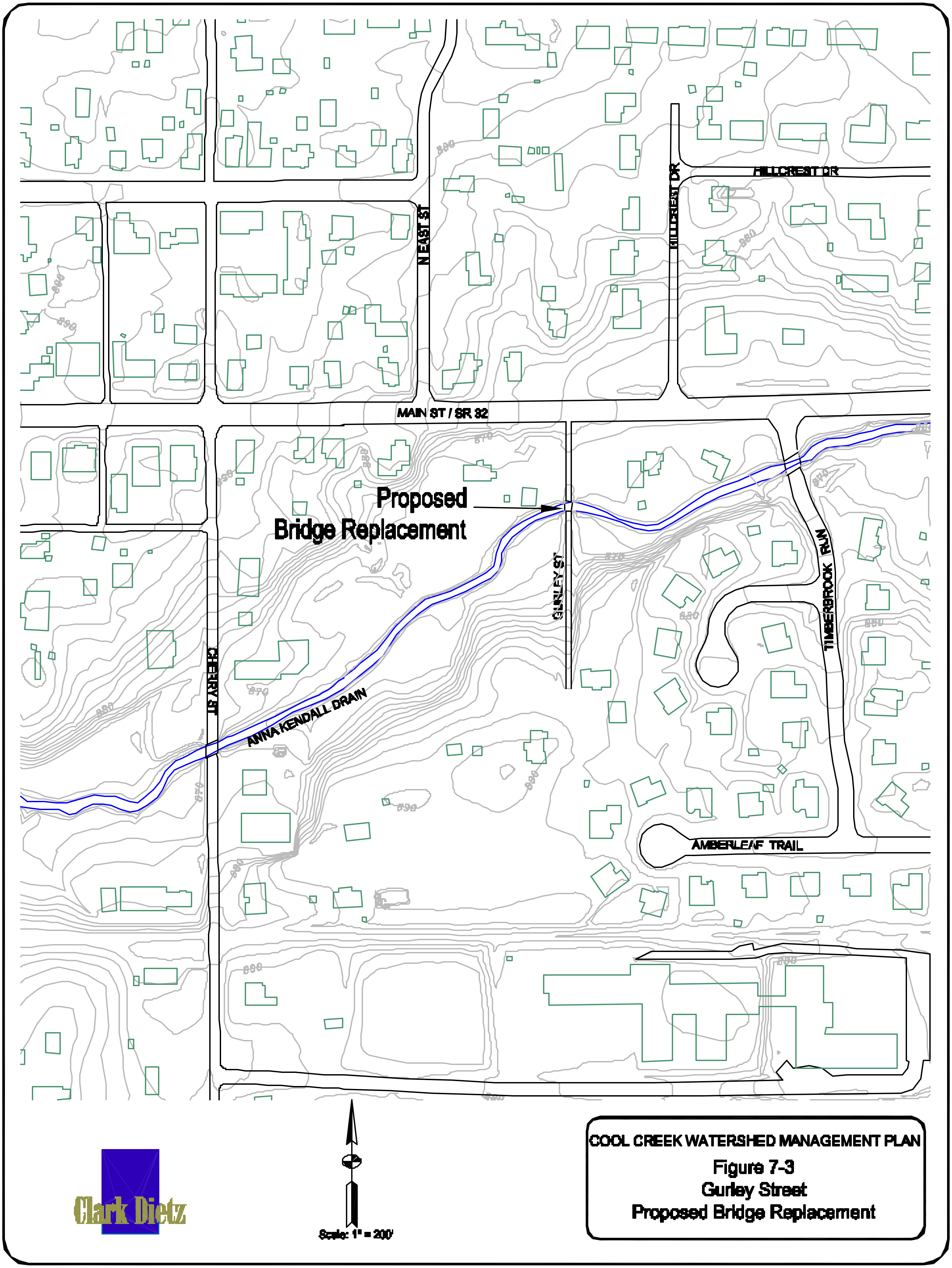


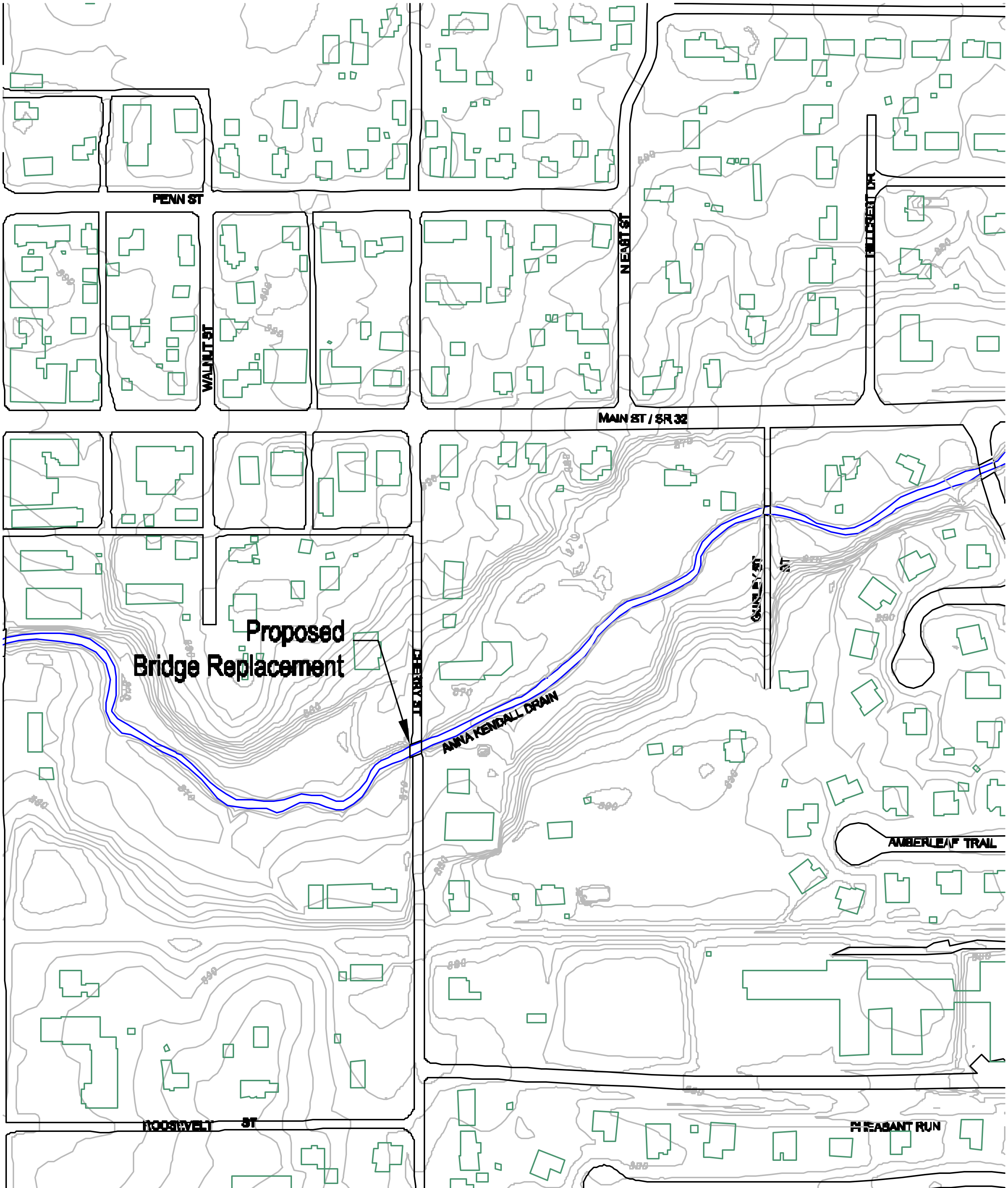
Clark Dietz

Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-2
171st Street
Stream Flooding/Roadway Overtopping

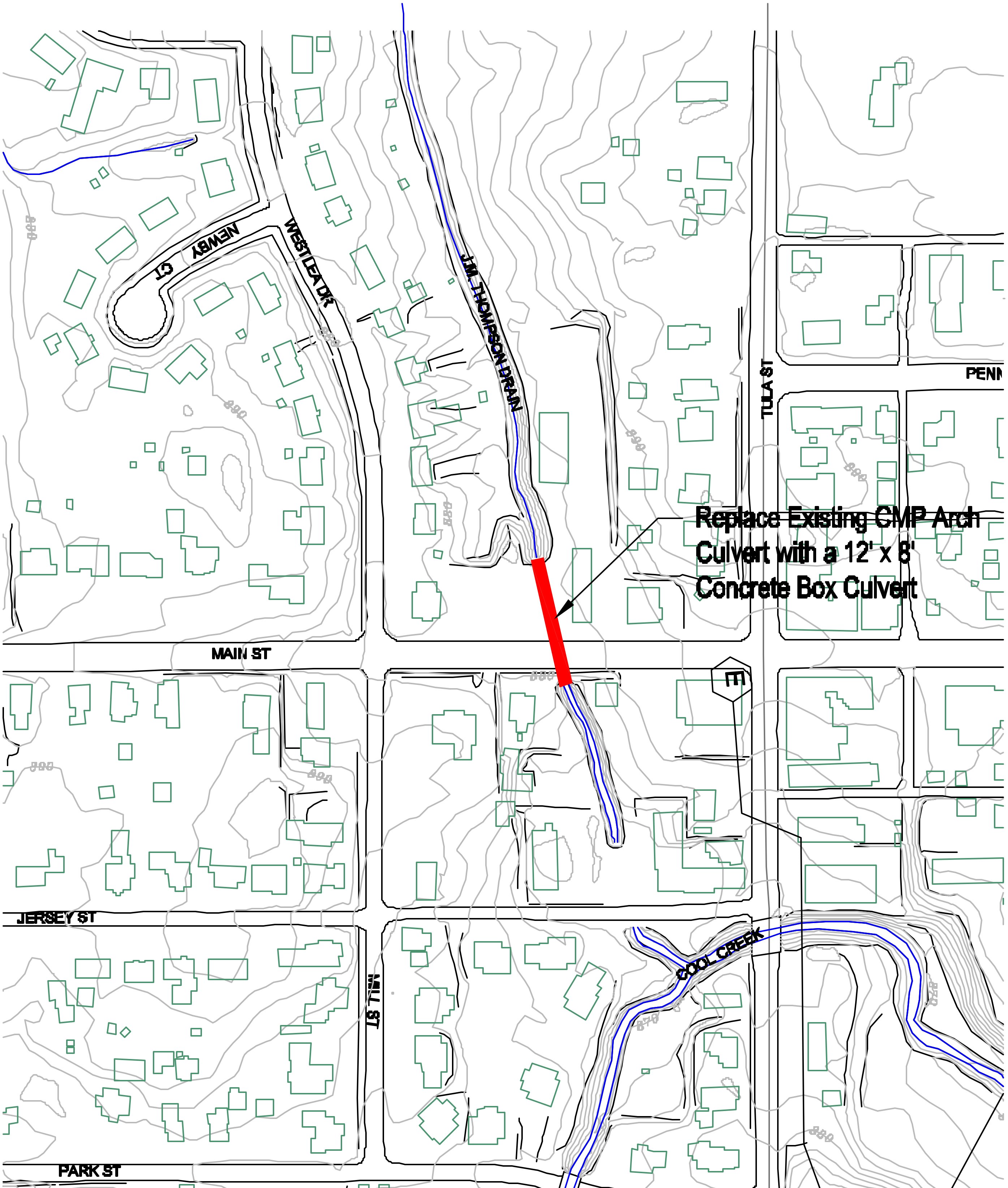

HILLCREST DR
N EAST ST
MAIN ST / SR 32
Proposed
Bridge Replacement
GURLEY ST
TIMBERBROOK RUN
CHERRY ST
ANNA KENDALL DRAIN
AMBERLEAF TRAIL
Clark Dietz
Scale: 1" = 200'
COOL CREEK WATERSHED MANAGEMENT PLAN
Figure 7-3
Gurley Street
Proposed Bridge Replacement



Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-4
Cherry Street
Proposed Bridge Replacement

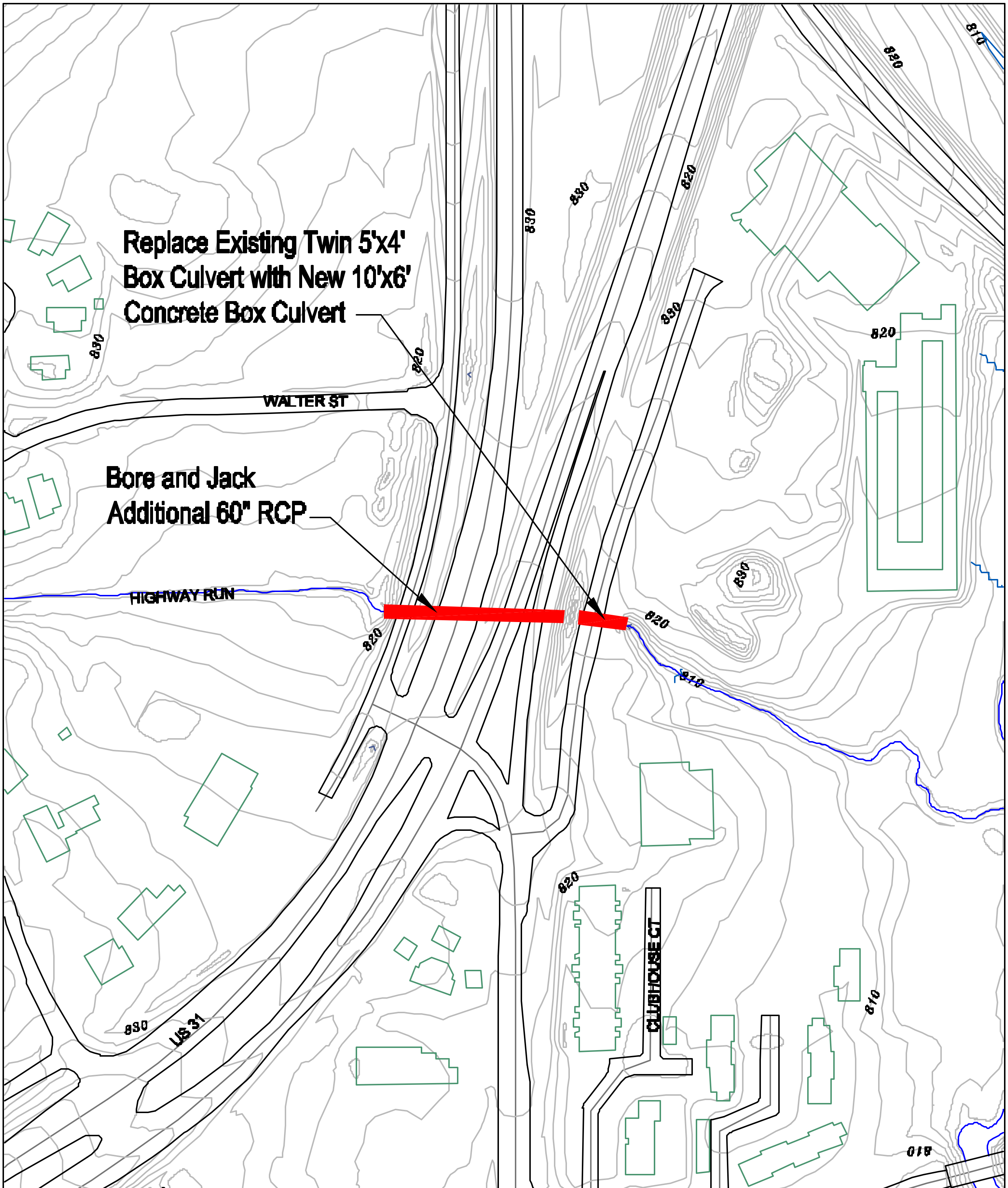


Clark Dietz

Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-5
Main Steet (J.M. Thompson Drain)
Culvert Replacement

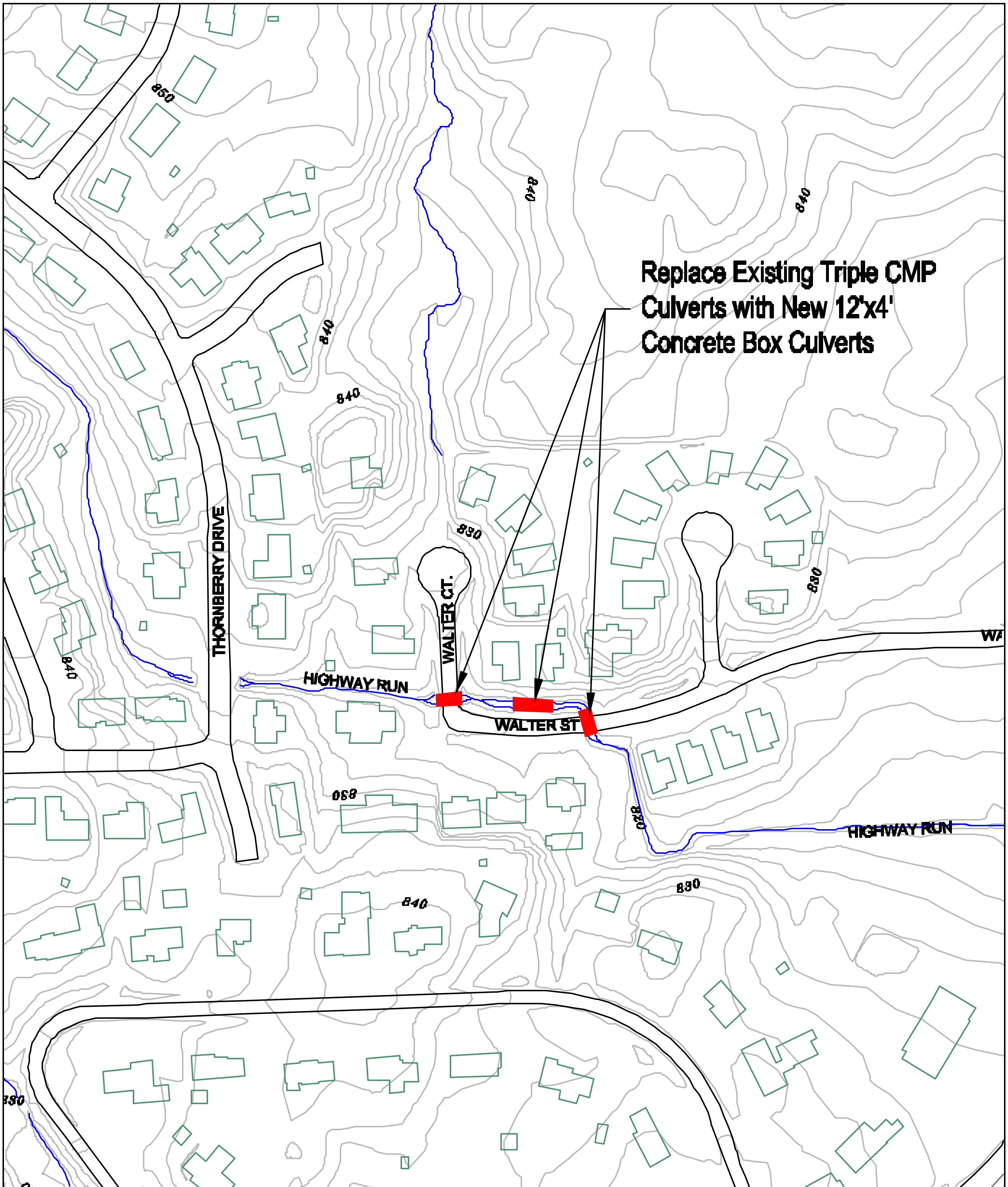


Scale: 1" = 200'

Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN

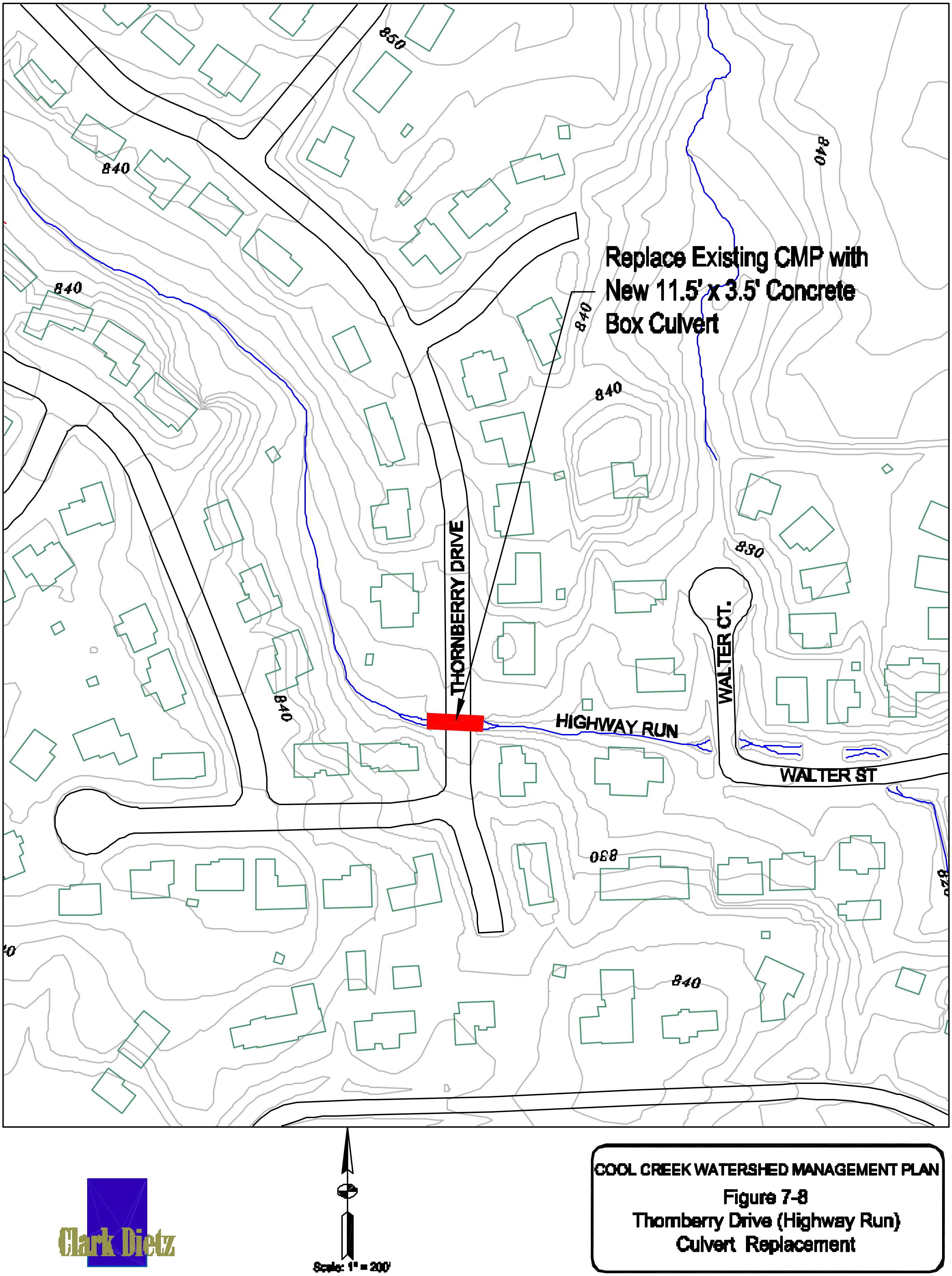
Figure 7-6
US31 & Private Drive (Highway Run)
Culvert Addition & Replacement



Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN

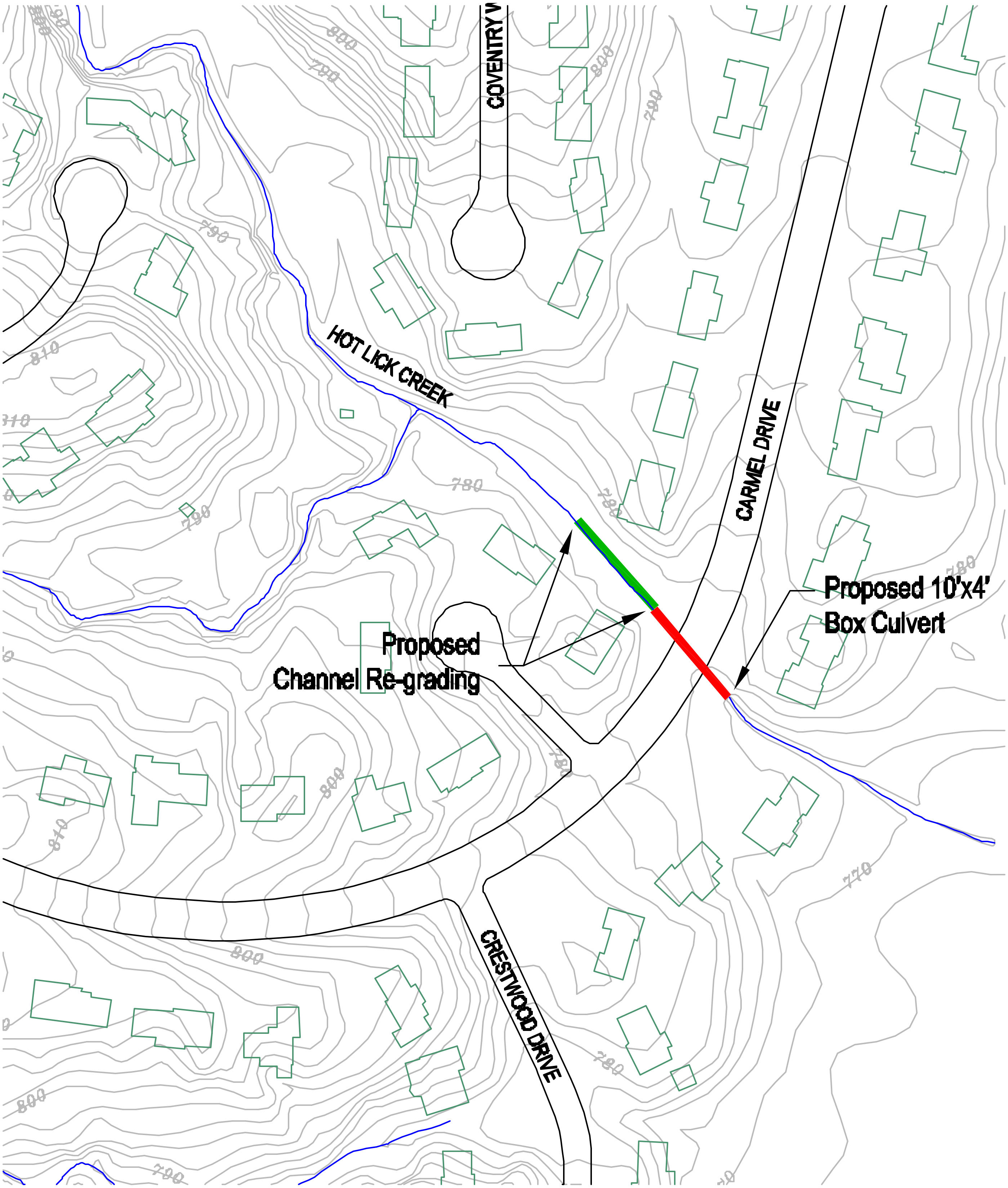
Figure 7-7
Walter St./Walter Ct. (Highway Run)
Culvert Replacements



Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN

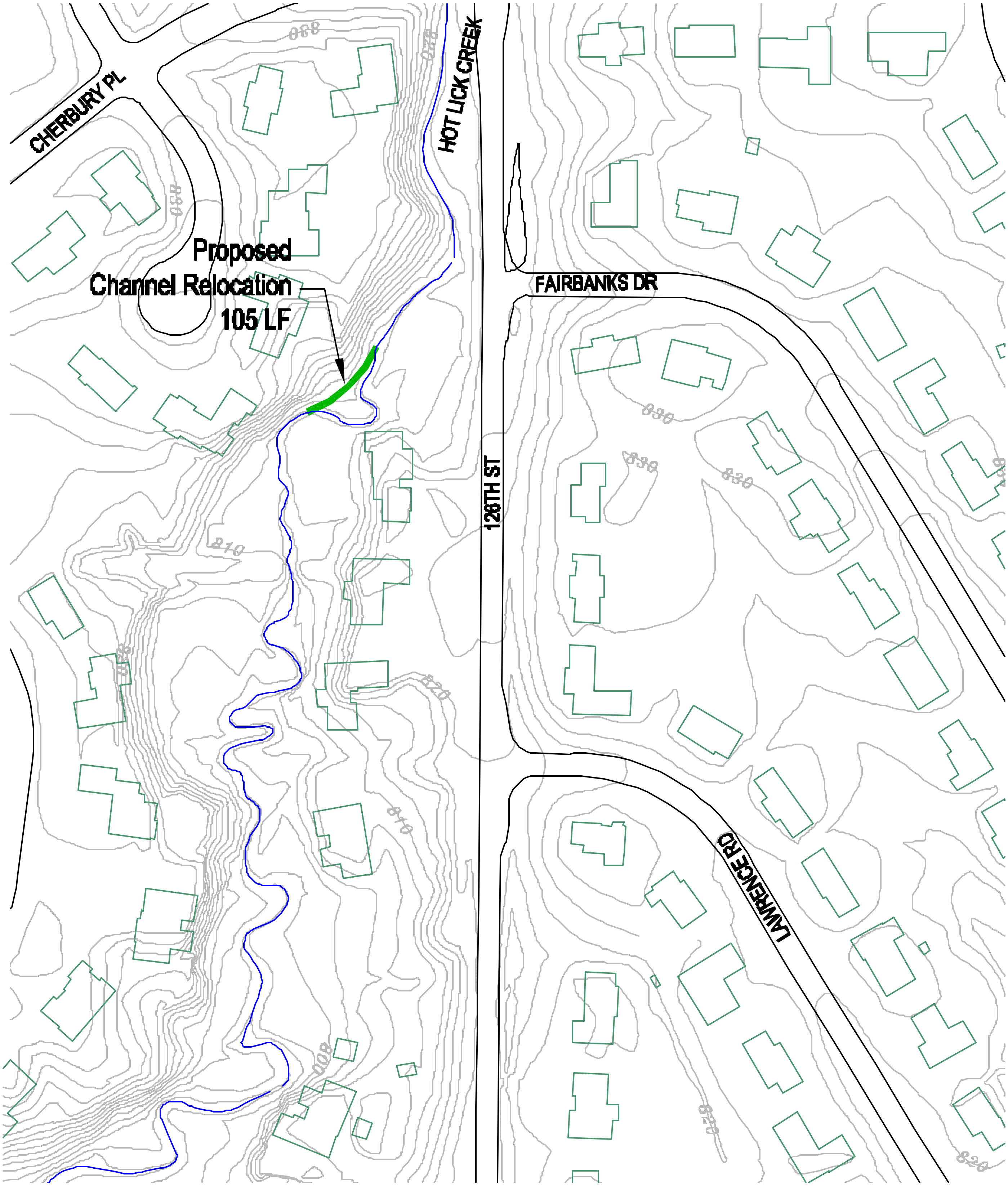
Figure 7-8
Thornberry Drive (Highway Run)
Culvert Replacement



Scale: 1" = 150'

Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN
Figure 7-9
Carmel Drive (Hot Lick Creek)
Neighborhood Problem Area



COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-10
Hot Lick Creek Channel Improvement
Neighborhood Problem Area

Clark Dietz

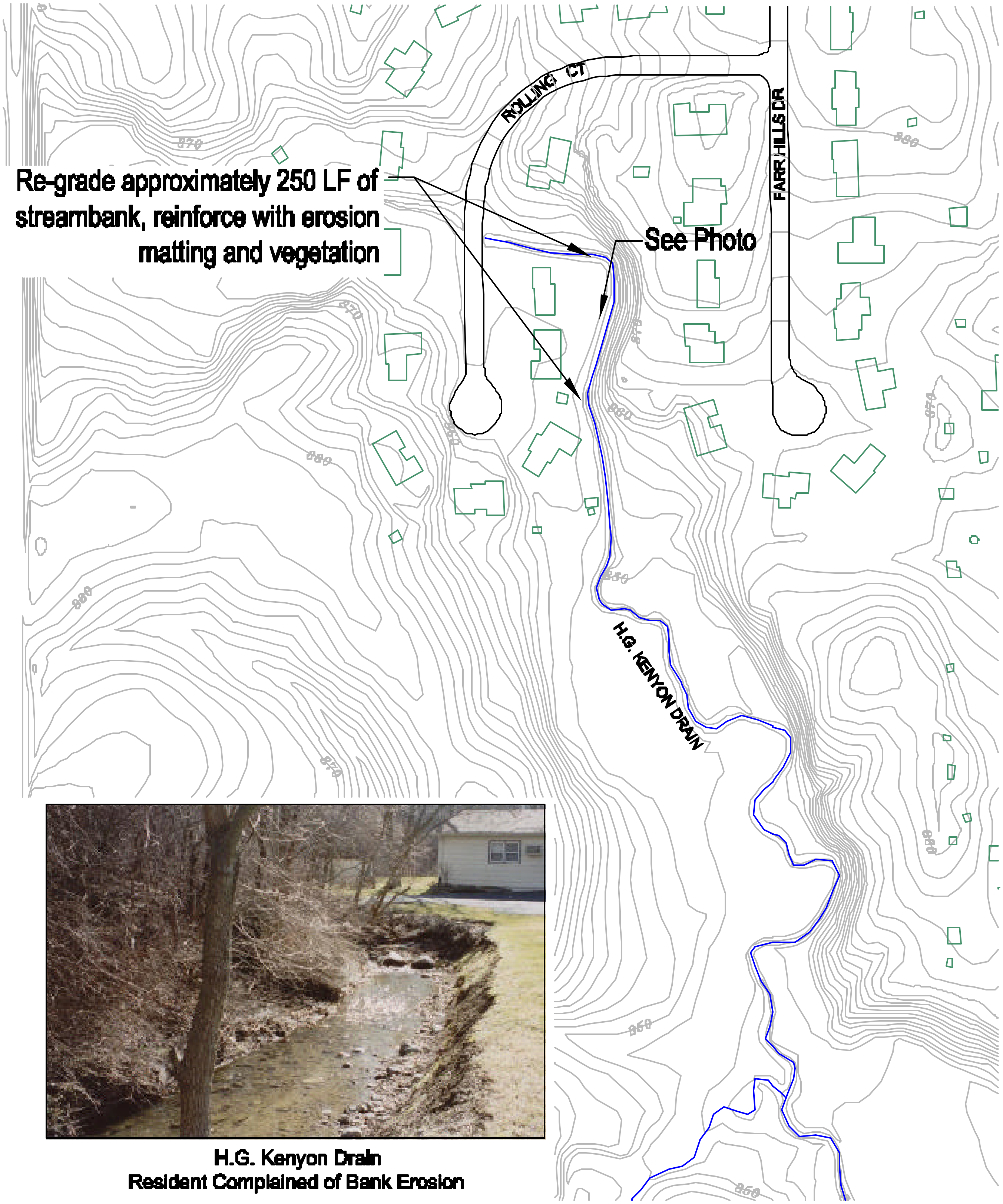
Photo #34 - Highway Run Drain
Trees Undercut by Bank Erosion

Clark Dietz

Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-11
Highway Run
D/S of Stonehedge Drive



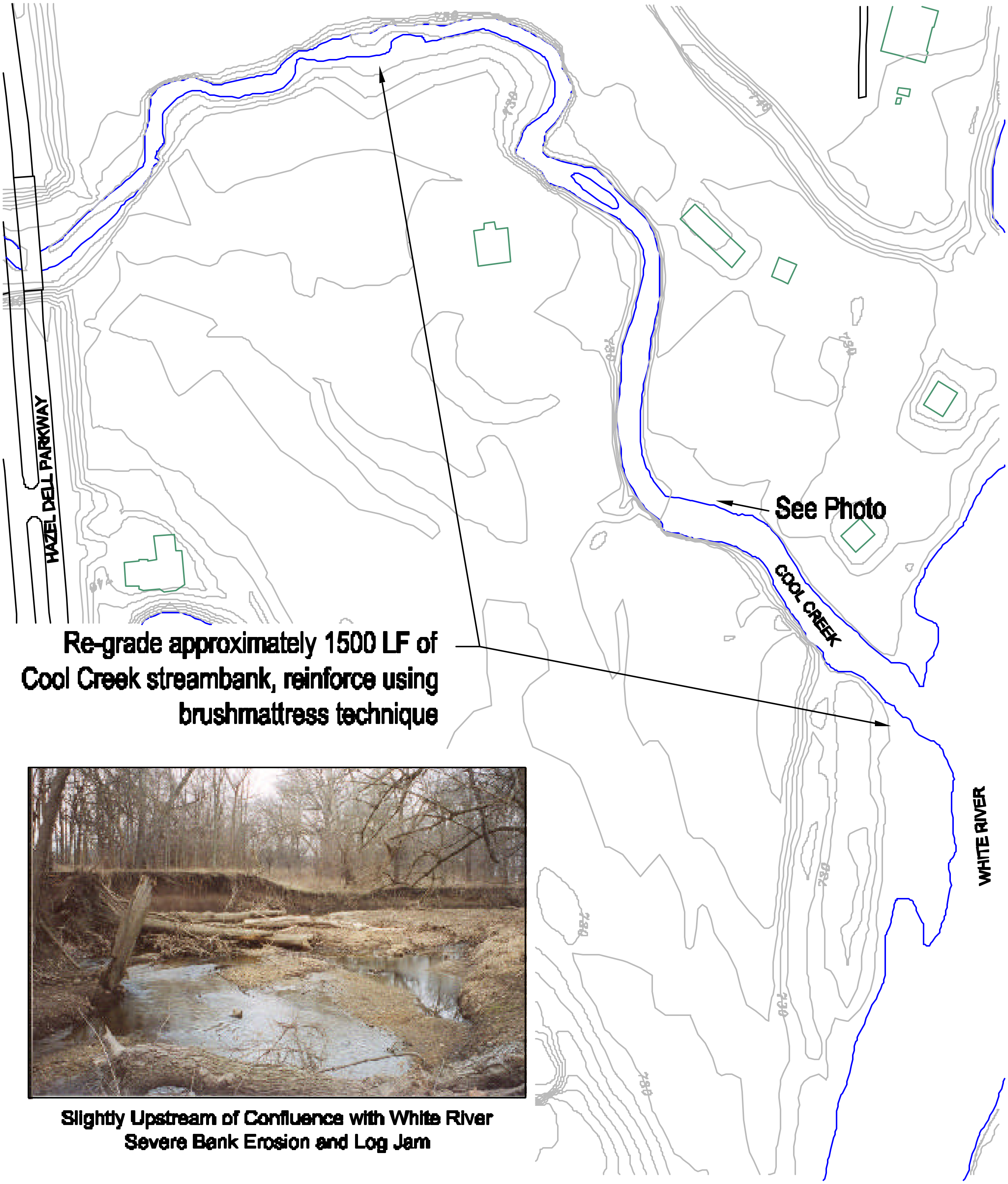
H.G. Kenyon Drain
Resident Complained of Bank Erosion

Scale: 1" = 200'

Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-12
H.G. Kenyon Drain
U/S of Rolling Court



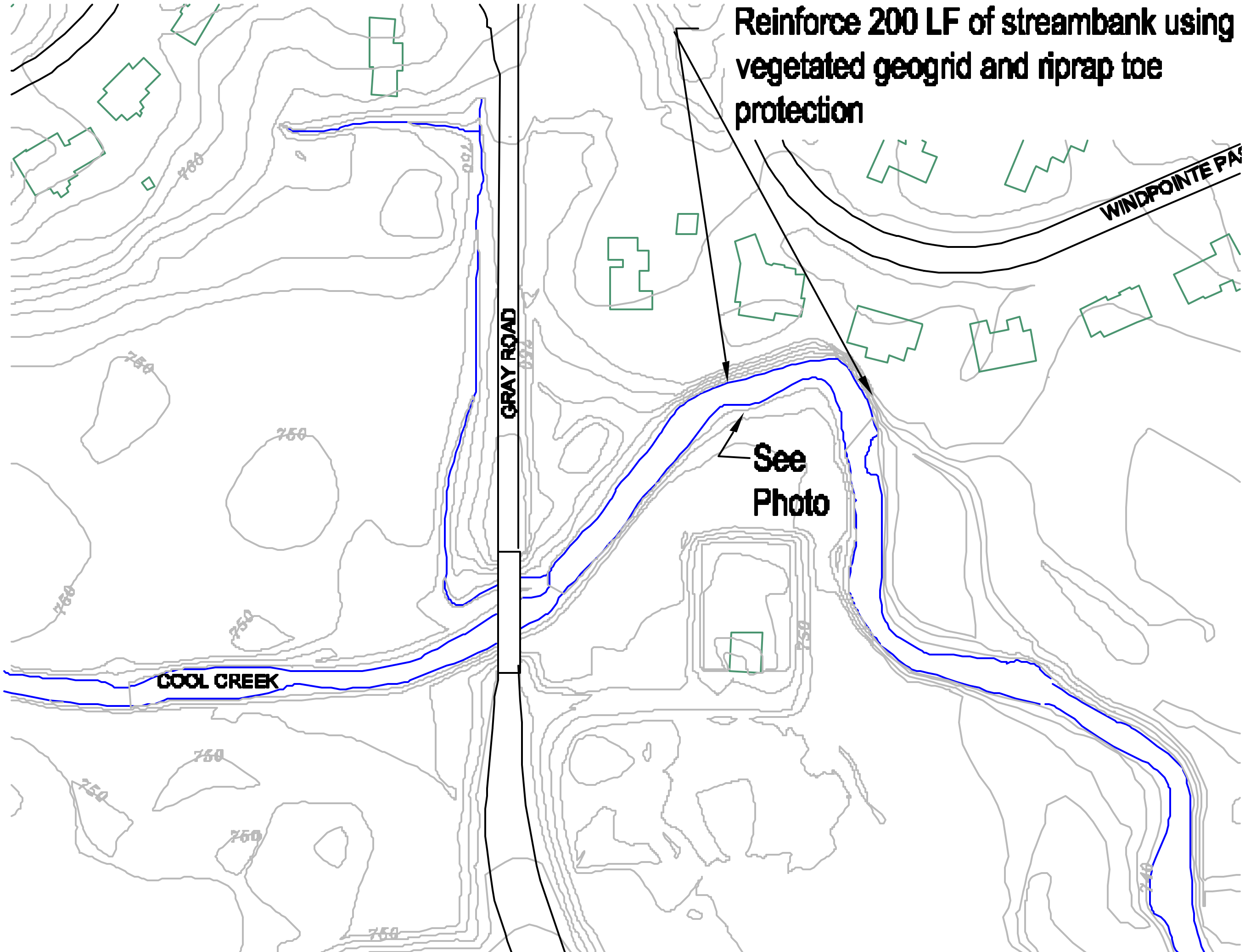
Slightly Upstream of Confluence with White River
Severe Bank Erosion and Log Jam

Clark Dietz

Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-13
Cool Creek
U/S of White River Confluence



Cool Creek
Severe Bank Erosion and Log Jam

Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-14
Cool Creek
D/S of Gray Road

Cool Creek in Brookshire Golf Course
Severe Bank Erosion, Cart Path Fallen into Creek

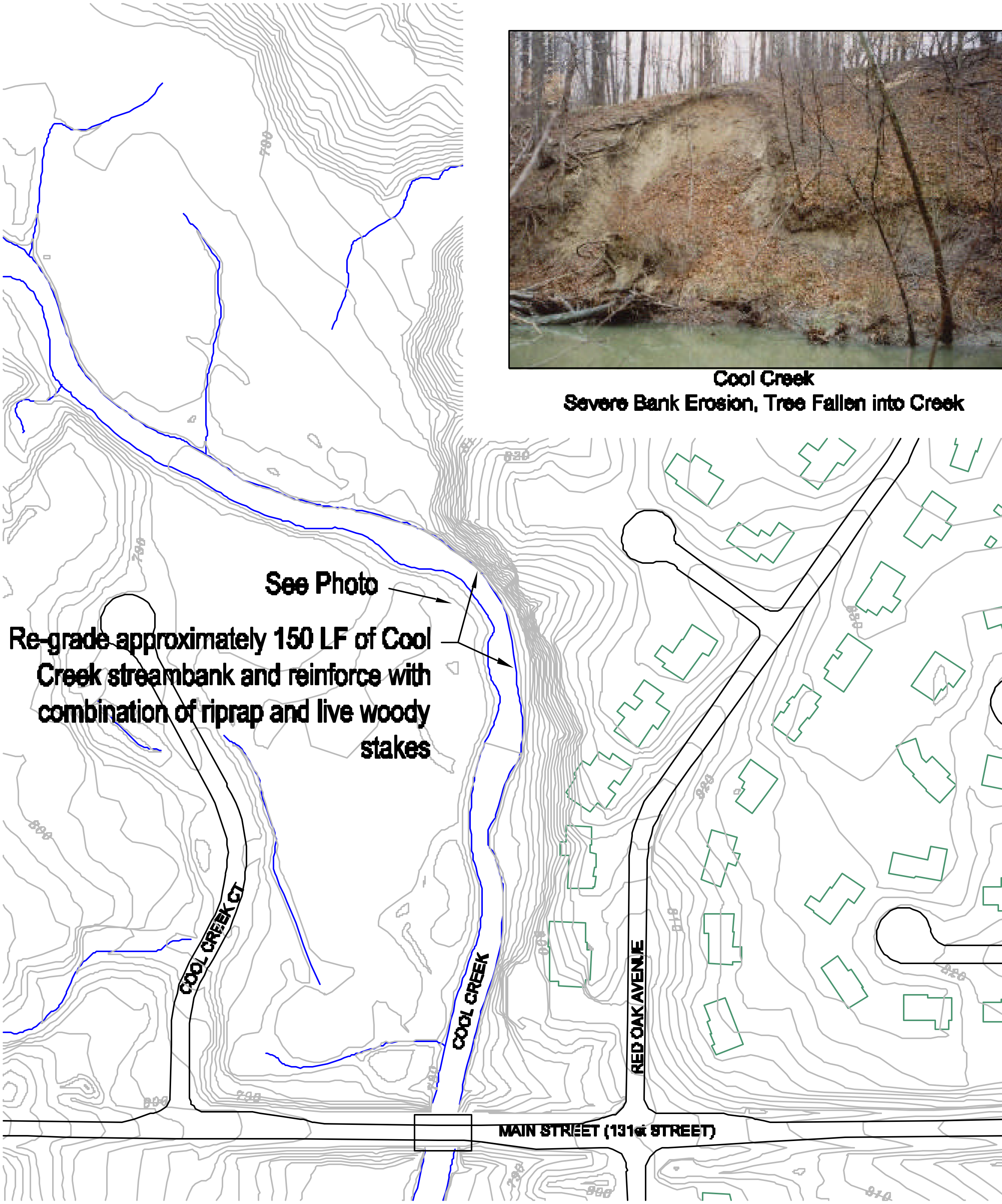
Cool Creek
Severe Bank Erosion

Clark Dietz

Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-15
Cool Creek
U/S & D/S of Hot Lick Creek



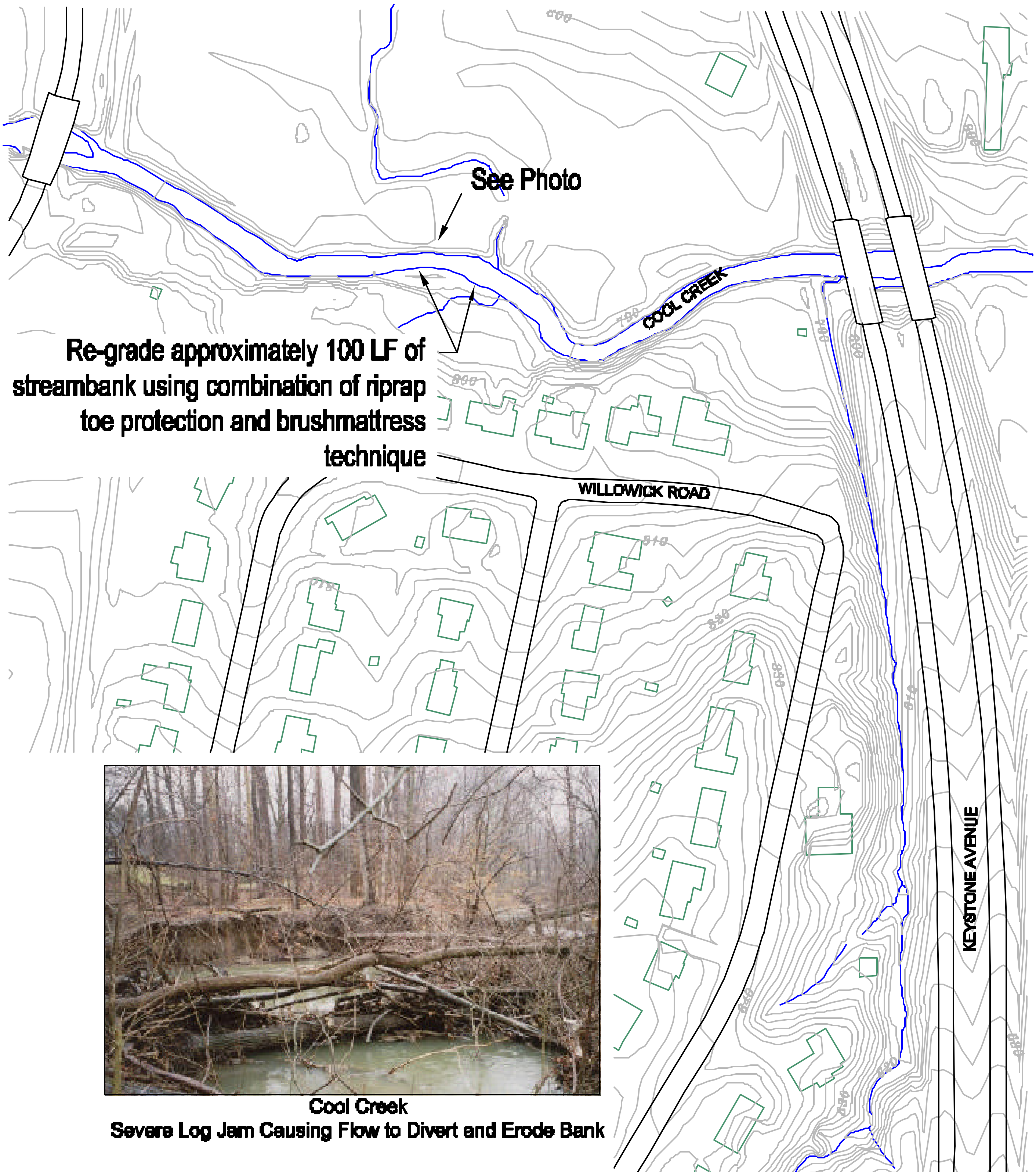
Cool Creek
Severe Bank Erosion, Tree Fallen into Creek

Scale: 1" = 200'

Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-16
Cool Creek
U/S of 131st Street



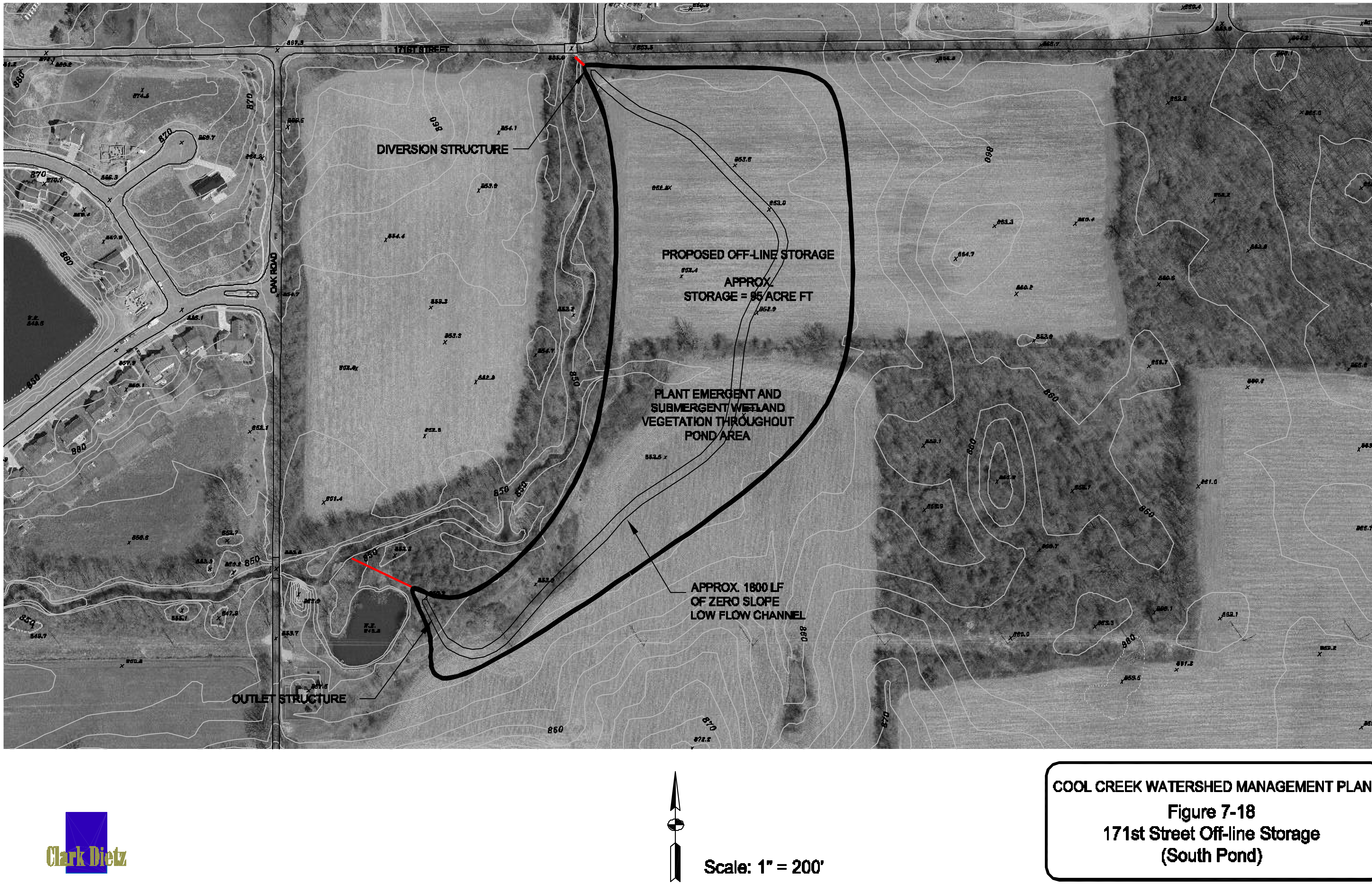
Cool Creek
Severe Log Jam Causing Flow to Divert and Erode Bank

Clark Dietz

Scale: 1" = 200'

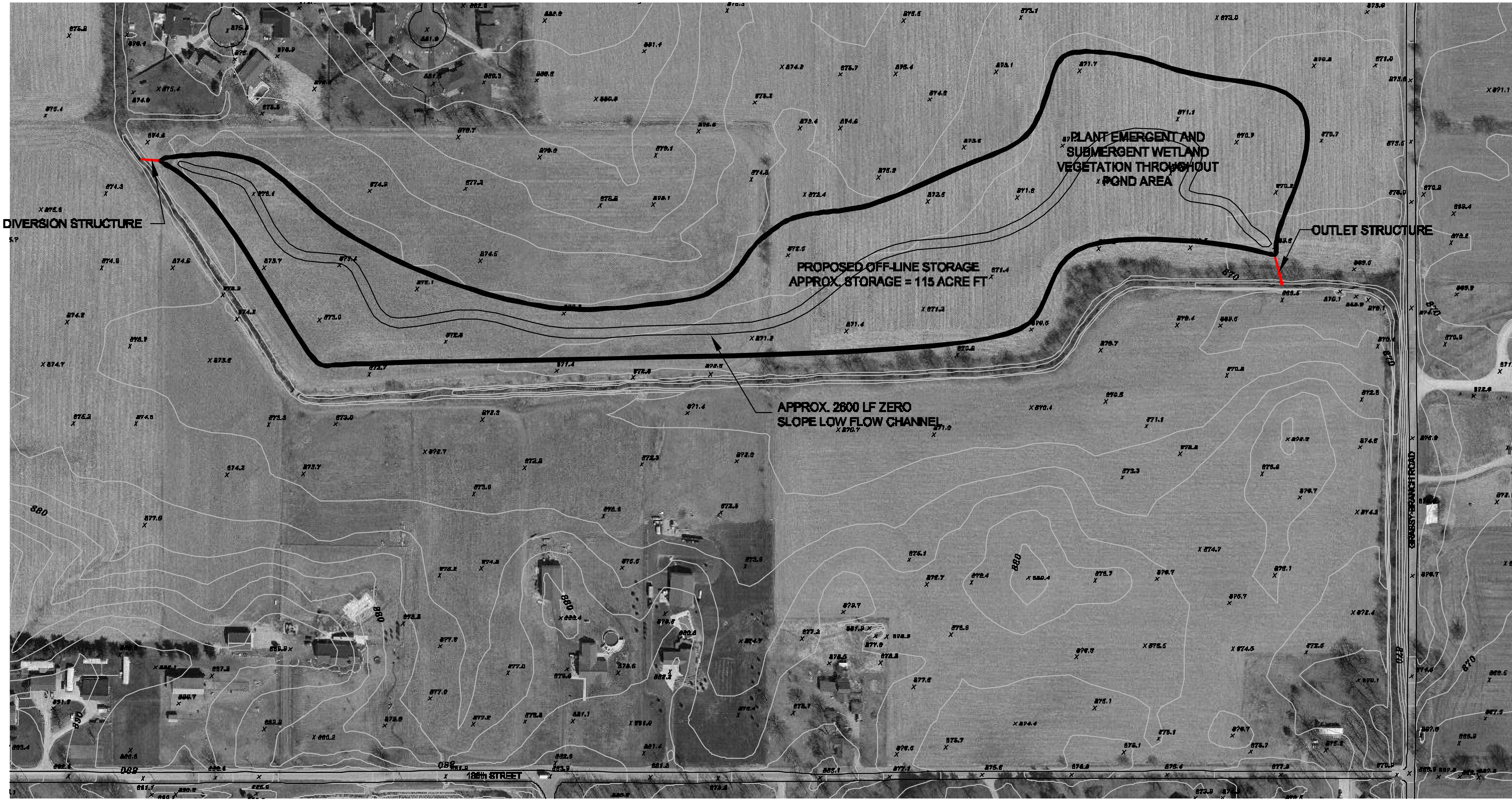
COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-17
Cool Creek
U/S of Keystone Avenue



Clark Dietz

COOL CREEK WATERSHED MANAGEMENT PLAN
Figure 7-18
171st Street Off-line Storage
(South Pond)



Scale: 1" = 200'

COOL CREEK WATERSHED MANAGEMENT PLAN

Figure 7-19
Grassy Branch Road Off-line Storage
(North Pond)

8.0 RECOMMENDATIONS, IMPLEMENTATION, AND FUNDING

8.1 INTRODUCTION

This chapter summarizes overall recommendations for the Cool Creek watershed and presents implementation and funding issues associated with each category of improvement projects. A detailed discussion of recommended projects is provided in Chapter 7.

8.2 RECOMMENDATIONS

8.2.1 Capital Projects

Bridge/Culvert Improvements - $1,820,000

- E. 151st Street (Cool Creek)
- E. 171st Street (Cool Creek)
- Gurley Street (Anna Kendall Drain)
- Cherry Street (Anna Kendall Drain)
- SR 32/Main Street (J.M. Thompson Drain)
- Thornberry Drive (Highway Run)

Bridge/Culvert Improvements that may not be needed (see Section 8.3.1 for reasons) - $900,000

- US 31 and Adjacent Private Drive (Highway Run)
- Walter Street, Private Drive, Walter Court (Highway Run)

Neighborhood Projects - $100,000

- Carmel Drive (Hot Lick Creek)
- Channel Improvement (Hot Lick Creek)

Streambank Erosion Projects - $570,000

- Highway Run
- H.G. Kenyon Drain
- Cool Creek (5 locations)

Regional Detention Projects - $5,100,000

- 171st Street Off-Line Detention Pond
- Grassy Branch Road Off-Line Detention Pond
- Anna Kendall In-Line Detention Pond

8.2.2 Land Use and Planning Policies

The following changes are recommended to land use and planning policies with regard to stormwater management:

- *Implement consistent floodplain fill regulations in the watershed.* Hamilton County prohibits fill in the floodplain while Carmel and Westfield currently allow fill, provided certain conditions are met. A consistent policy prohibiting fill within the 100-year floodplain would help prevent flooding and water quality problems.
- *Implement a stream buffer ordinance*. Stream buffer preservation/enhancement, coupled with floodplain regulations, will help prevent flooding problems and improve water quality.
- *Establish additional riparian vegetation along the upper reaches of Cool Creek.* Existing creeks have limited streamside vegetation. Additional vegetation would promote wildlife habitat and filter stormwater runoff.
- *Update stormwater ordinances and design standards to more proactively address water quality.* Best Management Practices, both structural and non-structural, should be implemented to prevent or reduce urban runoff problems associated with existing and future development.
- *Modify detention policies to incorporate channel and water quality protection.* Additional storage and more restrictive release rates for smaller storms will help capture stormwater runoff pollutants and reduce streambank erosion to receiving waters.
- *Identify and protect critical conservation areas* such as wetlands, forested areas, floodplains, and riparian areas.
- *Utilize sound site planning practices* by encouraging natural drainage protection and urban forestry when siting developments.
- *Utilize other structural and non-structural management practices* such as porous pavement, sand filters, infiltration practices, water quality swales, manufactured devices, vegetated filter strips, and bioretention areas.

The estimated cost to update ordinances and standards to incorporate the above recommendations is $200,000.

8.3 IMPLEMENTATION AND FUNDING

The follow is a brief summary of key implementation and funding issues associated with recommended improvements.

8.3.1 Bridge/Culvert Improvements *(see Chapter 7 Section 7.4 for project details)*

The optimal time to construct bridge/culvert improvement projects is in conjunction with planned roadway improvement projects so that traffic disruptions are minimized and projects are coordinated with overall infrastructure plans. The bridge/culvert improvements projects are generally located within public right-of-way with minimal land or easement acquisition needs. The Hamilton County Highway Department is responsible for all roads, bridges, and small structures (less than 20 foot span) within Hamilton County that are not state highways and that are not within the corporate limits of a city or town. They are also responsible for bridges which have a span of 20 or more feet on all roads in Hamilton County which are not state highways. Smaller structures within Carmel and Westfield are the responsibility of each community.

Implementation of the 151st Street and 171st Street bridge improvements should be coordinated with the Hamilton County Highway Department, as these structures fall under their jurisdiction. The Gurley Street and Cherry Street bridge replacement projects involve structures less than 20 feet and would fall under the jurisdiction of Westfield Utilities/Public Works Department. The SR 32/Main Street culvert replacement on the J.M. Thompson Drain would need to be coordinated with INDOT. Most of the bridge/culvert replacement projects will require a "Construction in a Floodway" permit from IDNR.

Improvements to culverts on Highway Run (US 31, Walter Street, Private Drive, and Walter Court) *may not be needed*. Plans were recently announced for a major retail development (Clay Terrace) along the west side of US 31 from 146th Street to south of Highway Run. Plans on the developer's web site (www.clayterrace.com) show that this development will encompass Highway Run and the Walter Street/Walter Court neighborhood. The costs for these culvert improvements remain in the Cool Creek Watershed Plan in the event that development plans change at this location. The other culvert replacement project on Highway Run (Thornberry Drive) is upstream from the proposed Clay Terrace development. Replacement of this culvert would fall under the City of Carmel's jurisdiction.

In terms of prioritizing the bridge/culvert replacement projects, the Gurley Street, Cherry Street, and SR 32/Main Street projects would have a higher priority as these structures restrict flows and place residential structures at risk to flooding. The US 31 and Walter Street area culvert improvements would also have a high priority for the same reason; however, the development plans in the area lower the priority of this project. Thornberry Drive would be a higher priority as this restrictive culvert also places residential structures at risk of flooding. The 151st Street and 171st Street bridge improvements are lower priority. While the roadway overtopping at these locations impedes traffic, it does not result in upstream flooding of residential or commercial structures. Alternate transportation routes exist should a flood occur that causes overtopping of these roads.

The recommended bridge/culvert improvement projects would likely be funded from capital budgets for streets and/or local drainage from the appropriate jurisdiction as these structures are a critical component of the transportation and drainage system. It may also be feasible to utilize the regulated drain funding mechanism above 146th Street, where Cool Creek, Anna Kendall Drain, and J.M. Thompson Drain are regulated drains.

8.3.2 Neighborhood Projects *(see Chapter 7 Section 7.5 for project details)*

The two projects categorized as neighborhood projects, are both located along Hot Lick Creek in the City of Carmel. The culvert replacement project at Carmel Drive would have a higher implementation priority than the upstream channel improvement. The restrictive culvert at Carmel Drive creates a backwater condition that places upstream structures at risk of flooding. The roadway (Carmel Drive) is also overtopped. The channel improvement project is primarily intended to direct the channel away from a fence along a residential property. There is a pool that is periodically flooded; however it is very low relative to the channel and extensive channel improvements would be needed to correct this problem.

The culvert replacement would be constructed in existing public right-of-way. The channel improvement portion of this neighborhood project is located on private property. Coordination with three property owners would be required and temporary construction easements would be needed. Funding for the culvert replacement would likely come from City of Carmel drainage funds. The channel improvement could also involve a cost share from the affected property owner.

8.3.3 Streambank Erosion Projects *(see Chapter 7 Section 7.6 for project details)*

Except for the H.G. Kenyon Drain, the streambank erosion projects are located within the City of Carmel (H.G. Kenyon Drain is in Unincorporated Hamilton County). The main implementation and funding impediment for the streambank erosion projects is that they are located on private property. South of 146th Street, Cool Creek is not a regulated drain and there are no maintenance easements. Hence, undertaking any of these streambank erosion projects will involve easement acquisition (either construction and/or permanent).

The City of Carmel has been reluctant to spend public funds on private property unless a particular streambank erosion area was causing damage or threatening a public utility or facility. If the property owner elects to repair streambank erosion on their own, technical assistance is available from the Hamilton County Soil and Water Conservation District (www.co.hamilton.in.us/gov/soil/services.asp). Technical assistance is *strongly encouraged* prior to any streambank restoration effort to ensure the project will be effective and will not create additional problems upstream or downstream. Most streambank projects would also involve a "Construction in a Floodway" permit from IDNR.

The estimated cost of the streambank erosion projects identified in this study ranges from $5000 to $300,000. It is probably not feasible for a property owner to undertake any of the larger projects. Funding would have to come from local drainage funds or possibly from grants and loans. Information on Federal funding is available at http://cfpub.epa.gov/fedfund/.

8.3.4 Regional Detention Projects *(see Chapter 7 Section 7.7 for project details)*

Implementation of the three recommended regional detention projects (two new basins and one retrofit) will be more difficult because of land acquisition and the high capital costs (relative to the other recommended projects). These ponds would provide significant flow reductions for the more frequent storm events, reduce downstream erosion, and improve water quality. All three government entities in the watershed (Hamilton County, Westfield, and Carmel) would benefit from their construction, indicating a joint funding approach may be appropriate. There may also be opportunities for partial grant funding because of the water quality component.
The 171st Street and Grassy Branch Road regional "off-line" detention basins are more costly to construct because of land acquisition and earthwork requirements. It may be more feasible to construct these ponds in conjunction with future development in the vicinity of the pond locations. Developers often require large volumes of fill for site grading. Having a nearby spoil area for excavated soil would significantly decrease pond construction costs.

The Anna Kendall Drain regional pond is less costly because the existing storage impoundment is created by an existing embankment. Significant upgrades to the embankment, including installation of an improved outlet structure and a new emergency spillway, will be required to meet dam safety regulations associated with "on-line" ponds. It is recommended the County use its regulated drain maintenance assessment to help generate funds for this project.

8.3.5 Ordinance and Standards Updates *(see Chapter 7 Section 7.8 for project details)*

The recommendations outlined in the land use and planning policies section of this chapter will require updates and/or new ordinances and design standards. These updates will likely be lead by Hamilton County since Carmel and Westfield already rely on County stormwater standards. The County is also leading efforts to coordinate upcoming IDEM Rule 13 requirements to address stormwater quality and impacts to receiving streams. The land use and planning recommendations in this study are directly applicable to Rule 13 implementation.

The estimated cost to update ordinances and standards is $200,000. This would include conducting stakeholder group meetings, internal staff meetings, design manual development/updating, and presentations/outreach to the development community.

8.3.6 General Discussion of Funding Options for Local Communities

Primary Sources

Adequate local funding sources for stormwater projects will be required to implement many of the recommendations in this study as well as other stormwater needs. Primary funding sources include tax supported funds, assessments, and user fees. Many Indiana communities use general funds, supported by property taxes, to fund stormwater improvement projects. General obligation, revenue, or special assessment bonds are often issued to finance large capital improvement programs. Repayment is normally through the general fund, special assessment district income and utility revenues. Demand for general funds is very high, as these funds are used for many programs, including police and fire protection. Stormwater often becomes a very low priority. Assessments, such as Barrett Law and Regulated Drains, can be used as a primary funding source for stormwater projects. Hamilton County effectively utilizes regulated drains and regulated subdivisions to construct and maintain drainage infrastructure. The maintenance assessment on the Anna Kendall Drain is an example of an effective method to fund improvements to the drain.

Faced with rising costs for regulatory compliance and a general reluctance to raise taxes, many communities have investigated or implemented user fees to fund drainage, flood control, stormwater runoff quality and other stormwater management activities. User fees are generally based on the volume of stormwater that runs off a property. The most common tool used to determine runoff is the relative amount of impervious area on a given property. Many communities find stormwater fees to be more equitable and stable than property taxes or other types of funding mechanisms. Indiana Counties (including Hamilton County) are also lobbying the State legislature and Governor's office to pass and sign into law enabling legislation that will allow Indiana Counties to establish stormwater user fees.

Secondary Sources

Secondary sources of funding can be used to supplement primary sources. They can be used for specific development or redevelopment projects, to fund ongoing processes like plan review and inspection, and to fund capital projects in existing developing areas.

Some of the more common secondary sources are:

- System Development Charges
- Special Assessments and Improvement Districts
- Plan Review and Inspection Fees
- In Lieu of Construction Fees
- Impact Fees
- Sales Taxes
- Grants and Loans

8.4 SUMMARY

Approximately $8.7 million in improvements are recommended for the Cool Creek watershed, including $8.5 million for capital projects and $200,000 to update stormwater ordinances and standards. Implementation of these recommendations will enhance public safety, improve water quality, assist in regulatory compliance, and provide a significant step towards achieving long-term environmental health for the Cool Creek watershed.

9.0 SECTION 319 UPDATES TO THE COOL CREEK WATERSHED MANAGEMENT PLAN

9.1 PROJECT INTRODUCTION

9.1.1 Preface and History of the Cool Creek Watershed Management Plan

Planning efforts for the Cool Creek watershed began in 2001, when Hamilton County, the Town of Westfield, and the City of Carmel agreed to jointly fund a study of the Cool Creek watershed. The project need grew out of concern about rapid development in the upper watershed of Cool Creek (Westfield and Hamilton County) and the potential for increases in downstream flooding and water quality degradation. Clark Dietz, Inc. was retained by Hamilton County (the lead agency) to conduct the necessary engineering analyses and develop the plan with input from watershed stakeholders. Planning efforts began in September 2001 and were completed in November 2003.

Subsequent to the completion 2003 plan, Cool Creek was placed on IDEM's 303(d) list for *E.Coli* impairment. To help address the impairment from *E.Coli*, as well as other pollutants of concern (nutrients, suspended solids, metals, etc.) Hamilton County applied to the Indiana Department of Environmental Management (IDEM) for a Section 319 Nonpoint Source Program Grant. The purpose of the grant application was to update the Cool Creek Watershed Management Plan to make it compliant with Section 319 requirements to reduce nonpoint source pollution. Although, the original 2003 plan did address stormwater quality issues, concerns, and recommendations, not all of the requirements of a Section 319 project were included. Having a fully compliant Section 319 Watershed Management Plan will further address nonpoint source pollution reductions and allow the County to apply for additional Section 319 grant funds to implement recommended improvement projects. The goal of implementing the water quality improvement projects is to remove Cool Creek from the 303(d) list of impaired waterbodies.

The section 319 grant was approved by IDEM in 2004 and a Contract for Services was formally approved by the State of Indiana on December 29, 2004. On January 24, 2005, Clark Dietz was retained by Hamilton County to provide the additional enhancements to the Cool Creek Watershed Management Plan.

The purpose of this chapter of the Cool Creek Watershed Management Plan is to address the Section 319 grant requirements that were not fully included in the 2003 plan.

9.1.2 Mission Statement

The original mission of the Cool Creek Watershed Management grew out of interest and concern regarding stormwater management practices and their effectiveness in controlling the quantity and quality of stormwater runoff. This issue was of special concern given the rapid growth in the Westfield area (upper half of the Cool Creek watershed). Over the course of the Cool Creek planning efforts, the mission of the Cool Creek Watershed Management Plan has evolved to:

> *Preserve and improve the overall health of the Cool Creek watershed by addressing existing stormwater quantity and quality concerns and by proactively guiding future stormwater management practices and decisions.*

9.1.3 Building Partnerships

A key element of the Cool Creek planning process was involving stakeholders and developing partnerships. The main partnership was through joint planning efforts by representatives of Hamilton County, the Town of Westfield, and City of Carmel. Stakeholders in these entities included the Surveyor's Office, the County Drainage Board, Engineering Departments, Planning Departments, Parks Departments, Soil and Water Conservation District, and others. Developers in the watershed were also consulted to obtain feedback and identify concerns. The general public was also involved through public meetings and outreach activities (newspaper articles, posting information on websites, etc.).

Meetings were held during the development of the 2003 plan as well as during the Section 319 planning process in 2005. Information on partnerships and stakeholder involvement during the original 2003 planning process can be found in the following locations in this report:

- Section 3.2 – Staff Interviews
- Section 3.3 – Developer Meetings and Input
- Section 3.4 – Public Meetings and Input
- Appendix B – Developer Meeting Summary
- Appendix C – Public Meeting Presentation Materials and Meeting Summaries

During the course of the current Section 319 update project, additional outreach and information activities were completed. The structure of these activities included public meetings, stakeholder committee meetings, interviews, and newspaper articles. The meetings were coordinated and advertised by the Hamilton County Surveyor's Office. Since most of the recommendations in the Cool Creek Watershed Management Plan were with regard to stormwater management public policy and public improvements, the primary decision makers were government representatives from Hamilton County, Westfield, and Carmel, which are the three public jurisdictions in the watershed. Clark Dietz's role was to prepare meeting presentations and materials, facilitate meetings, and summarize input obtained at the meetings.

Concerns and input on plan elements were obtained through conservations with the public or other stakeholders at the meetings. A variety of stakeholders were invited to participate in Stakeholder Committee meetings:

- Hamilton County, Westfield, and Carmel Staff (Surveyor's Office, SWCD, Engineering Department, Parks Department, Planning Department, Public Works)
- IDEM Staff
- IUPUI – Center for Earth and the Environment Staff
- Indianapolis Water (Veolia Water)
- Representatives from other Engineering and Ecological Consulting Firms
- Newspaper Reporters
- Business Community Representative
- Watershed Groups (Upper White River Watershed Alliance Technical Committee)

The following sections of Appendix H contain presentation materials, sign-up sheets, and summaries of input obtained at the various interviews and meetings:

- Appendix H.1 – Public Meeting Exhibits
- Appendix H.2 – Stakeholder Meeting Exhibits
- Appendix H.3 – Interview Exhibits
- Appendix H.4 – Newspaper Articles

9.2 WATERSHED DESCRIPTION

9.2.1 Watershed Features

The Cool Creek watershed is a sub-watershed of the Upper White watershed. The Hydrologic Unit Codes (HUC) and drainage areas are as follows:

- Upper White
  - o 8-digit HUC – 05120201
  - o Drainage Area – 2719.6 mi^2

- Cool Creek-Grassy Branch/Little Cool Creek *(commonly known as Cool Creek)*
  - o 14-digit HUC – 05120201090030
  - o Drainage Area – 23.6 mi^2

Figure 9-1 shows the Cool Creek watershed within the larger Upper White River Basin.

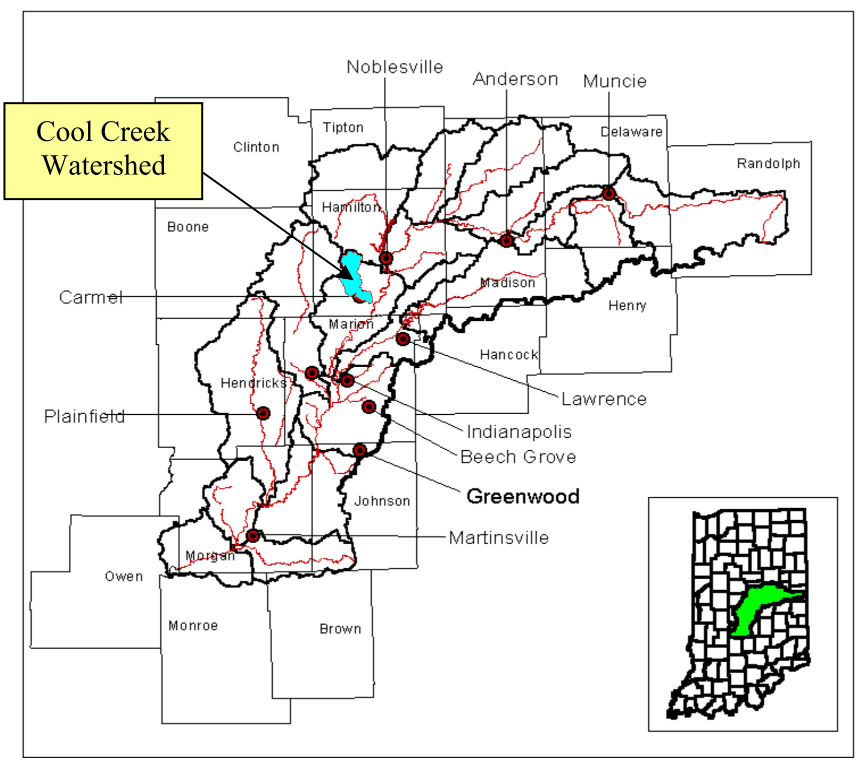


Figure 9-1
Cool Creek Watershed Location within Upper White River Basin
(Base map source – Upper White River Watershed Alliance)

Figure 1-1 in Chapter 1.0 of this report shows a map of the Cool Creek watershed with the approximate corporate boundaries of Westfield and Carmel shown. Figure 9-2 shows an aerial photograph (2003) with the Cool Creek watershed boundary and major streams.

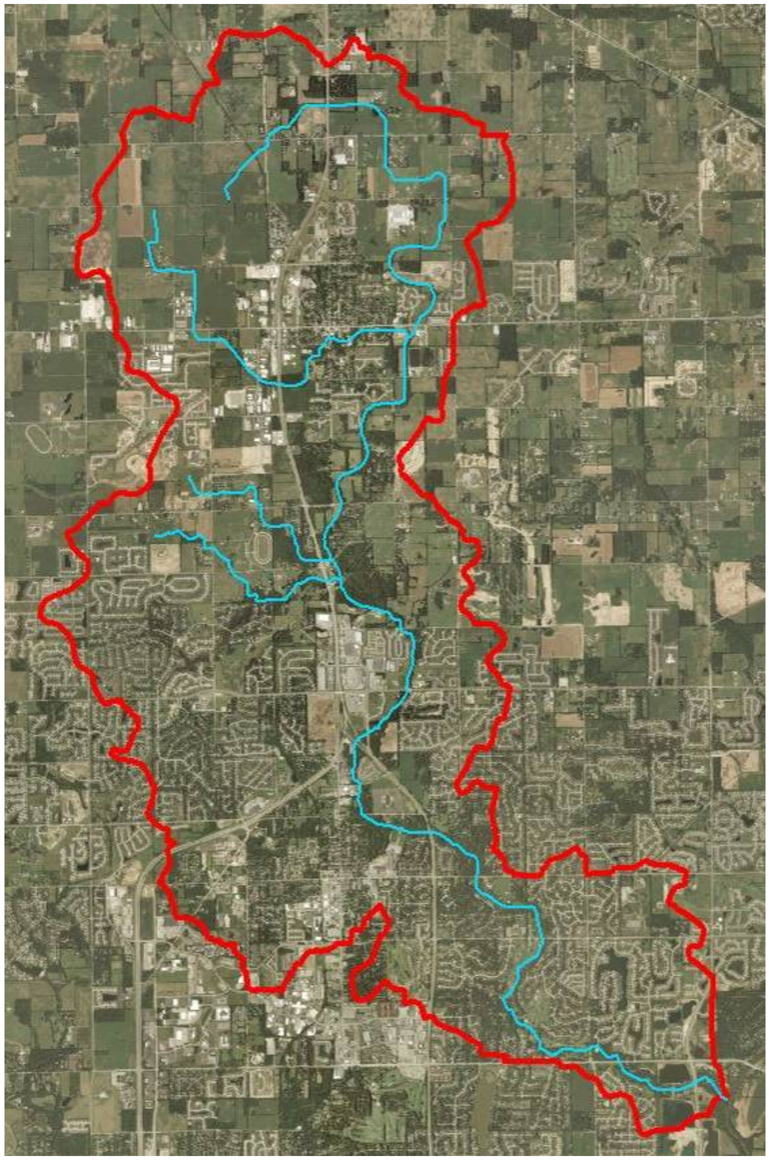


Figure 9-2
Cool Creek Watershed Aerial Photograph

Cool Creek flows south and southeasterly, discharging into the White River south of 116th Street. Tributaries include Hot Lick Creek, Little Cool Creek, Highway Run, Mary Wilson Drain, Osborn & Collins #2 Drain, H. G. Kenyon Drain, and Anna Kendall Drain (see Figure 3-1 in Chapter 3 for location of tributaries). US 31 and SR 431 are major roadways that run through the middle portion of the watershed.

The Westfield portion of the watershed contains both urbanized areas as well as significant tracts of undeveloped land (primarily agricultural). The Carmel portion of the watershed is fully urbanized. Portions of the watershed lie in unincorporated Hamilton County, but are subject to potential annexation in the future.

9.2.2 Physical Setting

The continental ice sheets covered Hamilton County some 20,000 years ago and earlier and had a profound effect on the terrain of the area. The preglacial bedrock topography which underlies the county was almost completely masked by the deposition of glacial clays, silt, sand, gravel and boulders. The existence of former valleys, which are today filled with as much as 350 feet of glacial materials, cannot be determined by visual examinations of or the present land surface. Much of the sand and gravel occurring within the valleys was deposited by the huge quantities of meltwater which issued from the receding glaciers.

(Source: www.state.in.us/dnr/water/publications/publicat/atlas608.htm)

The Hamilton County climate is temperate, with average monthly temperatures ranging from 24.9ºF in January to 74.3ºF. The climate varies with strongly marked seasons. Winters are often cold (sometimes very cold). The transition from cold to hot weather can produce an active spring with thunderstorms and tornadoes. Oppressive humidity and high temperatures arrive in summer. Autumn generally has lower humidity than the other seasons and mostly sunny skies.

Average precipitation (inches) is as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1.93	1.93	2.88	3.47	3.86	3.91	4.36	3.70	2.79	2.54	3.07	2.67	37.11

(Source: Indiana State Climate Office)

9.2.3 Natural History

Hamilton County, named for Alexander Hamilton, the first Secretary of the Treasury, was organized in 1823. It was largely agricultural and sparsely populated until well after World War II when suburban development began pushing into the area from Indianapolis. Since this time, most of the lower watershed has been converted from agricultural to primarily residential land. The upper watershed still has large tracts of agricultural land.

In the lower watershed, there are larger forested areas along Cool Creek and some of its tributaries. Native species in the forested areas include the following:

Trees

Black Cherry	Sugar Maple	American Basswood
Tulip	American Beech	Black Willow
Hackberry	Cottonwood	American Sycamore
White Ash	Ohio Buckeye	Red Oak
White Oak	Slippery Elm	Pignut Hickory

Shrubs and Small Trees

Flowering Dogwood	Elderberry	Wahoo
Spicebush	Pawpaw	Eastern Redbud

Red-osier Dogwood	Serviceberry	Hawthorne
Witch Hazel		

Forbs and Grasses

Swamp Milkweed	White Snakeroot	Wild Ginger
Pokeweed	Bottle-brush Grass	Blue-false Indigo
Pale Jewelweed	Tall Bellflower	Dutchman's Breeches
Bloodroot		

Vines

Poison Ivy	Virginia Creeper	Trumpet Creeper
Dutchman's Pipe	American Bittersweet	Wild Grape species
Clematis species		

(Source: Hamilton County Parks and Recreation Department)

9.2.4 Endangered Species

Information on threatened or endangered species was obtained from US 31 Preliminary Alternatives Analysis and Screening Report prepared for the Indiana Department of Transportation by the Parsons Transportation Group (July 2002). US 31 runs through the center of the Cool Creek watershed. The following is an excerpt from this report regarding threatened or endangered species:

> *"Information about threatened and endangered species within the project area was provided by the United States Fish and Wildlife Services (USFWS) and IDNR (Appendix C). The USFWS stated that the project area is within the range of the federally endangered Indiana bat and 11 US 31 Preliminary Alternatives Analysis and Screening Report federally threatened bald eagle. There are no current records of Indiana bats near the project corridor, however, the streams in the affected area have not been surveyed for the species. The USFWS indicated that there is suitable summer habitat for Indiana bats in forested areas along Cool Creek and possibly in the other riparian forest areas within the project area. Locally, there are multiple records of this species in adjacent Marion County, including a location within ten miles of the project area. It was also reported that there are no bald eagle nests or significant habitat areas near the project corridor. According to the IDNR NHP database (January 31, 2002), the Red Shouldered hawk, a state species of special concern, and the American badger, a state endangered species, have been reported to occur in the project vicinity, though these reports are 13 to 45 years old. No critical habitat for any threatened or endangered species, including the Indiana bat, has been identified within the project area."*

Table 9-1 also contains a listing of State and Federal endangered, threatened, or rare species in Hamilton County.

In addition to Table 9-1, the endangered, threatened, or rare birds listed below have been observed in Cool Creek Park. Cool Creek Park is a popular attraction for bird watching enthusiasts. The Red Shouldered Hawk (listed in Table 9-1 as a species of special concern) and the Black and White Warbler have been observed nesting in the park. Other birds listed as endangered or special concern by the IDNR Division of Fish and Wildlife that have been sighted in the park include:

Yellow-crowned Night Heron	Osprey
Bald Eagle	Sharp-shinned Hawk
Peregrine Falcon	Sandhill Crane
Golden-winged Warbler	Cerulean Warbler
Black-and-White Warbler	Worm-eating Warbler
Hooded Warbler	Broad-Winged Hawk

(Source: Hamilton County Parks and Recreation Department)

9.2.5 Soils

Section 2.3.4 of this report describes the predominant soil types and their characteristics in the Cool Creek watershed**.**

9.2.6 Topography

Topography in the Cool Creek watershed was reviewed as part of the hydrologic analysis. The watershed was subdivided into 35 subbasins (see Figure 5-2). To estimate hydrologic times of concentration, subbasin slopes were computed. The slopes ranged from 0.1 percent to 1.7 percent. The upper watershed generally has flatter slopes (average of 0.5 percent) while the lower watershed exhibits steeper slopes (average of 0.8 percent).

The lower watershed (south of 146th Street) generally has reaches of steep slopes (20 to 40 percent) along the floodplain fringe of Cool Creek. In areas where the channel of Cool Creek is located adjacent to the steep banks, streambank erosion is often found. These reaches can be seen on the Stream Inventory Maps contained on the CD found in Appendix H.5.

9.2.7 Hydrology

The major and minor stream systems of Cool Creek are shown on various figures in this report (Figure 3-1, Figure 5-2, and the Stream Inventory Maps on the CD in Appendix H.5). The overall stream system drains in a south, southeast direction, until its confluence with the White River. Some stream channelization and straightening has occurred in the far upper reaches of Cool Creek (referred to as Grassy Branch) as well as along the Anna Kendall Drain.

There are no dams or reservoirs in the watershed, other than a series of on-line lakes that provide stormwater detention for the Countryside development, which is located in subbasin C10 (see Figure 5-2). These lakes are located in the headwaters of the Osborn & Collins Drain.

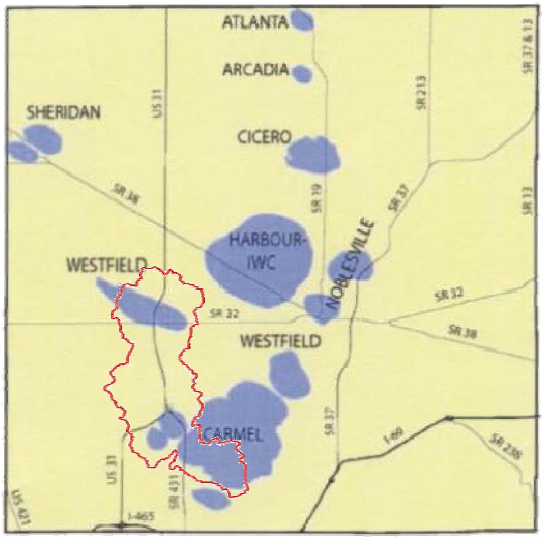
Table 9-1
State and Federal Endangered, Threatened or Rare Species in Hamilton County.

Common Name	State Rank	Federal Rank
	Vascular Plants	
Lake Cress	SE	**
Spoon-Leaved Sundew	SR	**
Prairie White-Fringed Orchid	SE	LT
	Mollusca: Bivalvia (Mussels)	
Black Sandshell	**	**
Round Hickorynut	SSC	**
Clubshell	SE	LE
Rabbitsfoot	SE	**
Lilliput	**	**
Rayed Bean	SSC	**
Little Spectaclecase	SSC	**
	Fish	
Eastern Sand Darter	SSC	**
	Amphibians	
Mudpuppy	SSC	**
	Reptiles	
Spotted Turtle	SE	**
Eastern Massasauga	SE	**
	Birds	
Upland Sandpiper	SE	**
Red-Shouldered Hawk	SSC	**
Least Bittern	SE	**
Black-Crowned Night-Heron	SE	**
Bewick's Wren	SE	**
	Mammals	
Bobcat	SE	**
American Badger	SE	**
	High Quality Natural Community	
Wet-Mesic Floodplain Forest	SG	**
Mesic Upland Forest	SG	**

Key:
State: SE=endangered, ST=threatened, SR=rare, SSC=special concern, SG=significant, **=not listed
Federal: LT=threatened, LE=Endangered, **= = not listed

(Source: http://www.in.gov/dnr/naturepr/species/)

There are no water supply reservoirs in the watershed. However, there are significant wellfield areas, as shown on Figure 9-3. A smaller wellfield is located in the upper portion of the watershed in Westfield. A larger wellfield is located in the lower watershed in Carmel. Signage is located in the watershed to raise awareness. Carmel, Westfield, and Hamilton County all provide outreach materials (website, brochures) on drinking water protection.



Example Signage for Wellfield Protection

Figure 9-3
Wellfield Protection Areas

(Source: Hamilton County Survey's Office Brochure on "Protecting Your Drinking Water")

Other hydrology features in the watershed include wetlands. Figure 9-4 shows wetlands (light blue areas) from the National Wetland Inventory Maps on an aerial photograph of the watershed. The types of wetlands are more fully described in Section 2.2.3 of this report.

Figure 9-4
Wetland Areas

9.2.8 Land Use

Hamilton County, near the geographic center of Indiana, has a population of about 175,000 (2000 Census) and a land area of 400 square miles. As shown in Figure 9-5, population has steadily increased since about 1970, with a significant increase between 1990 and 2000.

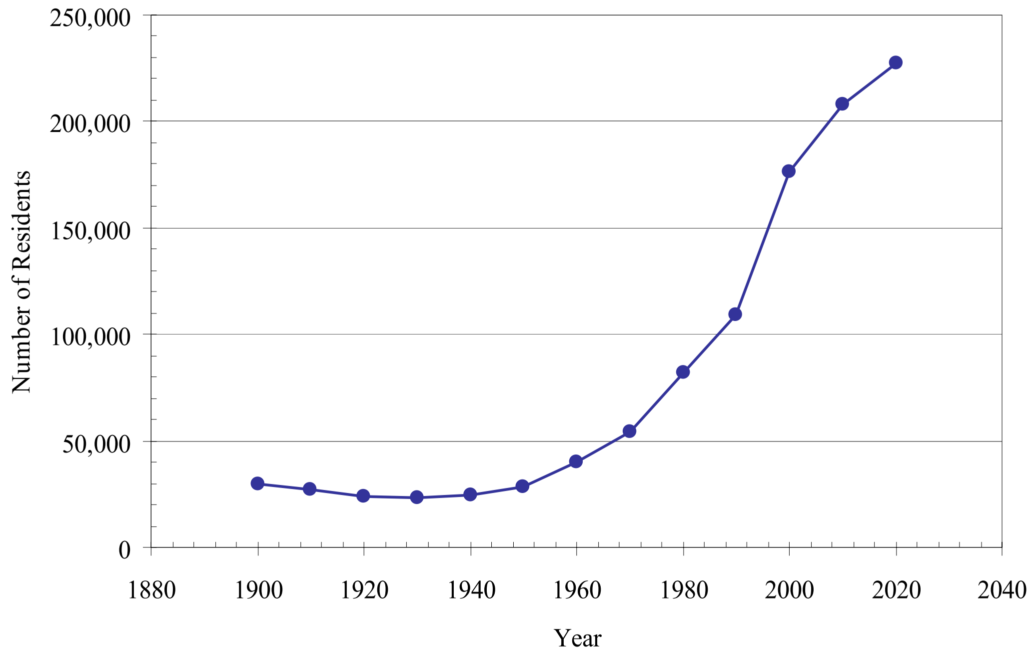


Figure 9-5
Population Trends for Hamilton County

With rapid increases in population, the corresponding land use has changed in the watershed. As part of the hydrologic analysis portion of this project, land use was computed for each of the watershed subbasins (Figure 5-2). Figure 9-6 illustrates the land use distribution for the total watershed, upper watershed, and lower watershed. For the overall watershed, land use consists of 47% agricultural, 39% residential, 7% wooded, 5% commercial, 2% Open Space, and less than one percent industrial. In the upper watershed, agricultural is the predominant land use (70%) while the lower watershed has residential as the predominant land use (70%). Agricultural land in the upper watershed is expected to be urbanized as population in Westfield and Hamilton County continues to grow. Appendix H.6 contains land use maps from the City of Carmel and Town of Westfield.

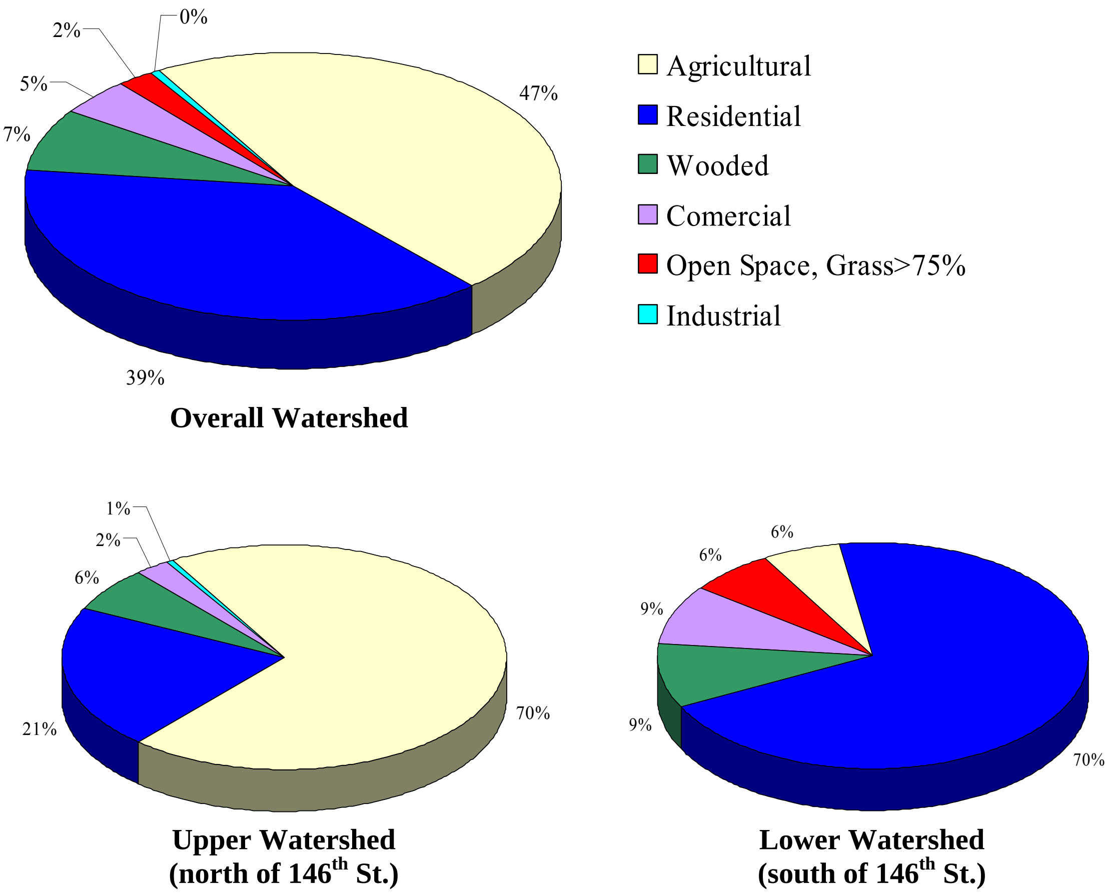


Figure 9-6
Land Use Distribution in the Cool Creek Watershed

The only significant public lands in the watershed are park areas. Cool Creek Park, located north of 151st Street and east of Westfield Boulevard, was opened by the Hamilton County Parks Department in 1990. The park is approximately 90 acres in size and is 80 percent forested and 20 percent open space, with Cool Creek meandering through the park. The park has a large trail network and is a popular attraction for bird watching enthusiasts. A nature center is also located at the park and provides educational exhibits on wildlife habitat.

Flowing Well Park located in the lower watershed (north of 116th Street and east of Gray Road) contains natural areas and open space, a one-and-half-mile walking trail, manmade wetlands, interpretive signs, two observation decks and an open shelter. Cool Creek also meanders through Flowing Well Park. The 18-acre park is a popular attraction for its flowing artesian well. According to historical accounts, the well was discovered by accident when a crew drilling for natural gas in the early 1900s missed the gas but hit a natural pocket of water that spewed under great pressure into the air. People from across Hamilton County gathered to see the geyser. In the 1920s, the well flowed at 60 gallons per minute, and it still runs about 15 gpm, according to the Carmel Parks Department, which maintains the Flowing Well and its small, heavily wooded park.

9.3 WATER QUALITY EVALUATION AND BENCHMARKS

9.3.1 Designated Uses and Stream Impairment

Under the provisions of the Clean Water Act, the Indiana Water Pollution Control Board has designated state waters, except waters within the Great Lakes system (327 IAC 2-2.5), for the following uses (327 IAC 2-1-3): Full-body contact recreation (April-October); capable of supporting a well-balanced, warm water aquatic community and where temperatures permit, capable of supporting put-and-take trout fishing.

Every two years, under Section 303(d) of the Federal Clean Water Act, states are required to identify waterbodies that do not meet water quality standards for designated uses. Impaired waterbodies may be impacted by both point and nonpoint sources of pollution. From the 303(d) list, states must establish priority rankings to develop Total Maximum Daily Loads (TDML). The most recent (2004) IDEM 303(d) list has Cool Creek included, with the parameter of concern being *E. Coli*.

The Indiana Integrated Water Quality Monitoring and Assessment Report (IDEM, 2004) lists Cool Creek as fully supporting for aquatic life support and non supporting for primary contact. The impairment is due to pathogens (classification is moderately impaired).

9.3.2 Water Quality Sampling

Stream sampling was performed during the development of the original Cool Creek Watershed Management Plan (sampling completed in 2002). Section 4.4 of this report provides a detailed description of this sampling program and results as well as more general observations, including the results of visual inspections.

Table 9-2 contains the results of existing pollutant loadings that were calculated for pollutants sampled during the 2003 Cool Creek Watershed Management Plan. The load calculations are based on the March 25th, 2002 sample results and HEC-HMS flow rates for the median storm event in an average year. The March 25th, 2002 storm event was 0.70 inches which approximates a median storm event for central Indiana (about 0.65 inches over 13 hours).

Table 9-2
Load Calculations of Existing Pollutants

Parameter	Units	116th St.	146th St.	186th St.
BOD	tons/yr	2,880	1,890	430
COD	tons/yr	5,640	3,790	870
Nitrogen, Kjelhdahl	tons/yr	1,300	800	100
Nitrogen, Nitrate	tons/yr	510	460	190
Nitrogen, Ammonia	tons/yr	500	1,930	370
Nitrogen, Total	tons/yr	1,800	1,250	290
Nitrogen, Organic	tons/yr	790	----	----
Suspended Solids	tons/yr	67,720	23,110	960
Dissolved Solids	tons/yr	158,000	110,000	34,000
E coli	mCFU/yr	4,620,000	1,030,000	710,000
Fecal Streptococcus	mCFU/yr	615,600	826,700	----

Note: Dissolved Phosphorus, Hex Chromium, Phenol, Copper, Nickel, and Zinc load calculations are not shown since the measured levels were below the detection limits.

Loadings were also calculated using the Indiana Water Quality Standard for *E. Coli* (235 CFU/100ml) in order to find the threshold value for Cool Creek at the different sample locations. E. coli levels for each sample location were above the Indiana Water Quality Standard for *E. Coli*. Table 9-3 shows these results:

Table 9-3
Indiana Water Quality Standard for *E. Coli* Load Calculations

Parameter	Units	116th St.	146th St.	186th St.
Indiana Standard	mCFU/yr	1,206,000	809,000	185,000
Sampled (03-25-02)	mCFU/yr	4,620,000	1,030,000	710,000

During the water quality sampling program completed as part of the 2003 plan, slightly elevated levels of two metals (Chromium Hex and Nickel) were found during one of the wet weather events (August 19, 2002 event). The most common source of metals is automobiles (tire wear, brake linings, leaking fluids, engine parts, etc.). The August 19, 2002 storm event was very heavy and intense, with 2.5 to 2.9 inches falling over a few hours. Runoff of particulates from vehicular roads was likely greater than in a typical median event of 0.65 inches of rain. During the other wet weather sampling event (0.7 inches of rain), metals were found to be below the detection limit. Hence it is not possible to conclude that metals are a major concern in the Cool Creek watershed. Promotion of pollution prevention practices such as proper automobile maintenance, municipal good housekeeping practices, and other stormwater BMPs will help to reduce metals entering Cool Creek during storm events.

As part of this Section 319 project, additional available water quality data from other sources was investigated and summarized. These sources include the IDEM Assessment Branch Data and volunteer monitoring.

Assessment Branch Data

The IDEM Division of Water's Assessment Branch collected water quality samples in 1992, 1996 and 2001. These results were reviewed and compared to water quality sampling data completed for the original Cool Creek study in 2002. The IDEM samples were taken in the 116th Street area.

The 1992 data included a survey of Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI). The resulting score was 4, which indicated fully supporting at that time. The mIBI support classifications are as follows:

- Fully Supporting mIBI ≥ 4
- Partially Supporting mIBI < 4 and ≥ 2
- Not Supporting mIBI < 2

Figure 9-7 and 9-8 compare the IDEM data to the data collected during the original Cool Creek study. The results are presented for E. Coli and nitrogen. E. Coli levels have increased significantly when comparing 1996 to 2001 and 2002. The three samples collected in 1996 were all below the standard for primary contact recreation (235 CFU/100ml). The 2001 IDEM and 2002 Cool Creek study results for E. Coli showed all but two samples exceeding the primary contact standard. This result is reflected in Cool Creek being placed on the 2004 303(d) list. For Kjelhdahl Nitrogen two of the four samples collected in 2002 were significantly higher than the IDEM 1996 data. The other two samples were similar to the 1996 IDEM data.

Figure 9-7
***E. Coli* Sample Results (116th St.)**

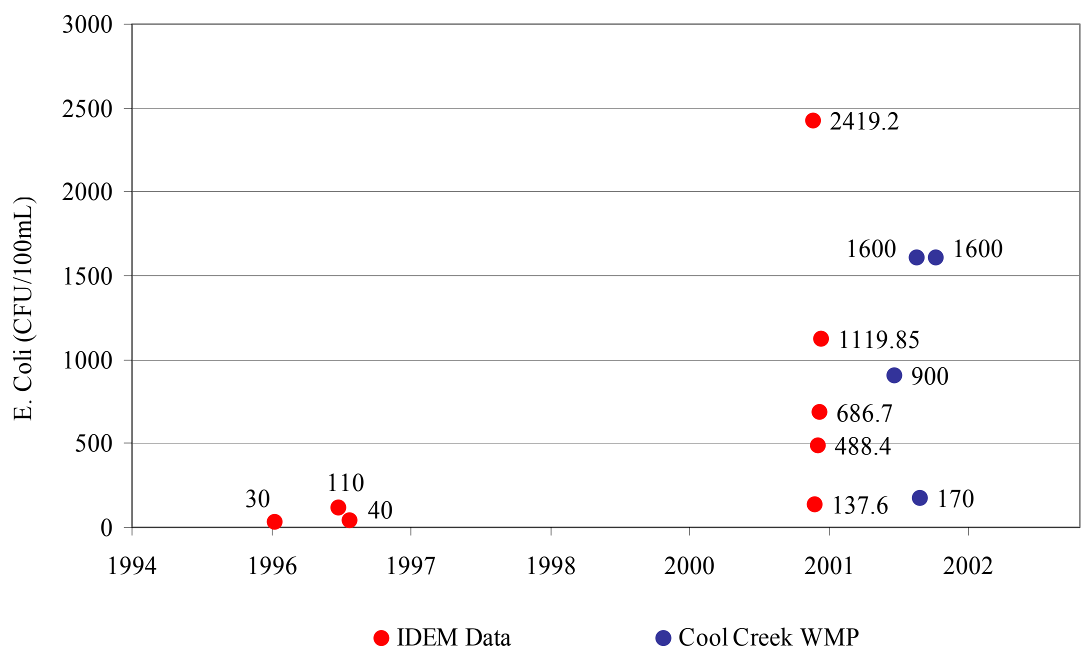
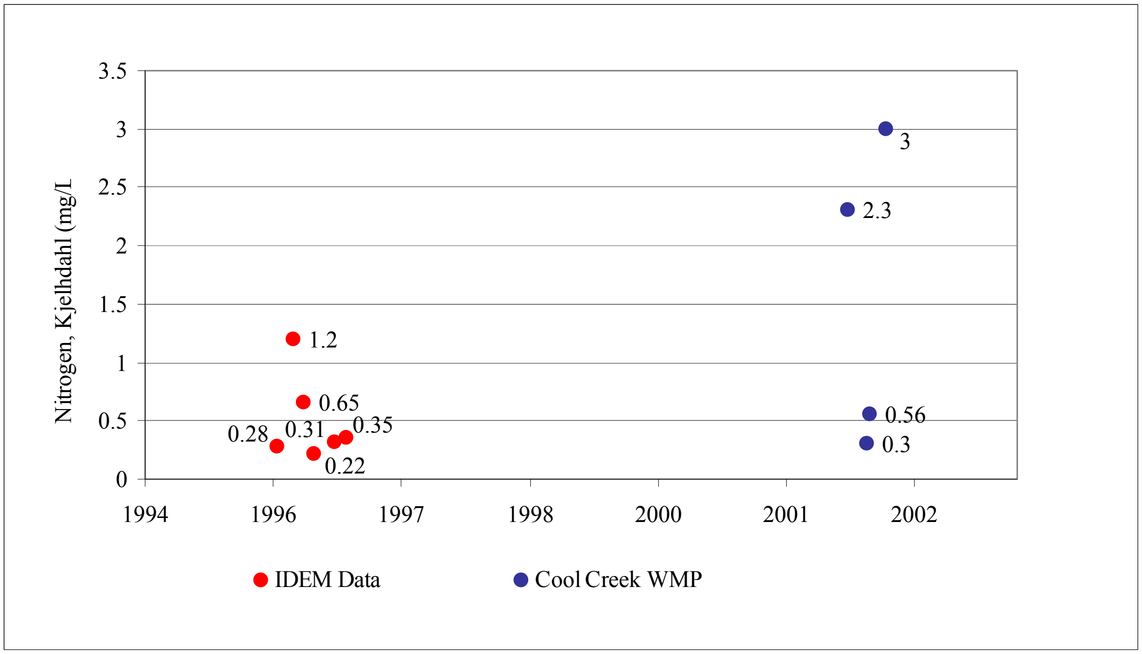


Figure 9-8
Kjelhdahl Nitrogen Sample Results (116th St.)

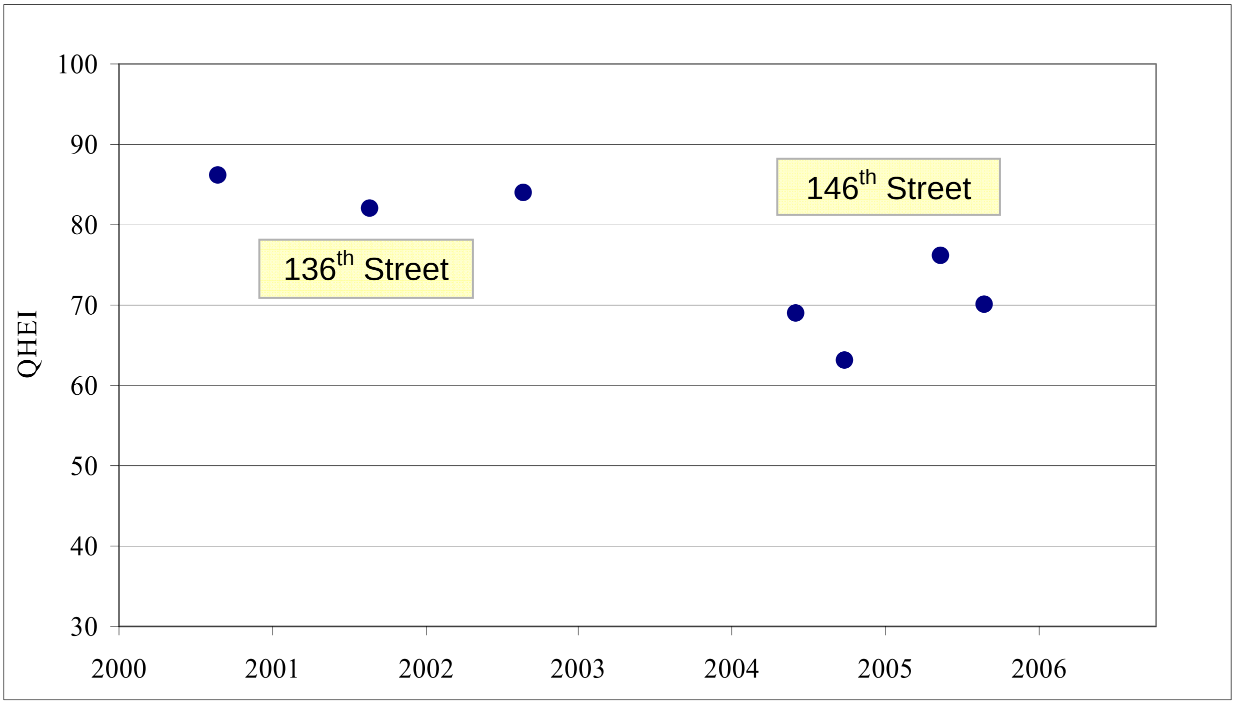


Volunteer Data

Volunteer data for Cool Creek watershed was obtained from the Hoosier Riverwatch Volunteer Stream Monitoring Internet Database. Indiana volunteer stream monitoring groups enter data collected during habitat, chemical, and biological sampling. Only volunteers who have completed a Hoosier Riverwatch training workshop may enter data into the statewide Internet Database. Available data for Cool Creek included the Qualitative Habitat Evaluation Index (QHEI).

The QHEI was developed by the Ohio EPA to provide a qualitative evaluation of the stream habitat by measuring the physical features that affect aquatic communities. This index provides information on a stream's ability to support fish and macroinvertebrate communities. The QHEI is composed of six parameters that are related to stream fish communities: substrate, in stream cover, channel morphology, riparian and bank conditions, pool and riffle quality, and gradient. Each parameter is scored individually and then summed to provide a total score, not to exceed 100. An QHEI of greater than 64 is fully supporting for designated uses, from 64 to 51 is considered partially supporting for designated uses, and less than 51 is not supporting for designated uses. Figure 9-9 illustrates the findings of the volunteer samples taken from 8/30/2000 to 8/29/2005:

Figure 9-9
QHEI Results



The QHEI results showed Cool Creek to be fully supporting for aquatic habitat in 6 of the 7 samples obtained. The samples on the left were taken at 136th Street and the samples shown on the right were taken at 146th Street. The stream characteristics at these two locations differ so the data points at the different location cannot be compared over time to indicate a trend. The scores at 146th Street are a result of a lower substrate scores which could be attributed to sediment from recent construction in the 146th Street area.

Other Sources

Though not directly tied to water quality, other observations and information obtained during the course of the previous and current Section 319 Cool Creek study provide additional insight into the overall health of the Cool Creek watershed. A detailed evaluation of the riparian corridor was completed to identify stream reaches with significant erosion, stormwater outfalls, encroachments, potential pollutant sources, and other noteworthy findings. The results of this effort are shown on the Problem Area Map (Figure 3-1) and on the Stream Inventory Maps contained on the CD in Appendix H.5.

Other observations on water quality included a review of the riparian areas along Cool Creek. South of approximately 171st Street, Cool Creek generally has a healthy riparian zone that provides wildlife and aquatic habitat. This accounts for approximately 9.8 miles of Cool Creek. North of 171st Street, the stream has limited riparian vegetation with agricultural land located very close to the stream (limited stream buffers). This accounts for approximately 2.2 miles of Cool Creek.

Another issue affecting habitat in wooded areas of Cool Creek is the invasion of non-native species. This issue has been identified as part of the Nature Center activities at Cool Creek Park. Staff at Cool Creek Park typically organize 5 to 10 service days for various organizations that assist in the removal of invasive species from the park. The Center for Earth Center for Earth and Environmental Science (CEES) at Indiana University ~ Purdue University, Indianapolis recently sponsored a service day, as outlined on their website as follows:

> *"One of the major threats to the ecology of Cool Creek Park are invasive species; namely Bush Honeysuckle. This shrub is extremely prevalent in the park. Over the last 10 years the plant has found its way into nearly every section of forested area of the park and is drastically effecting the ecological diversity. Several species of native shrubs and small trees including Spicebush, Elderberry, Dogwood, and Wahoo are beginning to decline due to this invasive. Efforts by park staff and volunteers have been underway for about 3 years to manage the issue."*

(Source: www.cees.iupui.edu/Service_Learning/All_Projects/Cool_Creek_Park.htm)

9.3.3 Water Quality Benchmark Summary

To summarize, the review of water quality information collected by IDEM, volunteer monitoring groups, and during the original Cool Creek Study has led to the following benchmark findings:

- Overall, Cool Creek is fully supportive for aquatic life.
- The constituents and concentrations of pollutants found in Cool Creek are generally comparable to urban and urbanizing watersheds across the country.
- Nutrients appear to be somewhat higher than national averages. This could be the result of excess fertilizer use coupled with agricultural runoff from the upper watershed. Public education regarding proper lawn care may be an appropriate follow up activity.
- Suspended solids were very high for one of the sampled events, though this was an atypical storm event. Proper erosion and sediment control on construction sites, in addition to streambank restoration, will help to control suspended solids levels.
- Bacteria levels exceed those required for recreational contact (problem common in many urban watersheds). Efforts should be made to track and reduce human sources of bacteria that may result from failing septic systems, illegal sanitary sewer connections, and other sources. Public education on proper disposal of pet waste would also be a best management practice to help reduce bacteria levels.
- Increased streambank erosion, particularly along Cool Creek south of Keystone Avenue, adversely impacts water quality as eroded channel banks result in downstream sedimentation.
- Limited riparian vegetation and stream buffers north of 171st Street provides limited wildlife habitat and increases transportation of sediment into Cool Creek.

9.4 DEVELOPMENT OF PROBLEM STATEMENTS AND GOALS

9.4.1 Stressors and Sources

The Cool Creek watershed is experiencing rapid development which is resulting in increased urbanization and impervious areas in the watershed. Sampling, investigation, and analysis of the data have shown that the sedimentation, streambank erosion, flooding, and stormwater pollutants have become areas of concern. Previous chapters of this report and previous sections of this chapter have identified numerous stressors and sources throughout the watershed. The following summarizes the stressors and sources that were used to develop problem statements and goals.

- Streambank Erosion
  - Urbanization (increase in impervious areas)
  - Impacts of detention basins (longer bank full flow conditions)
  - Channel encroachments
  - See Figure 3-1 for locations of stream reaches with erosion problems.

- Sedimentation
  - Inadequate erosion control on construction sites
  - Limited stream buffers in upper watershed
  - Supported by high TSS levels during wet weather event with nearby construction site (see Table 4-1)

- Elevated nutrients in wet weather runoff
  - Fertilizers (agricultural, residential, commercial)
  - Supported by high levels of nutrients during wet weather sampling event (see Table 4-1)

- Bacteria (now listed as non-supportive for primary contact on 305(b) report, on 303(d) list for E.Coli)
  - Wildlife, pet waste
  - Leaky septic systems
  - SSOs, spills, general urbanization
  - Supported by sampling results (see Table 4-1 and Figure 9-7)

- Flooding problems
  - Inadequate bridges, culverts
  - Undersized local drainage systems
  - Floodplain development
  - See Chapter 7

- Loss of Ecological Diversity in Riparian Areas (Cool Creek Park)
  - Influx of invasive species (Bush Honeysuckle)
  - Supported by Hamilton County Parks and Recreation Department

9.4.2 Problem Statements

Based on the water quality evaluation benchmarks and the identified watershed stressors and sources for Cool Creek, the following problem statements have been developed.

- Continued urbanization in the upper Cool Creek watershed is increasing streambank erosion, degrading aquatic habitat, and increasing the stormwater pollutants in runoff.
- Lack of riparian buffers in the agricultural areas in the upper Cool Creek watershed increase downstream sediment loads and provide limited wildlife habitat.
- Inadequate construction site erosion and sediment controls threaten downstream aquatic habitat.
- High nutrient levels (particularly ammonia) caused by both urban and agricultural runoff threaten aquatic life.
- Increased bacterial levels caused by urbanization and other sources have impaired full contact recreation use of Cool Creek.
- The influx of invasive species such as the Bush Honeysuckle has resulted in reduced ecological diversity in forested areas of Cool Creek.
- Inconsistent floodplain regulations have resulted in loss of floodplain storage and riparian habitat.
- Undersized bridges and culverts result in roadway overtopping and threaten public safety.

9.4.3 Development of Goals

The following goals have been developed to address the problem statements.

- Reduce impact of urbanization by modifying stormwater detention policy to control smaller storms and treat the first flush of runoff.
- Implement consistent floodplain development restrictions by adopting necessary legal authority (ordinances).
- Develop comprehensive erosion and sediment control programs in Hamilton County, Westfield, and Carmel (ordinance, plan review, inspection, and enforcement).
- Provide public education and outreach to residents and business in Cool Creek Watershed to promote good watershed behavior (disposal of pet waste, proper lawn chemical use, illicit discharges, etc.).
- Construct the bridge and culvert conveyance improvement projects to reduce flood hazards and protect of public safety.

- Continue the Hamilton County Parks and Recreation Department's community service program to remove invasive species and protect ecological diversity in forested areas.

- Implement the Oak Manor Regional Stormwater Quality Facility and other similar facilities to reduce downstream channel erosion and reduce non-point source pollutant levels (nutrients, sediment, metals, bacteria).

- Repair/restore severe channel erosion in the lower reaches of Cool Creek to improve aquatic habitat, reduce sedimentation, and protect public and private facilities.

- Improve the riparian habitat in the upper watershed by establishing stream buffers and vegetation as areas are developed around Cool Creek.

- Provide sanitary sewer service to the few neighborhood areas in Westfield still on septic systems.

9.5 CRITICAL AREA IDENTIFICATION

9.5.1 Targeting Critical Areas

Critical areas for the Cool Creek watershed were identified for each of the stressors/sources listed in section 9.4. The potential pollutant load reductions (for those that could be quantified) for these critical areas are presented in section 9.6.

Streambank Erosion

This is significant threat to the Cool Creek watershed. Streambank erosion transports sediment downstream as channel banks erode and fall into the creek. Erosion also threatens public and private property. Urbanization is the likely cause of increased erosion.

The most critical areas of streambank erosion are the orange shaded areas on the Problem Area Map in Figure 3-1 and summarized as follows:

- Cool Creek upstream of the confluence with the White River (1500 feet)
- Cool Creek downstream of Gray Road (200 feet)
- Cool Creek upstream and downstream of Hot Lick Creek (575 feet)
- Cool Creek upstream of 131st Street (150 feet)
- Cool Creek upstream of Keystone Avenue (100 feet)
- Highway Run downstream of Stonehedge Drive (100 feet)
- H.G. Kenyon Drain downstream of Rolling Court (250 feet)

Sedimentation (from construction sites and agricultural areas)

By volume, sediment is the largest contributor of pollutants to the receiving streams in the Cool Creek watershed. Construction sites are temporary and therefore cannot be specifically targeted. Hamilton County, Carmel, and Westfield will all be implementing programs for plan review, inspection, and enforcement of runoff from construction sites as part of their Rule 13 permit with IDEM.

Agricultural areas can also provide high sediment loads, particularly where conservation tillage is not practiced and where stream buffers are limited. Many agricultural lands in Hamilton County utilize conservation tillage (particularly for soy beans, less so for corn). Stream buffers on Cool Creek north of 171st Street are limited (approximately 2.2 miles of stream). This reach of Cool Creek is targeted for implementation of additional stream buffers.

Elevated Nutrients in Wet Weather Runoff

Elevated nutrients from fertilizers can be caused by both agricultural and urban land uses. As such, it is difficult to target specific critical areas. Elevated nutrients were found during the March 25, 2002 sampling event, but not the August 19, 2002 sampling event. This finding points to spring fertilizers (agricultural as well as residential/business lawn fertilizing) as a potential source. For agricultural runoff, grassed or vegetated buffer strips along Cool Creek would help reduce nutrients. This would be applicable for the Cool Creek from its headwaters, downstream to approximately SR 32. Another potential nutrient source includes a golf course that runs along Cool Creek between 116th Street and 126th Street. However, the sampling results at 116th Street did not show elevated nutrients. Golf courses typically are large users of fertilizers, but they are generally very careful in their application since this is a high cost operation item. Lastly, residential areas are potential sources for nutrients from lawn fertilizers. Neighborhood associations would be good targets to distribute information on proper use of lawn chemicals.

Bacteria

Potential sources of bacteria are widespread and difficult to target critical areas (see section 4.4.4 of this report for additional discussion). Specific areas that could be a source of bacteria are neighborhoods on septic systems. There are five neighborhoods in Westfield that are still on septic systems. These areas on shown on the Problem Area Map (Figure 3-1) and listed below:

- Far Hills
- Buena Vista
- Brookview Place
- Bokeelia
- Ridgewood

Other sources of bacteria include pet waste and wildlife waste. Pet walking is allowed in the two parks that Cool Creek runs through (Cool Creek Park and Flowing Well Park). Pet owners are required to have dogs on leashes and pick up pet waste. Education to homeowners in general regarding pet waste would be a good public education topic in the watershed given the bacteria impairment. Wildlife waste is also a source of bacteria. The proliferation of stormwater ponds associated with new development can be an attraction to increasing geese populations. Proper pond design with shoreline vegetation can discourage resident geese from populating these areas.

Flooding Problems

A total of 10 stream/roadway and neighborhood flooding problems have been identified as critical to the affected communities. These include:

- E. 151st Street (Cool Creek)
- E. 171st Street (Cool Creek)
- Gurley Street (Anna Kendall Drain)

- Cherry Street (Anna Kendall Drain)
- SR 32 (J. M. Thompson Drain)
- US 31 and Adjacent Private Drive (Highway Run)
- Walter Street, Private Drive, and Walter Court (Highway Run)
- Thornberry Drive (Highway Run)
- Carmel Drive (Hot Lick Creek)
- Hot Lick Creek Channel Improvement

These critical flooding problem areas are detailed in Sections 7.4 and 7.5 of this report.

Loss of Ecological Diversity in Riparian Areas

Invasive species such as the Brush Honeysuckle have resulted in loss of ecological diversity in forested riparian areas of Cool Creek. To date, this problem has been primarily targeted towards Cool Creek Park, which is publicly owned land.

9.5.2 Prioritizing Critical Areas

Goals were prioritized to target the most critical areas and maximize environmental benefits to the Cool Creek watershed. Goals are numbered to reflect the general priority (see Section 9.6). Goals 1 through 5 would have higher priority than Goals 5 through 10. Sedimentation in the watershed is one of the primary focuses for this plan since reducing sedimentation generally reduces other pollutants attached to the sediment.

The key critical areas that Hamilton County and other stakeholders would like to address are the channel erosion problems that are worsening with upstream urbanization. The County feels there are viable solutions to address this problem that can be implemented in the next three to five years. In particular, a regional off-line stormwater quality facility at Oak Road and 171st Street appears to be feasible. This facility will help reduce future downstream erosion as well as capture and treat other stormwater pollutants such as suspended solids, nutrients and bacteria. Repairing areas already damaged by streambank erosion is also feasible, especially given some of the cost share programs available for property owners through the Hamilton County SWCD.

The critical flooding areas are also a priority for Westfield, as many of the flooding problems in the Cool Creek watershed are located in this community. These problems are a priority to reduce safety concerns, traffic disruptions, and property damage that can be associated with flooding.

Though stream buffers in agricultural lands would be desirable, they are a lower priority because much of the agricultural land will be developed in coming years. There may be opportunities to establish additional riparian vegetation in the upper reaches of Cool Creek as these areas are converted to residential and commercial land uses.

9.6 IMPLEMENTATION MEASURES

This section summarizes implementation measures needed to implement the goals that were identified during the project. Goals are listed higher priority lower priority. Load reduction calculations and action registers are provided where applicable.

Goal #1 – Develop comprehensive erosion and sediment control program in Hamilton County, Westfield, and Carmel (ordinance, plan review, inspection, and enforcement)

As part of the their requirements for their Rule 13 permits, Hamilton County, Westfield, and Carmel have developed comprehensive erosion and sediment control programs to manage runoff from construction sites. These programs include enacting the necessary legal authority and implementing plan review, inspection, and enforcement procedures. Hamilton County recently has enacted a new ordinance regulating storm water runoff associated with construction and post-construction activities as well as an Illicit Discharge and Detection Elimination (IDDE) ordinance. These county ordinances as well as a Report-a-Polluter program can be found at following link:

http://www.co.hamilton.in.us/services.asp?id=3921&entity=2200

Since Goal #1 is already being implemented by Rule 13 requirements for MS4s which encompass the entire Cool Creek Watershed no action register is included for this goal.

Goal Indicators: Number of construction site inspections and enforcements, reduced concentrations of TSS

Goal #2 – Implement the Oak Manor Regional Stormwater Quality Facility and other similar facilities to reduce downstream channel erosion and reduce nonpoint source pollutant levels (nutrients, sediment, metals, bacteria)

Regional Stormwater Quality Facilities

Natural drainage channels are highly sensitive to changes in the magnitude of frequent stormwater runoff (i.e. 1-year and 2-year recurrence interval) events. Urban development, despite the presence of stormwater detention ponds, often increases the magnitude of 1-year and 2-year peak flows. This is a result of a detention pond design focus on the design (i.e. 100-year and 10-year) events. Although detention ponds typically reduce peak flow rates for larger (i.e. 100-year and 10-year) storm events, they often *increase* peak flow rates for more frequent (i.e. 1-year, 2-year) storm events and extend the overall duration of higher flow.

The hydrologic analysis completed for this project showed that major regional detention is not warranted to control the larger storms. Flooding is not a major problem in the lower watershed reaches and the existing detention policy for new development will be effective in controlling peak flows from these larger storms. However, it is recommended that regional detention/water quality treatment facilities be constructed in the upper reaches of Cool Creek to help control the magnitude of 1-year and 2-year recurrence interval rainfall events and filter stormwater pollutants. These facilities should be constructed "off-line" so as to maintain base flow in the channel, avoid disrupting the existing riparian corridor, and avoid extensive dam safety requirements.

Regional stormwater detention facilities will provide the following benefits to the Cool Creek watershed:

- Reduce peak flow rates for more frequent storms
- Improve water quality by reducing concentrations of sediment, nutrients, metals, and bacteria
- Increase aquatic habitat by providing wetland and open water areas
- Reduce downstream erosion potential by decreasing the magnitude and duration of the 1-year and 2-year flows, thus further reducing sediment pollution

Several potential sites for regional stormwater quality detention facilities were identified during the course of the Cool Creek planning efforts. In the original Cool Creek study two sites were identified. The first site was along the Grassy Branch of Cool Creek north of 186 Street. The second site was south of 171st Street and east of Oak Road. Two additional sites were identified during the Section 319 update project. The first is at the confluence of the Anna Kendall Drain with Cool Creek. The second is along Cool Creek at the southeast corner of 161st Street and Westfield Boulevard. Figure 9-10 shows the general locations of these facilities.

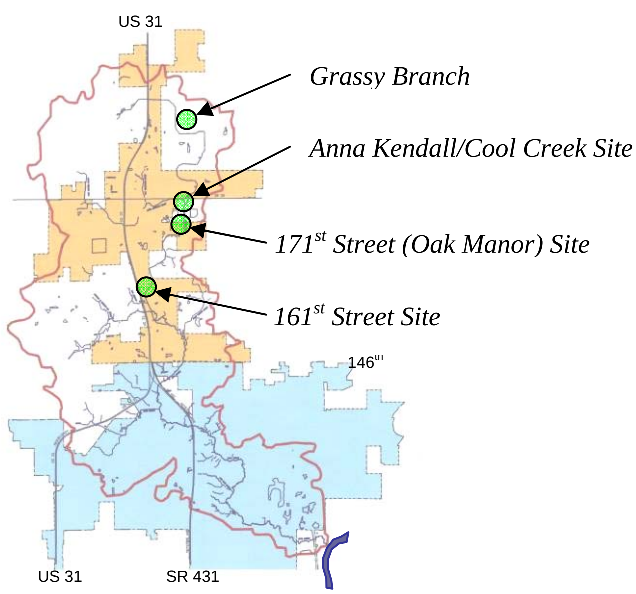


Figure 9-10
Regional Off-Line
Stormwater Quality Facility Locations

Hamilton County has been working on planning and design efforts for the site south of 171st Street. This site was selected because of cooperation with an adjacent development, called Oak Manor. The developer of this site has agreed to donate the land for the facility and possibly coordinate earthwork activities during construction of the facility. The following sections describe the Oak Manor facility in more detail, followed by an overview of the other three sites identified for regional off-line stormwater quality facilities.

Oak Manor Regional Stormwater Quality Facility

The Oak Manor Stormwater Quality Facility (previously referred to as the 171st Street facility in Chapter 7 of this report) involves the construction of a regional stormwater quality facility, off-line and adjacent to Cool Creek south of 171st Street and east of Oak Road. The area where the facility is planned is in the floodplain of Cool Creek, and is currently being farmed. The facility will be situated on the east side of the creek, and will consist of a 3-month storm event inflow channel which will divert flows to a settling pool, approximately one (1) acre in size and then into an additional six (6) acres of a constructed wetland system with a meandering shallow channel. Treated water from this facility will flow back into Cool Creek through a staged outfall pipe system, including a submerged orifice. A similar facility is also envisioned for the west side of Cool Creek, which Hamilton County would like to pursue in the future. Figure 9-11 is a schematic of the Oak Manor Stormwater Quality Facility.

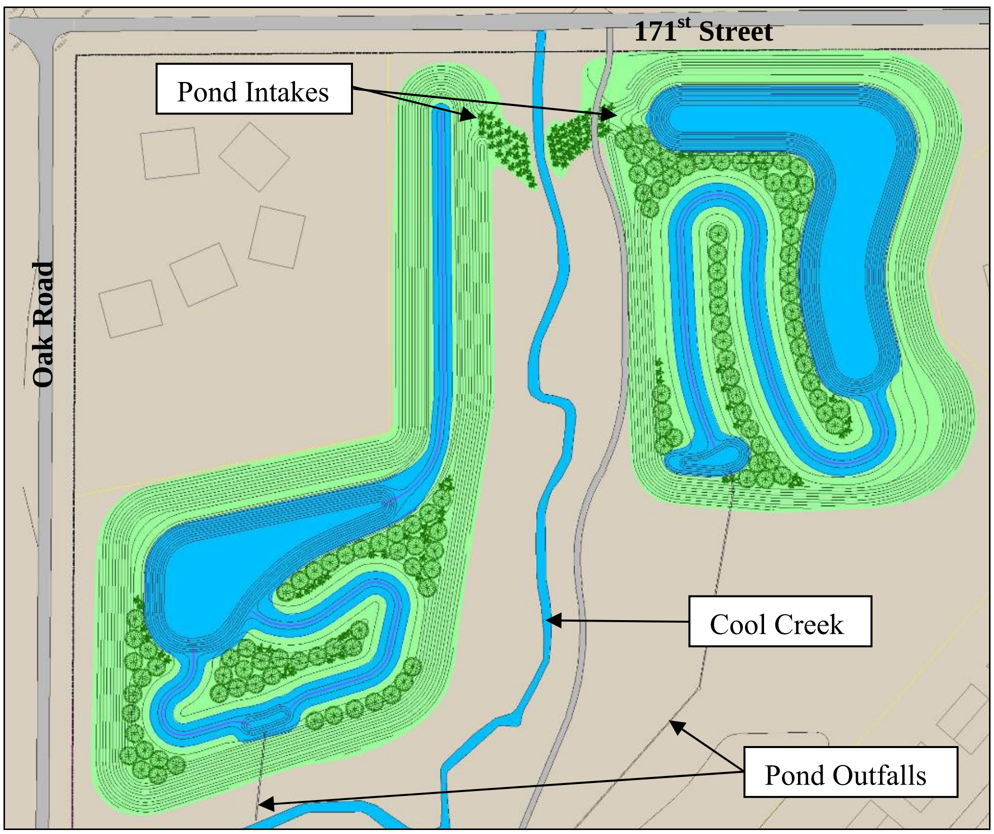


Figure 9-11
Oak Manor Stormwater Quality Facility Schematic

The stormwater quality facilities are designed to collect, detain and treat the "first flush" of urban nonpoint source pollutants. Additionally, downstream peak flows will be reduced by approximately 23% for events up to a 1-year event. Slowing the flow down during these smaller events (up to 1-year) will help reduce downstream bank erosion currently occurring due to urbanization in the watershed.

The Oak Manor pond/wetland system is anticipated to achieve the following pollutant removal percentages *(Source: National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas, U.S. EPA, Draft, July 2002)*:

- 80% - Total Suspended Solids
- 56% - Total Phosphorus
- 37% - Ortho-Phosphorus
- 19% - Total Nitrogen
- 40% - Nitrate and Nitrite Nitrogen
- 58% - Copper
- 56% - Zinc

In addition, stormwater wetland systems can help reduce bacteria by a 2 log reduction factor (or 99%) *(Source: Design of Stormwater Wetland Systems, Metropolitan Washington Council of Governments, October, 1992.)*

Existing loadings and load reductions for the Oak Manor Stormwater Quality Facility were computed using the sample taken at 186th Street and flow calculated by HEC-HMS at the Oak Manor location. Flows were based on a median central Indiana storm event (0.65 inches). Load reductions were also based on the above pollutant removal percentages. It was assumed that the Oak Manor Stormwater Quality Facility would treat 75% of the flow during this event.

Pollutant	**Units**	**Existing Loadings**	**Projected Load Reductions**
Total Suspended Solids	tons/yr	2104	1262
Total Nitrogen	tons/yr	631	156
Nitrogen, Nitrate	tons/yr	421	136
E. Coli	mCFU/yr	1,565,050	1,162,050

Additional Off-Line Stormwater Quality Detention Facilities

Though Hamilton County is currently focusing on the Oak Manor Stormwater Quality Facility, three other locations for similar facilities were identified during the course of the original Cool Creek study and during the Section 319 plan update. Figures 9-12, 9-13, and 9-14 show the sites for Grassy Branch, Anna Kendall/Cool Creek, and 161st Street (respectively). The Grassy Branch site was identified in the original Cool Creek study (see Section 7.7.2). The site, at the confluence of the Anna Kendall Drain with Cool Creek, was identified by the Hamilton County Surveyor as a good site to treat runoff from the Anna Kendall Drain. The site at the southeast corner of 161st Street and Westfield Boulevard was suggested by a participant at a public meeting held in the spring of 2005 for the Section 319 update project.

These three additional sites are located off-line in the floodplain of Cool Creek. The sites are currently farmed and would all provide opportunities to enhance water quality and reduce downstream channel erosion by constructing pond/wetland systems in these areas.

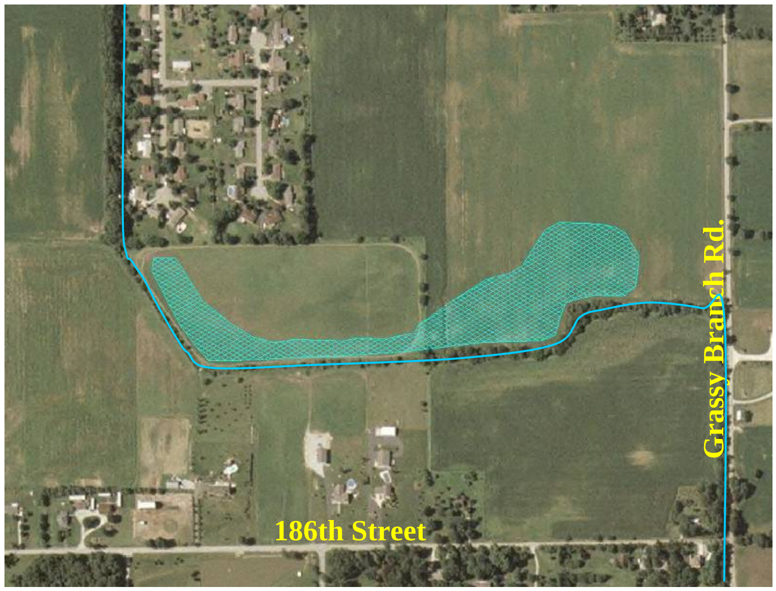


Figure 9-12
Grassy Branch Location
Regional Off-Line Stormwater Quality Facility

Figure 9-13
Anna Kendall/Cool Creek Location
Regional Off-Line Stormwater Quality Facility

Figure 9-14
161st Street and Westfield Boulevard Location
Regional Off-Line Stormwater Quality Facility

161st Street and Westfield Boulevard Stormwater Quality Facility

In November of 2005, the project team learned that a constructed wetland/pond system is planned for the 161st Street and Westfield Boulevard location. This facility is being funded by a private developer who is using the site for mitigation for filling of another isolated wetland in the watershed. The land was already owned by the Town of Westfield Parks Department.

The following is a project summary from Williams Creek Consulting, Inc. who is the consulting firm that designed the project.

> *"Early coordination with a local site developer, Williams Creek Consulting, Inc., Westfield Parks Department, Indiana Department of Environmental Management, and the U.S. Army Corps of Engineers has allowed the implementation of this plan as early as spring of 2006. Through this coordination, the property owned by Westfield Parks will be converted into a 2 acre wetland park for the purpose of natural flood control and water quality improvement with an educational theme for the heavily developed watershed"*

> *"The Westfield Parks Department desires to create a wetland area along Cool Creek for the creation of additional community greenspace. The wetland park will additionally provide for an educational public feature demonstrating the important functions and values of wetlands and stream buffers in our environment. Approximately 2 acres will be graded for the wetland area and will include low-flow braided channels. The wetland will be planted with a wet meadow seed mixture and the surrounding upland will be planted with a diverse tall prairie seed mixture. Thirty four native trees and thirty eight native shrubs will be planted within the wetland including species such as oak, sweetgum, maple, river birch, buttonbush, and dogwood. Additionally, the wetland park*

will have a trail and an observation deck constructed to help facilitate the educational experience."

A schematic of the 161st Street and Westfield Boulevard wetland park facility is shown in Figure 9-15.

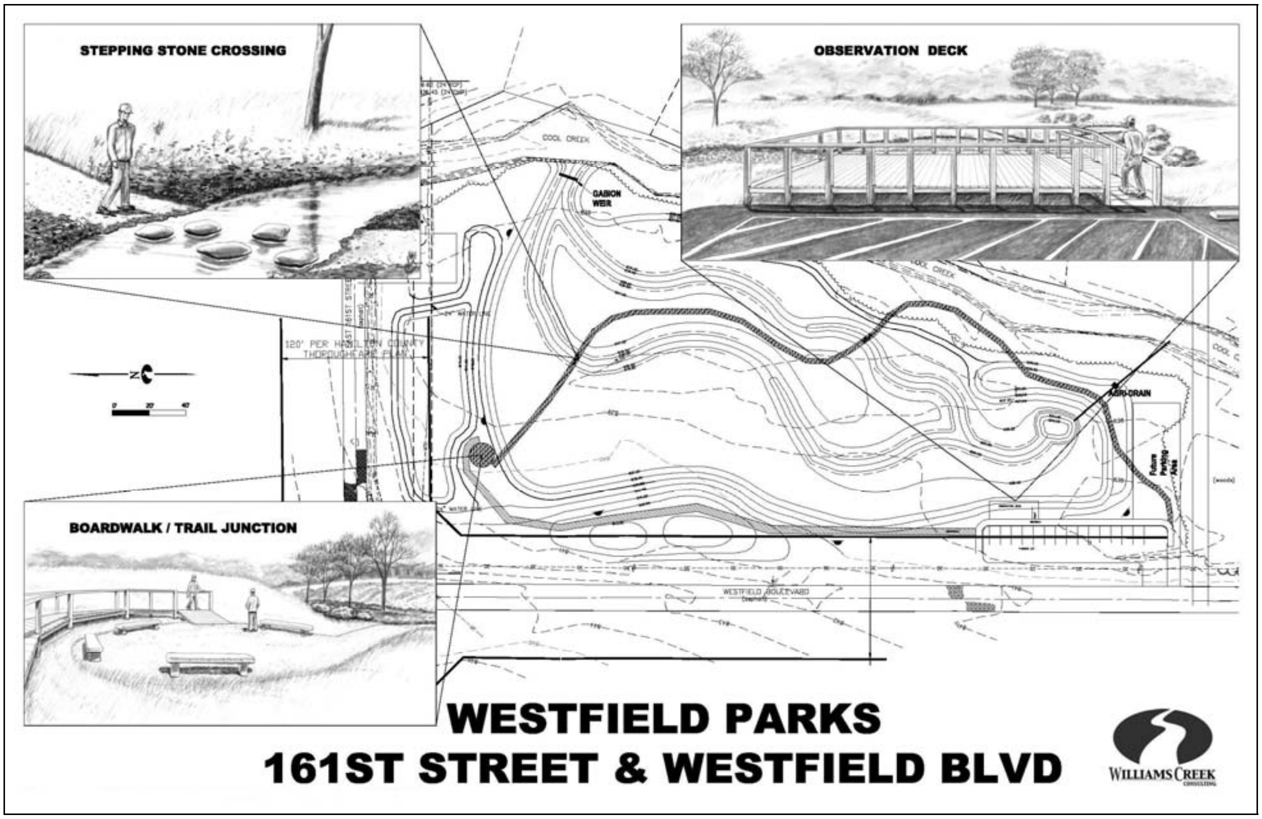


Figure 9-15
161st Street and Westfield Boulevard Location
Site Layout

Goal # 2 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Oak Manor Regional Stormwater Quality Facility	Complete Construction Plans (East Facility)	Hamilton County	Currently in progress	Hamilton County	Construction Plans
	Bid and Construct	319 Grant, Local Funding	Start in 2006	Hamilton County	Completed Facility
	Complete Construction Plans (West Facility)	Hamilton County	Currently in progress	Hamilton County	Construction Plans
	Bid and Construct	319 Grant, Local Funding	Start in 2007	Hamilton County	Completed Facility

Goal # 2 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
161st Street and Westfield Stormwater Quality Facility	Construct Pond	Developer	Start in 2006	Local Developer	Completed Facility
Anna Kendall/Cool Creek Stormwater Quality Facility	Acquire property	Donation	One year from plan approval	Hamilton County	Property
	Complete Construction Plans	319 Grant, Local Funding	Immediately after grant approval	Hamilton County	Construction Plans
	Bid and Construct	319 Grant, Local Funding	One year after grant approval	Hamilton County	Completed Facility
Grassy Branch Stormwater Quality Facility	Acquire property	Developer	As development occurs near site	Developer or Hamilton County	Property
	Complete Construction Plans	Developer or Hamilton County	As development occurs near site	Developer or Hamilton County	Construction Plans
	Bid and Construct	Developer or 319 Grant	One year after grant approval	Developer or Hamilton County	Completed Facility

Goal Indicators: Number of completed facilities, lower pollutants levels (nutrients, bacteria, TSS, metals, etc.), increased habitat

Goal #3 – Provide public education and outreach to residents and business in Cool Creek watershed to promote good watershed behavior (disposal of pet waste, proper lawn chemical use, illicit discharges, etc.)

Since Goal #3 is already being implemented by Rule 13 requirements for MS4s which encompass the entire Cool Creek Watershed no action register is included for this goal. As part of its Rule 13 program, Hamilton County surveyed residents in the Cool Creek watershed (as well as other parts of the County) to determine current awareness of stormwater quality issues. This survey was completed during the period of July 2004 through October 2004. The surveys were distributed at various local events. When asked "how concerned are you about stormwater pollution," nearly 85 percent responded either somewhat concerned or very concerned. When asked "whether you agree that waterbodies in Hamilton County are polluted," more than 88 percent responded somewhat agree or agree. When asked to rank four key stormwater pollutants in terms of their severity, the respondents ranked toxins (oils and greases) as having the largest impact, followed closely by bacteria, then sediment and nutrients. When asked to select the top three sources of stormwater pollutants from a list of ten potential sources, respondents ranked agricultural runoff as the top source, followed by runoff from industrial/municipal facilities and runoff from parking lots.

Hamilton County residents (including Carmel and Westfield) will be surveyed throughout the Rule 13 permit term to evaluate and monitor the effectiveness of the stormwater education program. Surveys will likely be distributed during local events, at public meetings, via stormwater websites, and as inserts to local utility bills. Details of each community's Rule 13 program can be found at the following websites.

Hamilton County Stormwater Website:

http://www.co.hamilton.in.us/services.asp?id=3921&entity=2200

Carmel Stormwater Website:

http://www.ci.carmel.in.us/government/deptcommunityrelations3.html

Westfield Stormwater Website:

http://www.westfield.in.gov/egov/apps/directory/list.exe?path=divs&action=47&fDD=8-47

Goal Indicators: Improved public knowledge of water quality issues, reflected through awareness surveys; number of brochures disturbed; number of public outreach events completed

Goal #4 – Repair/restore severe channel erosion in the lower reaches of Cool Creek to improve aquatic habitat, reduce sedimentation, and protect public and private facilities.

Streambank Erosion Solutions (See Section 7.6)

Proposed solutions range from minor regrading and seeding (for areas experiencing moderate flow velocities) to more intensive improvements such as riprap, geotextile fabric, woody plantings, vegetated geogrids, etc. for areas experiencing high flow velocities or containing steep channel sideslopes. Whenever possible, streambank stabilization should employ vegetative measures, so as to maintain the natural state of the channel corridor and to enhance instream water quality. In some instances of severe erosion, a more structural solution such as gabion baskets or revetment may be a more appropriate solution.

The proposed solutions described in this section are preliminary only. Upon choosing specific streambank restoration sites, detailed information will need to be collected and each site will need to be analyzed separately. Detailed information needed for a final design would be as follows:

- Channel cross sections at each restoration site, including location of private features, property corners, and nearby utilities.
- Hydraulic analysis for each restoration site, including velocity calculations and shear stress calculations for more frequent (i.e. 1-year, 2-year) recurrence interval rainfall events.
- Soil analysis for each restoration site.
- Determination of land availability (i.e. easements, right-of-way, and land acquisition) for proposed grading.
- Determination of construction access points.
- Public input on proposed improvements (most important when improvements are immediately adjacent to existing homes)

Critical stream bank erosion areas are listed below. Load calculations for each area have been performed and the areas have been prioritized based on this calculation. A photograph of the erosion area is shown on the right for each area. A figure for each stream bank solution can be found at the end of Chapter 7 (Figures 7-11 through 7-17). Additional details, including costs, are provided in Section 7.6.

Priority #1 - Cool Creek: upstream of confluence with the White River (See Section 7.6.3)

Severity of Erosion: Very Severe

Lateral Recession Rate: 0.7 ft./yr.

Length: 1500 feet

Height: 4 feet

Load Reduction: **189.0 tons per year**

Priority #2 - Cool Creek: upstream and downstream of Hot Lick Creek (See Section 7.6.5)

Severity of Erosion: Very Severe

Lateral Recession Rate: 0.7 ft./yr.

Length: 575 feet

Height: 4 feet

Load Reduction: **72.5 tons per year**

Priority #3 - Cool Creek: downstream of Gray Road (at bend) (See Section 7.6.4)

Severity of Erosion: Very Severe

Lateral Recession Rate: 0.6 ft./yr.

Length: 200 feet

Height: 8 feet

Load Reduction: **43.2 tons per year**

Priority #4 - Cool Creek: upstream of 131st Street (Main Street) (See Section 7.6.6)

Severity of Erosion: Very Severe

Lateral Recession Rate: 0.6 ft./yr.

Length: 150 feet

Height: 9 feet

Load Reduction: **36.5 tons per year**

Priority #5 - Cool Creek: upstream of Keystone Avenue (See Section 7.6.7)

Severity of Erosion: Very Severe

Lateral Recession Rate: 0.7 ft./yr.

Length: 100 feet

Height: 8 feet

Load Reduction: **25.2 tons per year**

Priority #6 - H.G. Kenyon Drain: downstream of Rolling Court (See Section 7.6.2)

Severity of Erosion: Severe

Lateral Recession Rate: 0.5 ft./yr.

Length: 250 feet

Height: 4 feet

Load Reduction: **22.5 tons per year**

Priority #7 - Highway Run: downstream of Stonehedge Drive (See Section 7.6.1)

Severity of Erosion: Severe

Lateral Recession Rate: 0.4 ft./yr.

Length: 100 feet

Height: 6 feet

Load Reduction: **10.8 tons per year**

Goal # 4 Action Register

Objective	Task	Funding	Schedule	Responsible	Products
Reduce Sedimentation from Channel Erosion	Priority #1 - Cool Creek: upstream of confluence with the White River	319 Grant	Initiate within 1 year	Hamilton County	Complete Project/Reduced TSS
	Priority #2 - Cool Creek: upstream and downstream of Hot Lick Creek	319 Grant	Initiate within 1 year	Hamilton County	Complete Project/Reduced TSS
	Priority #3 - Cool Creek: downstream of Gray Road (at bend)	319 Grant	Initiate within 1 year	Hamilton County	Complete Project/Reduced TSS
	Priority #4 - Cool Creek: upstream of 131st Street (Main Street)	319 Grant	Initiate within 3 to 5 year	Hamilton County	Complete Project/Reduced TSS

Goal # 4 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
	Priority #5 - Cool Creek: upstream of Keystone Avenue	319 Grant	Initiate within 3 to 5 year	Hamilton County	Complete Project/Reduced TSS
	Priority #6 - H.G. Kenyon Drain: downstream of Rolling Court	319 Grant	Initiate within 3 to 5 year	Hamilton County	Complete Project/Reduced TSS
	Priority #7 - Highway Run: downstream of Stonehedge Drive	319 Grant	Initiate within 3 to 5 year	Hamilton County	Complete Project/Reduced TSS

Goal Indicators: Number of projects completed, reduced concentrations of TSS

Goal #5 – Reduce impact of urbanization by modifying stormwater detention policy to control smaller storms and treat the first flush of runoff

Modify Detention Pond Design Standards (See Section 7.8.1)

Many communities require detention pond designs that incorporate features to help capture pollutants in stormwater runoff. This is generally accomplished by providing a *Water Quality Volume*. The water quality volume is the storage needed to capture and treat runoff from 90% of the average annual rainfall (runoff from approximately a 1-inch rain event). Design standards for reviewing authorities within the Cool Creek watershed should be modified to contain a similar requirement. The *Water Quality Volume* standard will help to control peak flows during more frequent storm events, reduce pollutant loadings to receiving streams, and reduce the potential for downstream channel erosion.

Properly designed and constructed stormwater ponds are generally capable of the following pollutant load reductions:

Pollutant	Percent Reduction*
Total Suspended Solids	80%
Total Phosphorus	51%
Ortho-Phosphorus	65%
Total Nitrogen	33%
Nitrate and Nitrite Nitrogen	43%
Copper	57%
Zinc	66%

**Source: National Management Measure Guidance to Control Nonpoint Source Pollution from Urban Areas. U. S. EPA, Draft, July 2002*

Ordinance and Standards Updates (See Section 8.3.5)

The recommendations outlined in the land use and planning policies section of this report will require updates and/or new ordinances and design standards. All three entities in the watershed are currently updating their ordinances and standards to address stormwater quality.

Goal # 5 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Reduce impact of urbanization	Modify Detention Pond Design Standards	Local Funding	Initiate by year 1	Hamilton County, Carmel, Westfield	Updated Detention Pond Design Standards
	Ordinance and Standards Updates	Local Funding	On Going, complete by year 1	Hamilton County, Carmel, Westfield	Updated Ordinances and Standards

Goal Indicators: Completed Design Standards and Ordinances, lower pollutants levels

Goal #6 – Continue the Hamilton County Parks and Recreation Department's community service program to improve watershed quality, including removing invasive species, stream trash pick up and public education.

Community Service Program

To improve the Cool Creek watershed quality, the Hamilton County Parks and Recreation Department has been organizing community service days for volunteers. These days can be either open to the public or for private groups such as the Boy/Girl Scouts, churches, environmental organizations, and other interested groups. A Service Learning Day was recently (October 16, 2005) sponsored by IUPUI Center for Earth and Environmental Science to get volunteers to assist in removing invasive species. This is a valuable program to improve watershed health and provide public education. The goal included continuing to support and promoting awareness of this program.

Goal # 6 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Improve Watershed Quality	5-10 Community Service Days a Year	Local Funding	On Going	Hamilton County Parks and Recreation Department	Ecological Diversity and Improved Watershed Quality

Goal Indicators: Number of community service days per year, increased public awareness

Goal #7 – Provide sanitary sewer service to the few neighborhood areas in Westfield still on septic systems

The Town of Westfield has identified five neighborhoods that are served by septic systems, rather than sanitary sewers. Some of these neighborhoods have had failure problems. These neighborhoods are shown on the Problem Area Map in Figure 3-1 of this report. Septic system failures occur when systems are not maintained properly which can increase bacterial levels in receiving streams. Therefore, converting neighborhoods from septic systems to sanitary collection systems has been made a goal of this plan and of the Town. Based on an estimated cost of $15,000 per home, a preliminary estimate of cost to install sanitary sewers in these neighborhoods is as follows:

- Far Hills - $540,000
- Buena Vista - $195,000
- Brookview Place - $615,000
- Bokeelia - $195,000
- Ridgewood - $405,000

Goal # 7 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Provide Sanitary Service to reduce *E. Coli*	Far Hills Sanitary Sewers	Local Funding	Initiate within 2 years	Westfield	Reduced *E. Coli*
	Buena Vista Sanitary Sewers	Local Funding	Initiate within 2 years	Westfield	Reduced *E. Coli*
	Brookview Place Sanitary Sewers	Local Funding	Initiate within 2 years	Westfield	Reduced *E. Coli*
	Bokeelia Sanitary Sewers	Local Funding	Initiate within 2 years	Westfield	Reduced *E. Coli*
	Ridgewood Sanitary Sewers	Local Funding	Initiate within 2 years	Westfield	Reduced *E. Coli*

Goal Indicators: Number of households converted form septic system to sanitary sewers, lower bacteria levels

Goal #8 – Implement consistent floodplain development restriction by adopting necessary legal authority (ordinances)

Floodplain Protection (See Section 7.8.3)

Floodplain development concerns tie directly to preservation of the riparian stream buffers along Cool Creek (and its tributaries). Filling of floodplains can cause loss of flood storage and riparian habitat. As noted previously, Hamilton County has an ordinance that prohibits filling of land in the floodplains of its regulated drains. It would be very beneficial for Carmel and Westfield to adopt similar policies for floodplains under their jurisdiction. This would provide a uniform policy and would help preserve existing riparian buffers. Carmel and Westfield are currently considering these issues as part of their ordinance updates.

Goal # 8 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Reduce Flooding and Protect Riparian Areas	Ordinance and Standards Updates	Local Funding	On Going, complete by year 1	Carmel, Westfield	Updated Ordinances and Standards

Goal Indicators: Adoption of consistent floodplain development ordinances

Goal #9 – Construct the bridge and culvert conveyance improvement projects to reduce flood hazards and protect public safety

Stream Flooding/Roadway Overtopping Critical Areas and Solutions (See Section 7.4)

Proposed improvements to solve the critical flooding areas are presented in Section 7.4 of this report. These improvements will be completed as local funds allow.

Goal # 9 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Reduce Flood Hazards	E. 151st Street (Cool Creek)	Local Funding	During Roadway Improvements	Westfield	Reduced Local Flooding
	Walter Street, Private Drive, and Walter Court (Highway Run)	Local Funding	During Roadway Improvements	Westfield	Reduced Local Flooding
	E. 171st Street (Cool Creek)	Local Funding	During Roadway Improvements	Westfield	Reduced Local Flooding
	Gurley Street (Anna Kendall Drain)	Local Funding	During Roadway Improvements	Westfield	Reduced Local Flooding
	Cherry Street (Anna Kendall Drain)	Local Funding	During Roadway Improvements	Westfield	Reduced Local Flooding
	SR 32 (J. M. Thompson Drain)	Local Funding	During Roadway Improvements	Westfield	Reduced Local Flooding
	US 31 and Adjacent Private Drive (Highway Run)	State Funds	During Roadway Improvements	Carmel	Reduced Local Flooding
	Thornberry Drive (Highway Run)	Local Funding	During Roadway Improvements	Carmel	Reduced Local Flooding
	Carmel Drive (Hot Lick Creek)	Local Funding	During Roadway Improvements	Carmel	Reduced Local Flooding
	Hot Lick Creek Channel Improvement	Local Funding	During Roadway Improvements	Carmel	Reduced Local Flooding

Goal Indicators: Number of completed projects, amount of roadway overtopping occurring during a year

Goal #10 – Improve the riparian habitat in the upper watershed by establishing stream buffers and vegetation as areas are developed adjacent to Cool Creek

Buffer strips should be incorporated into development plans as Hamilton County, and more specifically areas adjacent to Cool Creek and its tributaries, continue to develop. Currently agricultural lands in the northern watershed adjacent to Cool Creek have limited or no buffer strips. Based on current population trends in Hamilton County these lands will be developed relatively soon. Space for buffer strips and green space along Cool Creek provide valuable stormwater runoff protection by filtering pollutants before they enter the stream. These features should be provided as part of the development of the area and incorporated in the plan review process for each community.

Goal # 10 Action Register					
Objective	**Task**	**Funding**	**Schedule**	**Responsible**	**Products**
Improve the Riparian Habitat	Increase Amount of Buffer Strips by Incorporating into Development Plans	Developer, Local Funding	On Going	Hamilton County, Carmel, Westfield	Additional Stream Buffers

Goal Indicators: Length of stream with additional buffers strips added that previously did not have buffers

9.7 EVALUATING, MONITORING, AND ADAPTING THE PLAN

Hamilton County, Carmel, and Westfield will ultimately be responsible for tracking the progress of the plan achievements, making any changes to the plan that the Stakeholder Committee deems necessary, keeping all plan-related records and documents, and distributing copies of the plan to necessary participants. The follow items are recommended to evaluate and monitor the plan achievements:

Stakeholder Meetings

- Quarterly meetings
- Include Hamilton County, Carmel, Westfield representatives
- Include any other parties who have been involved to this point
- Once a year, the Stakeholder committee should invite new participants that have not been involved to this point.
- Review the progress of the plan and implementation measures
- Organize and review water quality monitoring data
- Organize and review visual Inspection
- Organize and review progress of implementation projects in the WMP
- Organize and review plan updates as needed

Water Quality Monitoring Data

- Samples should be taken once per year (ideally two times)
- Samples should be obtained during typical storm events (0.5 inches to 1.0 inches of rain)
- A minimum of 3 sample locations should be considered for each event. If needed more sites could be added to measure the effectiveness of the implementation measures
- Additional samples could be taken in dry weather
- Parameters sampled should included:
    - Sediment
    - Bacteria
    - Nutrients
    - Other Physical Properties (temperature, D.O., pH, etc.)
- Sampling for pesticides should also be considered (at least once) to determine baseline conditions
- Continue to promote volunteer monitoring by Hoosier Riverwatch or other similar programs

Visual Inspection

- Visual inspections responsibilities should be shared by Hamilton County, Westifield, and Carmel.
- Visual inspection logs should be kept for each tributary including the following
    - Date inspected
    - Inspector initials
    - Stream reach location
    - Photo log identified on map of area
    - Specific data on channel problems
- Streams in the watershed should be inspected at least once every three years

- Severe channel problems should be monitored quarterly
- Feet per year estimates of erosion problems should be made and documented in the log

Implementation of Recommended Improvements

- Recommended improvements shall have monthly progress meetings
- Progress reported at quarterly Stakeholder meetings

Update the Plan as Needed

- Plan updates will be made by Hamilton County with input from Carmel and Westfield
- Plan updates will be based on monitoring, visual inspections, and stakeholder and public input
- Plan updates will be discussed at quarterly Stakeholder meetings

The approval of this Section 319 Cool Creek Watershed Management Plan will not be the end of the project but rather the start of continual effort to achieve the mission statement:

> *Preserve and improve the overall health of the Cool Creek Watershed by addressing existing stormwater quantity and quality concerns and by proactively guiding future stormwater management practices and decisions.*

Contact Information

The following persons can be contacted with suggestions to improve the Cool Creek Watershed Management Plan.

Hamilton County

Robert Thompson, RLA, CLARB
Program Manager, Phase II Stormwater
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City of Carmel

Amanda Foley
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APPENDIX A

IDNR PERMITS SUMMARY

IDNR PERMITS SUMMARY
COOL CREEK WATERSHED

LITTLE COOL CREEK		
Application Date	**Status**	**Description**
6/26/01	Terminated	Fill for parking lot near stream
9/28/00	Terminated	Installation of 15" Storm Sewer with underground storage
6/28/96	Approved	Construction of vehicular and pedestrian bridge
3/25/91	Approved	Excavation and fill in floodplain
3/25/91	Approved	Excavation and fill in floodplain
3/11/91	Approved	Fill in floodplain
COOL CREEK		
Being Reviewed	N/A	Fill for retaining wall
3/7/02	Approved	Bank stabilization
9/25/01	Approved	Bridge replacement
8/28/01	Approved	Bridge replacement
8/1/01	Approved	Construction of bridge
5/14/01	Approved	Excavation for ponds
12/14/00	Approved	Bridge replacement
12/14/00	Approved	Bridge replacement
12/14/00	Approved	Bridge replacement
6/15/00	Denied	Installation of booster station
2/10/00	Approved	Installation of water main
1/1/00	Approved	Excavation for pond, and rechannel Mary Wilson Drain
1/1/00	Approved	Installation of storm outfall
1/1/00	Approved	Installation of storm outfall
4/16/99	Approved	Installation of water main

IDNR PERMITS SUMMARY
COOL CREEK WATERSHED

2/25/99	Approved	Installation of private drive
1/29/99	Approved	Installation of storm outfall
1/22/99	Approved	Bridge widening
8/21/98	Approved	Construction of gabions
4/24/98	Approved	Bridge widening
3/25/98	Approved	Excavation for sand and gravel mining
11/7/97	Approved	Installation of 24" storm sewer
6/16/97	Approved	Bridge replacement
5/29/97	Approved	Bridge replacement
5/23/97	Approved	Excavation for sand and gravel mining and bridge construction
5/9/97	Approved	Bank stabilization
7/26/96	Approved	Bridge widening
7/17/96	Approved	Installation of sanitary sewer
7/5/96	Approved	Fill in floodplain for access drive
6/7/96	Approved	Installation of new culverts and excavation/fill in floodplain
2/2/96	Approved	Installation of storm outfalls and trails
12/8/95	Approved	Installation of tennis courts and storm outfalls
10/27/95	Approved	Construction of bridge and playground and bank stabilization
9/1/95	Approved	Construction of a low water crossing
8/25/95	Approved	Installation of 27" and 36" Storm Sewer
8/25/95	Approved	Installation of storm outfalls
8/25/95	Approved	Excavation for pond and installation of storm outfall
8/18/95	Approved	Installation of new culvert

IDNR PERMITS SUMMARY
COOL CREEK WATERSHED

5/19/95	Approved	Excavation for ponds and installation of storm outfalls
3/2/95	Approved	Installation of new 36" Storm Sewer
12/15/94	Approved	Installation of 27" Storm Sewer
11/18/94	Approved	Bridge widening
6/28/94	Terminated	Construction of trail
9/3/93	Terminated	Construction of new trails
9/3/93	Approved	Construction of a pedestrian bridge
5/14/93	Approved	Fill for road realignmnet
4/8/93	Approved	Construction of a dog pen
3/12/93	Denied	Construction of boardwalk and trails
2/8/93	Approved	Installation of storm outfall
2/2/93	Approved	Fill for parking lot near stream
11/6/92	Approved	Installation of storm outfall
11/6/92	Approved	Installation of storm outfall
10/23/92	Terminated	Installation of storm outfall
6/26/92	Approved	Bank stabilization
2/17/92	Approved	Bank stabilization
1/27/92	Approved	Water main crossing
11/13/91	Approved	Bridge replacement (151st street)
10/7/91	Approved	Excavation for lake
10/7/91	Approved	Installation of sanitary sewer
10/7/91	Approved	Installation of storm outfall
10/7/91	Approved	Installation of storm outfall

IDNR PERMITS SUMMARY
COOL CREEK WATERSHED

9/23/91	Approved	Construction of retention pond
7/1/91	Terminated	Installation of tennis courts
7/1/91	Approved	Installation of storm outfall
7/1/91	Approved	Installation of storm outfalls
7/1/91	Approved	Water line crossing
7/1/91	Terminated	Installation of storm outfall
6/3/91	Approved	Installation of storm outfall
6/3/91	Approved	Bridge widening
2/5/91	Approved	Installation of storm outfalls
2/5/91	Approved	Construction of storage building
6/13/90	Approved	Excavation for sand and gravel mining
4/18/90	Approved	Installation of sanitary sewer
4/18/90	Approved	Installation of storm outfall
4/18/90	Approved	Construction of swale
3/21/90	Approved	Construction of swale
1/8/90	Approved	Installation of water main
11/21/89	Approved	Installation of gabions
9/26/89	Approved	Construction of water tower
7/20/89	Approved	Excavation/Fill for parking lot and dry detention
6/23/89	Approved	Natural gas crossing
11/28/88	Approved	Installation of sanitary force main

IDNR PERMITS SUMMARY
COOL CREEK WATERSHED

GRASSY BRANCH (ANNA KENDALL DRAIN)		
No Date	Not Listed	Stream dredging
10/18/02	Approved	Private tennis court and swimming pool
11/14/01	Approved	Replace a private road bridge
2/4/99	Approved	Fill for construction of a parking lot
11/12/97	Terminated	Installation of storm outfall
8/1/97	Approved	Installation of storm outfall
8/9/96	Approved	New private drive crossing
6/19/96	Approved	Bridge deck replacement
5/16/96	Approved	Installation of storm outfall
10/11/91	Approved	Water main crossing
8/6/90	Approved	Installation of storm outfall
6/11/90	Approved	Water main crossing
6/11/90	Approved	Sanitary sewer force main crossing
3/21/90	Approved	Fill along the right (south) bank of the stream (about 200 feet)

APPENDIX B

DEVELOPER MEETING SUMMARY

Clark Dietz

MEMO

To: Project File - Cool Creek Watershed Management Plan
From: Hans J. Peterson, P.E.
Date: October 30, 2002
Subject: Meeting Summary – Developer Input

Copies: Meeting Attendees
Kent Ward, Hamilton Co.
Kate Weese, Carmel
David Johnston, Westfield

On October 30, 2002, a meeting was held at the Hamilton County Surveyors Office to obtain input from the development community on stormwater issues affecting the Cool Creek watershed. The following were in attendance at the meeting:

Name	Representing	E-mail
Hans Peterson	Clark Dietz, Inc.	hansp@clark-dietz.com
Dale Tekippe	Clark Dietz, Inc.	dalet@clark-dietz.com
Robert Thompson	Hamilton County	rct@co.hamilton.in.us
Steven Cash	Hamilton County	stc@co.hamilton.in.us
Bruce Hauk	Town of Westfield	bhauk@netdirect.net
Mike McBride	City of Carmel	mmcbride@ci.carmel.in.us
John Talbot	Estridge	talbotj@estridge.net
Jose Kreutz	Brenwick	josek@ brenwick.com
Tim Walter	Platinum Properties	Twalter platinum-properites.com
Jim Langston	Langston Development	jlang@langstondev.com
John Edwards	Langston Development	Jedwards@langstondev.com

Topics covered at the meeting included:

- Overview and purpose of the Cool Creek Watershed Plan
- Existing stormwater problems in the watershed
- Effectiveness of stormwater runoff controls associated with new development
- Regional detention facilities
- Rule 13 requirements and impacts to new development

Overview

Hans Peterson reviewed the overall purpose of the watershed study. One of the key drivers of the study was the concern with stormwater impacts resulting from new development, particularly with the upper watershed (Westfield) developing and the lower watershed (Carmel) being already fully developed. The project included a detailed review of existing problems in the watershed, analysis of the watershed using hydrologic/hydraulic modeling, identification of impacts from development, and development of solutions to existing stream problem areas.

Stormwater Problems

Stream flooding on the main Cool Creek channel is generally not currently a problem in Carmel. The stream does get out of its channel banks during major storms, but for the most part, does not overtop roads or flood structures. Some of the tributaries to the main channel do have some flooding problems. Westfield has some roads that overtop and the Evan Kendall drain has some potential flooding concerns. The primary concern in Carmel is with stream bank erosion. Several reaches of the stream have moderate to severe erosion. A photo book was shared with the meeting attendees showing typical stream bank erosion examples.

Effectiveness of Stormwater Controls

The impacts of new development were analyzed with the hydrologic model. Undeveloped areas in the watershed were simulated in the model as fully developed. The County's detention policy (100-year controlled at pre-development 10-year rate and 10-year controlled at the pre-development 2-year rate) was factored into the model. Hydrograph printouts of the results were distributed to the attendees. The analysis showed that under future full build-out conditions, the County's detention policy would result in a 5 to 10 percent reduction in peak flows. However, the duration that flow remains in the channel following a storm event is 20 to 30 percent longer. Also, the flow rates on the trailing limb of the hydrograph are much higher (two to four times) than existing flows. The higher flows over a long period of time following a storm event will tend to increase stream bank erosion in Carmel. This situation can be better controlled if the smaller, more frequent storm events are retained on site through modifications to the detention policy to incorporate a "channel protection" volume in detention basin designs.

Regional Detention

The advantages/disadvantages of regional detention were discussed. John Talbot of Estridge commented that they built an on-line regional pond, but ran into significant permitting challenges with IDEM, even though the basin was built on a small, normally dry channel that ran through a farm field. The regional pond was then considered a "water of the State" and required "pre-treatment" of any stormwater discharges into the basin. Tim Walter of Platinum Properties has also built on-line ponds in series and has also run into similar obstacles. If the drainage area to the pond is less than one square mile (640 acres), IDNR and IDEM do not get involved and regional ponds can be permitted directly with the County.

Off-line regional facilities can be used; however, the size and location of ponds in a development is often dictated by the need for earthwork fill as well as the need to provide water amenities. Also, the cost of building larger conveyance facilities to reach a regional pond can preclude their use. Tim Walter commented that they have "over-detained" in some instances to reduce the size of the outlet pipe that is needed to discharge into a nearby creek. If the County desires to use larger regional basins, they should be identified early on in the planning process so the development community can anticipate them. John Talbot also indicated that if regional ponds with amenities are promoted, they should count towards the open space requirement (they currently do not count toward this requirement in Westfield).

Rule 13

A handout summarizing the requirements of Rule 13 was distributed. The primary impact to the development community will be that erosion and sediment controls will be required for all sites greater than one acre (vs. the current 5-acre threshold) and best management practices (BMPs) will be required to control the quality of post-construction runoff.

A handout was distributed with some examples of BMPs. The primary BMP that is used to control post-construction runoff quality is wet ponds with water quality features incorporated. Smaller developments and re-developments can use other structural BMPs such as sand filters, vortex devices, etc. Jose Kruetz of Brenwick commented that BMPs that rely on infiltration for treatment would not work in Hamilton County or many other parts of central Indiana due to clayey soils. He also asked whether these requirements apply to just new development or will cities be required to retrofit existing development. We discussed that this requirement applies to new development and re-development.

John Talbot of Estridge asked whether zoning and land use issues would be addressed as part of the post-construction runoff issue. He commented that impervious area could be reduced if street lane width requirements were reduced and other parking lot space requirements were re-considered.

John Edwards of Langston Development asked how development in the floodplain would be addressed in the watershed. We discussed that the County prohibits any development in the floodplain. Carmel and Westfield do not have the same requirements, but that would make sense on a watershed basis to be consistent on this issue. Mr. Edwards indicated that this policy is unrealistic in situations where floodplains are very wide (300 or 400 feet) and the flood depths are shallow (less than one foot). A lot of prime development area is lost and property owners see reduced land values. We discussed the importance of maintaining buffer strips along streams and that these could be an important component of Rule 13 compliance with post-construction runoff controls. Perhaps there is a compromise to maintain buffers while allowing some development in instances where floodplains are very wide and shallow. Compensatory storage could also be included to account for lost floodplain storage.

Robert Thompson discussed that the County and other communities affected by Rule 13 are just beginning the process of deciding how to approach the requirements of the rule and what types of BMPs will be used. He mentioned that there was an upcoming BMP seminar that Hamilton County and a BMP vendor are sponsoring.

Summary

Key feedback from representatives of the development community is summarized as follows:

- Regional on-line detention has become very difficult to implement because of environmental permitting issues.
- Regional detention for areas less than one square mile can work; however detention basin configurations are often dictated by other engineering issues (need for earthwork fill, limitations on conveyance facility sizes, etc.)
- If regional basins are constructed, credit should be given towards open space requirements.
- If the communities or the County want a particular regional detention basin site, the development community should know this early on so it can be accommodated in the development process.
- Development restrictions in the floodplain should be re-considered in areas of very wide, shallow floodplains.
- Street widths and parking space requirements should be considered when looking at the non-structural aspects of the post-construction runoff control requirement.

Please contact Hans Peterson if there are comments or corrections to this meeting summary.

Hans J. Peterson, PE
Clark Dietz, Inc.
8445 Keystone Crossing, Suite 105
Indianapolis, IN
Hansp@clark-dietz.com
317.259.4644

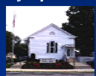
APPENDIX C

PUBLIC MEETING PRESENTATION MATERIALS AND MEETING SUMMARIES

Public Meeting
Cool Creek Watershed Management Plan

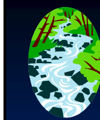
May 21, 2002

City of Carmel



Town of Westfield

Hamilton County



Agenda

- Project Purpose/Scope Review
- Progress Review/Findings to Date
- Upcoming Activities
- Input on Drainage Problem Areas

Project Purpose

- Identify and solve existing stormwater flooding problems (focus on regional problems associated with Cool Creek and its tributaries)
- Prevent future stormwater problems due to rapid development

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NEWS / CENSUS 2000

Hamilton County growth paces Indiana, brings challenges

By JOSH DUKE, Ledger regional editor

March 10, 2001 - - Hamilton County eclipsed all Indiana counties, ranking No. 1 in population growth and percent of population change from 1990 to 2000, according to Census 2000 numbers released Friday.

The population increased by 73,804 people, a 67.7 percent jump during the 1990s.

Hamilton outdistanced Marion County, which finished second in population growth with 63,295. In fact, Hamilton, Marion and Johnson counties combined to account for 30 percent of the entire state's growth during the decade.

Malcolm Bray, 85, was born in rural Westfield, and has lived there most of his life. Hamilton County's explosive growth is no surprise to him.

More on Census 2000

Click here to go to an index of stories on Census 2000.

Links

* USA Today.com's census data and maps
* STATS Indiana
* U.S. Census Bureau

Growth...

Planning is key to town's growth

■ Master plan gives officials map to follow to ensure that town expansion is smooth.

By Phil Dunlap
Correspondent

WESTFIELD

Annexation, investment in technology and expanding infrastructure are topics of discussion for Westfield officials these days.

They're all signs of a growing community.

This month, the town is preparing to annex about 264 acres on top of 102 acres annexed in December. An additional 350 acres are being considered for annexation by the end of the year.

Westfield also is negotiating with land owners and developers to annex an additional 1,700 acres by July 2003, assuming the economy and real estate markets remain steady.

There is no controversy, no angry outcry from the public — just a smooth transition for several parcels asking to be brought into the town.

"We want to be a smart growth community and (do it) in an orderly fashion, building out from our existing base," said Westfield Town Manager David Johnston. "It's all driven by our 2020 Comprehensive Plan."

The town requires written agreements with developers that their subdivisions will become part of Westfield once the municipal limits are contiguous with their developments.

The new 340-acre Centennial subdivision built by the Estridge Co., south of 156th Street between Spring Mill and Ditch roads, falls under these guidelines and will become part of the town when annexation reaches it.

The new 590-acre Bridgewater Club, a planned-unit development with a golf course, retail/commercial and residential areas, also is expected to become a part of the town.

For growth to progress logically and make annexation practical, the water, sewer and road infrastructure must be in place.

"We've had a water and sewer master plan completed since last January, and have received a special sewer grant with the help of (U.S. Rep. Dan) Burton's office to help open up the westside of U.S. 31 to economic development — particularly the (230-acre) Thunder Island property," Johnston said.

This year, Westfield Utilities bought the portion of Hamilton Western Utilities that served

See Growth, Page NB6

Growth

■ Town growth is estimated at 1,300 people a year.

From NB1

Washington and Noblesville townships. Those parts of Hamilton Western originally were built by Wilfong Development nearly 30 years ago to serve its own subdivisions. The move substantially increases Westfield's water/sewer infrastructure.

Johnston said the Town Council also has sent a draft of a new thoroughfare plan to the Plan Commission for review over the next few months.

He said officials have made roads a priority out of necessity.

"We're estimating we now gain about 1,300 people a year in our town. That's quite a population jump — and along with that come vehicles."

Town officials also are excited about access to technology.

From cell phone networks and wireless technology to fiber optics, Johnston says it's up to the community to plan and make certain technology is available.

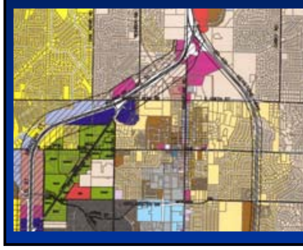
"We need to package Westfield to be successful in its economic development, decide which area we want to target and do some niche marketing. We do have competitive assets, and we need to understand that we can't just settle for anything," he says.

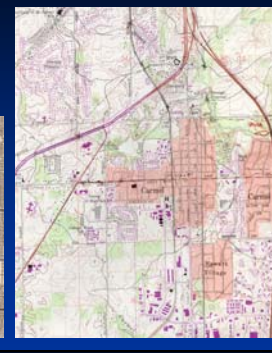
Project Scope

- Inventory & Problem Identification
- Problem Analysis
- Solution Development
- Recommendations and Implementation
- Watershed Management Plan

Inventory & Problem Identification

- Maps, Plans, Reports

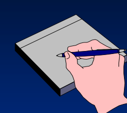




Inventory & Problem Identification

- Hamilton County online mapping

Inventory & Problem Identification

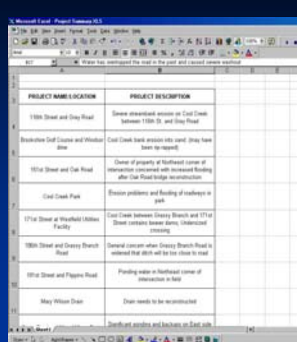


- Standards, Ordinances, Policies

- Interviews

Inventory & Problem Identification

- Public Input



Inventory & Problem Identification

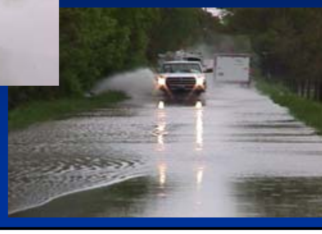
Cool Creek at 151st St

- Field Investigation

Anna Kendall Drain, Westfield

Mary Wilson Drain, Soccer Fields

Inventory & Problem Identification



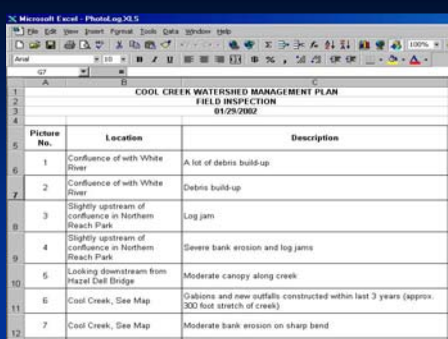
Grassy Branch Road North of SR 32

Inventory & Problem Identification

Cool Creek in Brookshire Golf Course

Cool Creek near confluence with White River

Inventory & Problem Identification

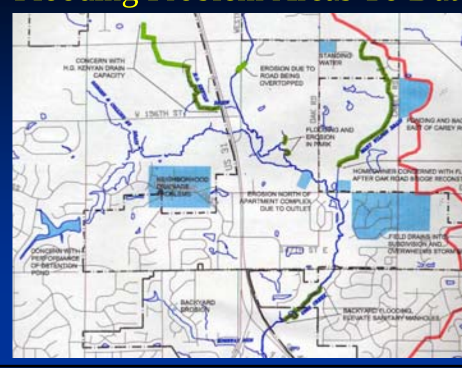


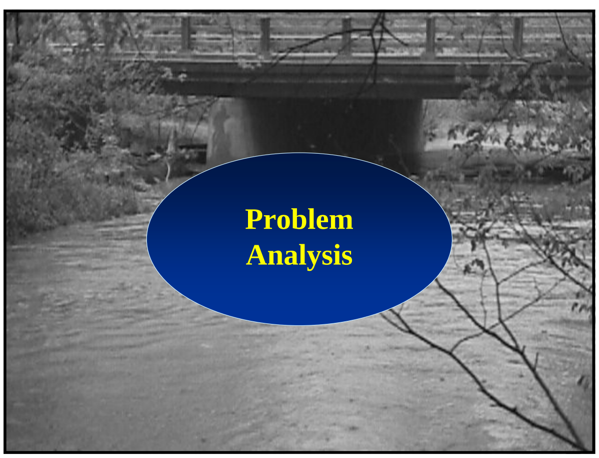
Microsoft Excel - PhotoLog.XLS

COOL CREEK WATERSHED MANAGEMENT PLAN
FIELD INSPECTION
01/29/2002

Picture No.	Location	Description
1	Confluence of with White River	A lot of debris build-up
2	Confluence of with White River	Debris build-up
3	Slightly upstream of confluence in Northern Reach Park	Log jam
4	Slightly upstream of confluence in Northern Reach Park	Severe bank erosion and log jams
5	Looking downstream from Hazel Dell Bridge	Moderate canopy along creek
6	Cool Creek, See Map	Gabions and new outfalls constructed within last 3 years (approx. 300 foot stretch of creek)
7	Cool Creek, See Map	Moderate bank erosion on sharp bend

Flooding Problem Areas To Date

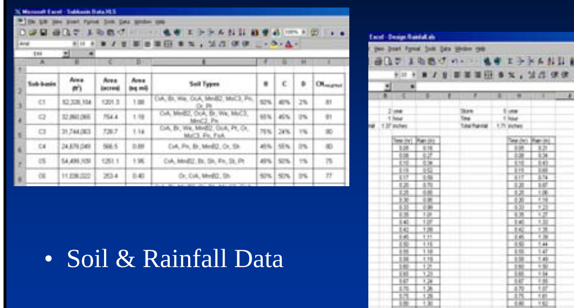




Problem Analysis

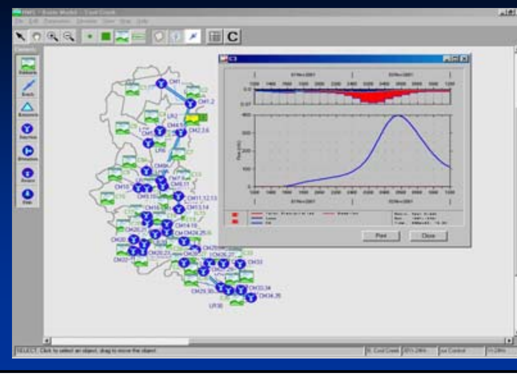
- Field Survey for detailed reach information
- Develop computer model of stream
- Stream Sampling

Hydrologic/Hydraulic Analysis



- Soil & Rainfall Data

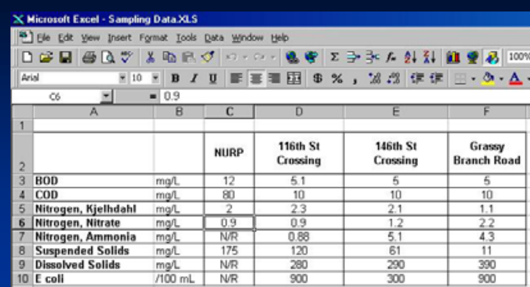
HEC Modeling



Stream Sampling Locations

- 116th Street Crossing
- 146th Street Crossing
- Grassy Branch Road North of SR 32

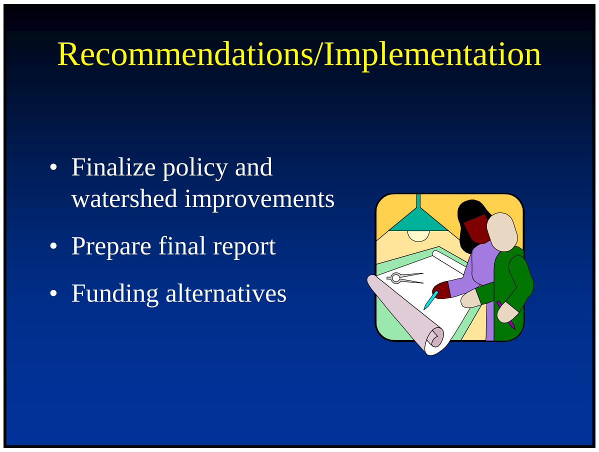
Sampling Results


Microsoft Excel - Sampling Data.XLS

		NURP	116th St Crossing	146th St Crossing	Grassy Branch Road
BOD	mg/L	12	5.1	5	5
COD	mg/L	80	10	10	10
Nitrogen, Kjelhdahl	mg/L	2	2.3	2.1	1.1
Nitrogen, Nitrate	mg/L	0.9	0.9	1.2	2.2
Nitrogen, Ammonia	mg/L	N/R	0.88	5.1	4.3
Suspended Solids	mg/L	175	120	61	11
Dissolved Solids	mg/L	N/R	280	290	390
E coli	/100 mL	N/R	900	300	900

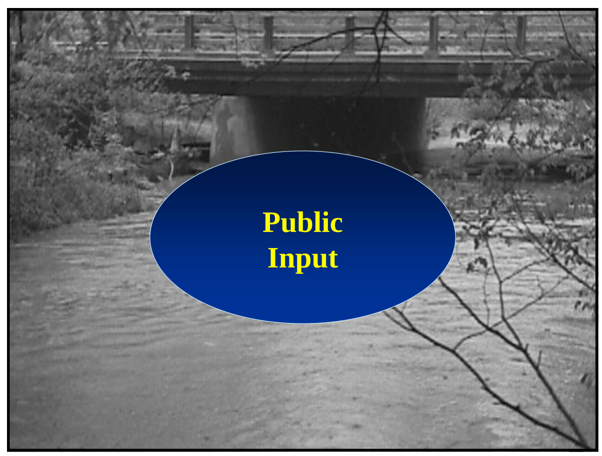
Solution Development

- Modifications to ordinances, standards, and policies
- Preliminary design solutions for local and regional problems (size, location, etc.)
- Meet with developers and public


Recommendations/Implementation
• Finalize policy and watershed improvements
• Prepare final report
• Funding alternatives


Upcoming Activities


Upcoming Activities
• Solution development
• Continue stream sampling
• Continue public input
• Watershed Management Plan
• Hamilton County Website
www.co.hamilton.in.us/news/Public.htm


Public Input

Clark Dietz

Westfield Public Meeting Summary

Project:	Cool Creek Watershed Management Plan
Date:	May 21, 2002
Staff Attendees:	Kent Ward, Tricia Banta – Hamilton County Surveyor's Office David Johnston – Town of Westfield Dale Tekippe, Hans Peterson, Wes Christmas – Clark Dietz

The meeting was held as a public information meeting for the Cool Creek Watershed Management Plan. Approximately 40 people attended the meeting. A listing of the people who signed in at the meeting is attached (not all attendees signed in). A brief summary of comments/questions was prepared by Wes Christmas of Clark Dietz, Inc. Please forward any comments or corrections on to him or Hans Peterson. The meeting discussions are summarized as follows:

David Johnston and Kent Ward kicked off the meeting by introducing the project and the consultant preparing the management plan, Clark Dietz.

Hans Peterson gave a presentation covering the scope of the project, description of the findings to date, and the upcoming activities pertaining to the project. Following the presentation the floor was opened to questions and/or comments from the public. The following were the general concerns mentioned:

- Several residents expressed concern with filling or development taking place within the floodplain.

- A general desire was expressed to maintain the aesthetic value of the creek, including preservation of riparian areas.

- Concerns about water quality were discussed. Residents showed interest in continued sampling and monitoring of the quality of water in the creek. Residents would also like to see sampling results compared to target values rather than national averages. There was interest in dry weather sampling as well as wet weather sampling of the creek. Comments were expressed that we should strive to improve the water quality, not just maintain it.

- Concern was expressed regarding the amount of native plant growth residing in the riparian areas adjacent to the creek and the invasion of non-native plants. It was suggested that a bio-diversity assessment of the creek/watershed system be considered.

- General concern was expressed regarding blockages in the creek. Kent Ward discussed which drains were regulated and maintained and which were private and did not have maintenance access.

- Interest was expressed to have information available on the Internet, including the presentation slides. The County Surveyor's web site was included in the handout packet and residents were encouraged to check the site for updates.

Four stations with watershed maps were setup and occupied by project personnel to discuss individual problems, concerns, or questions. Several individual concerns were recorded.

Clark Dietz

Carmel Public Meeting Summary

Project:	Cool Creek Watershed Management Plan
Date:	May 22, 2002
Staff Attendees:	Kent Ward, Tricia Banta – Hamilton County Surveyor's Office Kate Weese – City of Carmel Dale Tekippe, Hans Peterson, Wes Christmas – Clark Dietz

The meeting was held as a public information meeting for the Cool Creek Watershed Management Plan. Approximately 30 people attended the meeting. A listing of the people who signed in at the meeting is attached (not all attendees signed in). A brief summary of comments/questions was prepared by Wes Christmas of Clark Dietz, Inc. Please forward any comments or corrections on to him or Hans Peterson. The meeting discussions are summarized as follows:

Kate Weese kicked off the meeting by introducing the project and the consultant preparing the management plan, Clark Dietz.

Hans Peterson gave a presentation covering the scope of the project, description of the findings to date, and the upcoming activities pertaining to the project. Following the presentation the floor was opened to questions and/or comments from the public. The following were the general concerns mentioned:

- There were some questions regarding the future expansion of US 31 and its impact on the watershed. Kate Weese discussed that bridges under US 31 are generally sized for at least the 100-year event and that existing bridges are usually extended to accommodate additional lane expansions. Hans Peterson discussed that we did not have detailed information on the plans for the expansion incorporated into the hydrologic model because this information is not yet available. Following the meeting, it was discussed that environmental data (fish and wildlife habit, wetlands, native species, etc.) may be available in conjunction with some of the planning work being performed by INDOT's consultant. We will follow up to determine the availability of this data.

- Residents displayed interest in performing channel clean out, erosion control, streambank stabilization, and general creek maintenance. It was discussed that creek maintenance on private property is the responsibility of the landowner. John South of the Hamilton County SWCD mentioned that the SWCD provides permitting and technical assistance to property owners with stream maintenance concerns.

- Residents showed interest in Rule 5 compliance within the watershed. Kent Ward indicated he was not aware of any significant violations in the watershed. We will check with the state to determine the status of any Rule 5 violations in the watershed.

- Several complaint/concerns were voiced regarding construction and filling taking place in the floodplain.

- Some residents expressed concern regarding the formation of sandbar islands that change the direction of the creek and cause erosion. Kate Weese discussed how channel movement and sandbar formation is often a natural process. We will follow up on some specific locations mentioned.

- General concern was expressed regarding flooding and erosion along the creek adjacent to Cool Creek Drive.

- Interest was expressed to have information available on the Internet, including the presentation slides. The County Surveyor's web site was included in the handout packet and residents were encouraged to check the site for updates.

Four stations with watershed maps were set up and occupied by project personnel to discuss individual problems, concerns, or questions. Several individual concerns were recorded.

Study looks at reasons for flooding

By Phil Dunlap
Correspondent

Flooding — and how to prevent it — was on the minds of a group of about 50 residents who met this week at Westfield Town Hall.

At the center of discussion

WESTFIELD

was a $150,000 Cool Creek Watershed Management Study enlisted to identify storm water flooding problems along Cool Creek and its tributaries and propose possible solutions.

Officials hope that by identifying potential flood areas early, communities can find ways to solve problems before they begin.

Hans Peterson, vice president of Clark Dietz, Inc., the firm hired to do the study, said modifying ordinances and policies will be a part of the effort.

Peterson noted that, beginning in March, communities will see much stricter federal regulations on water management.

He suggested that totally avoiding development in sensitive areas is a possibility.

"Any town over 10,000 people will have to develop programs to address these issues."

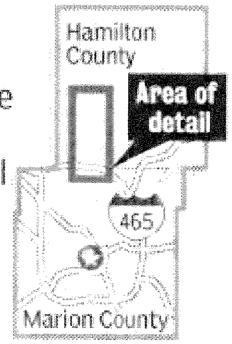
Hamilton County Surveyor Kent Ward led the presentation and said having the study in hand puts the county ahead of the new Environmental Protection Agency regulations.

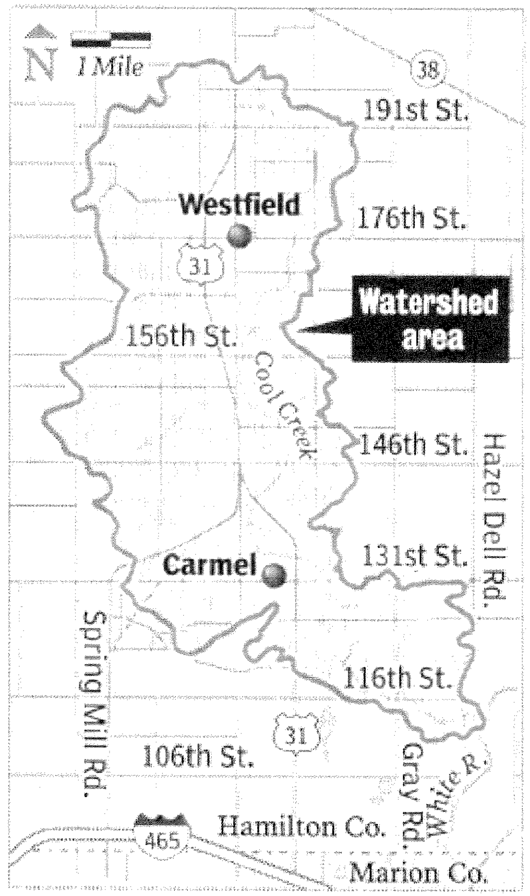
Increased interest in the pres-

See Flooding, Page NA2

Watershed studied

Officials of Carmel, Westfield and Hamilton County are looking at flooding potential in the Cool Creek watershed in hopes of heading off problems in the future.





Staff graphic

Flooding

■ Banning development in some areas may be needed.

From NA1

entation was likely sparked by recent heavy rains and significant flooding.

The cost of the study was borne by Carmel, Westfield, and Hamilton County, all of which are affected by the 14.7 mile tributary to White River.

The watershed accommodates drainage to more than 23 square miles of land.

An idea from biologist Dawn Stelts peaked considerable interest.

She said too many invasive plants, not native to Indiana, have been allowed to proliferate along the creek and in watershed areas.

She suggested that a program to reintroduce native plant species could help filter and absorb more of the impurities in runoff water, and be beneficial to wildlife.

The need to identify potential drainage problems when proposals come in from developers was a repeated theme.

Westfield Town Council President Mike McDonald said the Plan Commission is sensitive to that issue, having recently denied a petition for a large shopping center at 161st Street and U.S. 31.

"A big consideration for rejecting their proposal was that they (wanted to) fill in a flood plain area," said McDonald.

"Westfield has been pretty strict with how drainage impacts the region."

APPENDIX D

STREAM WATER QUALITY TEST RESULTS

WET WEATHER SAMPLING EVENT

MARCH 25, 2002

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job Number: 02.01329

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
316473	116TH ST. CROSSING	03/25/2002	09:10	03/25/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Project Representative

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job No.: 02.01329

Date Received: 03/25/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
316473 116TH ST. CROSSING			03/25/2002 09:10				
BOD - Five Day	5.1		mg/L	sld	04/01/2002 08:52	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	03/27/2002 10:50	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	jss	03/25/2002 14:30	SM3500CrD	<0.010
COD	10		mg/L	tpd	03/26/2002 10:00	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	03/27/2002 08:30		Complete
Cyanide, Total	<0.005		mg/L	dsp	03/28/2002 13:18	EPA 335.4	<0.005
Nitrogen, Ammonia	0.88		mg/L	dsp	03/28/2002 15:36	EPA 350.1	<0.10
Nitrogen, Kjeldahl	2.3		mg/L	dsp	04/04/2002 08:51	EPA 351.2	<0.30
Nitrogen, Nitrate	0.90		mg/L	dsp	03/26/2002 13:33	EPA 353.2	<0.02
Nitrogen, Organic	1.4		mg/L	sld	04/10/2002	EPA 351-EPA	<0.10
Nitrogen, Total	3.2		mg/L	sld	04/10/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl	04/01/2002 14:30	EPA 1664A	<5.
pH	7.7		S.U.	jss	03/25/2002 14:00	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	03/29/2002 09:30		Complete
Phenol	<0.010		mg/L	dsp	04/01/2002 13:38	EPA 420.2	<0.010
Phosphorus, Dissolved	<0.05		mg/L	tpd	03/27/2002 09:40	EPA 365.2	<0.05
Phosphorus, Total - Prep	Complete			tpd	03/27/2002 09:40		Complete
Solids, Dissolved	280		mg/L	lng	03/27/2002 13:16	EPA 160.1	<20.
Solids, Suspended	120		mg/L	lng	03/27/2002 13:03	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	04/02/2002 08:30		Complete
Antimony, ICP	<0.10		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.005
Cadmium, ICP	<0.030		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.030

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TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job No.: 02.01329

Date Received: 03/25/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
316473 116TH ST. CROSSING			03/25/2002 09:10				
Chromium, ICP	<0.040		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.040
Copper, ICP	<0.020		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	03/28/2002 07:12	EPA 245.1	<0.0002
Nickel, ICP	<0.010		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	03/28/2002 13:05	EPA 200.7	<0.50
Zinc, ICP	<0.050		mg/L	400	03/27/2002 12:14	EPA 200.7	<0.050
E. coli	900		/100 mL	out	03/29/2002	SM9222G	<1
Fecal Streptococcus	120		/100 mL	out	03/29/2002	SM9230C	<1

KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ____________

Client Name: CLARK DIETZ   Client #: ________
Address: 8445 KEYSTONE CROSSING SUITE 105
City/State/Zip Code: INDIANAPOLIS IN 46240
Project Manager: HANS PETERSON
Telephone Number: 317-259-4644   Fax: 317-259-4660
Sampler Name: (Print Name) WES CHRISTMAS
Sampler Signature: W. Christmas

Project Name: COOL CREEK WATERSHED STUDY
Project #: H21010
Site/Location ID: 1 - 116TH STREET CROSSING   State: IN
Report To: HANS PETERSON
Invoice To: CLARK DIETZ
Quote #: 01.0122   PO#: ________

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ____________

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ________

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	Preservation & # of Containers: HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Analyze For: PHENOL	E. COLI, FECAL, STREP	TKN, NH_4, ORG. N, COD, TOTAL N	CN	METALS	PH, TDS, TSS, BOD, NITRATE, Cr^{6+}	DISS. PHOS.	OIL + GREASE			REMARKS
1a - 116TH ST. CROSSING	3/25/02	9:10			STREAM				1				X										(AMBER GLASS)
1b - 116TH ST. CROSSING	3/25/02	9:10			STREAM							3		X									
1c - 116TH ST. CROSSING	3/25/02	9:10			STREAM				1						X								
1d - 116TH ST. CROSSING	3/25/02	9:10			STREAM			1	[illegible]							X							
1e - 116TH ST. CROSSING	3/25/02	9:10			STREAM	1											X						
1f - 116TH ST. CROSSING	3/25/02	9:10			STREAM						2							X	X				LAB FILTER
1g - 116TH ST. CROSSING	3/25/02	9.10			STREAM				1											X			

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
W. Christmas	3/25/02	1050	[signature]	3-25-02	1050

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 4.2° C
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment: Client

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job Number: 02.01330

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
316474	146TH ST. CROSSING	03/25/2002	09:35	03/25/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Reproduction of this analytical report is permitted only in its entirety.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

ïr. Hans J. Peterson
:LARK DIETZ, INC.
ı445 Keystone Crossing
ìuite 105
:ndianapolis, IN 46240

04/15/2002

Job No.: 02.01330

)ate Received: 03/25/2002
Iob Description: COOL CREEK WATERSHED STUDY

;ample Number / Sample I.D. ?arameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
316474 146TH ST. CROSSING			03/25/2002 09:35				
BOD - Five Day	<5		mg/L	sld	04/01/2002 08:52	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	03/27/2002 10:50	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	jss	03/25/2002 14:30	SM3500CrD	<0.010
COD	<10.		mg/L	tpd	03/26/2002 10:00	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	03/27/2002 08:30		Complete
Cyanide, Total	<0.005		mg/L	dsp	03/28/2002 13:18	EPA 335.4	<0.005
Nitrogen, Ammonia	5.1		mg/L	dsp	03/28/2002 15:36	EPA 350.1	<0.10
Nitrogen, Kjeldahl	2.1		mg/L	dsp	04/04/2002 08:51	EPA 351.2	<0.30
Nitrogen, Nitrate	1.2		mg/L	dsp	03/26/2002 13:33	EPA 353.2	<0.02
Nitrogen, Organic	<0.10		mg/L	sld	04/10/2002	EPA 351-EPA	<0.10
Nitrogen, Total	3.3		mg/L	sld	04/10/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl	04/01/2002 14:30	EPA 1664A	<5.
pH	7.7		S.U.	jss	03/25/2002 14:00	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	03/29/2002 09:30		Complete
Phenol	<0.010		mg/L	dsp	04/01/2002 13:38	EPA 420.2	<0.010
Phosphorus, Dissolved	<0.05		mg/L	tpd	03/27/2002 09:40	EPA 365.2	<0.05
Phosphorus, Total - Prep	Complete			tpd	03/27/2002 09:40		Complete
Solids, Dissolved	290		mg/L	lng	03/27/2002 13:16	EPA 160.1	<20.
Solids, Suspended	61		mg/L	lng	03/27/2002 13:03	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	04/02/2002 08:30		Complete
Antimony, ICP	<0.10		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.005
Cadmium, ICP	<0.030		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.030

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job No.: 02.01330

Date Received: 03/25/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
316474 146TH ST. CROSSING			03/25/2002 09:35				
Chromium, ICP	<0.040		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.040
Copper, ICP	<0.020		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	03/28/2002 07:14	EPA 245.1	<0.0002
Nickel, ICP	<0.010		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	03/28/2002 13:11	EPA 200.7	<0.50
Zinc, ICP	<0.050		mg/L	400	03/27/2002 12:17	EPA 200.7	<0.050
E. coli	300		/100 mL	out	03/29/2002	SM9222G	<1
Fecal Streptococcus	240		/100 mL	out	03/29/2002	SM9230C	<1

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
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mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
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ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
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k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ________

Client Name: Clark Dietz Client #: ________
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644 Fax: 317-259-4660
Sampler Name: (Print Name) Wes Christmas
Sampler Signature: W. C[signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 2 - 146TH Street Crossing State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01.0122 PO#: ________

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ________

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ______

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Phenol	E. Coli, Fecal, Strep	TKN, NH_4, Org. N, COD, Total N	CN	Metals	pH, TDS, TSS, BOD, Nitrate, Cr^{6+}	Diss. Phos	Oil + Grease			REMARKS
2a - 146TH St. Crossing	3/25/02	9:35			Stream				1				X										(Amber Glass)
2b - 146TH St. Crossing	3/25/02	9:35			Stream							3		X									
2c - 146TH St. Crossing	3/25/02	9:35			Stream				1						X								
2d - 146TH St. Crossing	3/25/02	9:35			Stream			1								X							
2e - 146TH St. Crossing	3/25/02	9:35			Stream	1											X						
2f - 146TH St. Crossing	3/25/02	9:35			Stream						2							X	X				Lab Filter
2g - 146TH St. Crossing	3/25/02	9:35			Stream				1											X			

Special Instructions:

Relinquished By: W. C[signature]	Date: 3/25/02	Time: 10:30	Received By: [signature]	Date: 3-25-02	Time: 1050
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 4.2 °C
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment: Client

TestAmerica
INCORPORATED

RECEIVED
APR 18 2002

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job Number: 02.01331

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
316475	186TH ST. CROSSING	03/25/2002	09:55	03/25/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Reproduction of this analytical report is permitted only in its entirety.

Sarah Hemmes
Project Representative

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
3445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job No.: 02.01331

Date Received: 03/25/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
316475 186TH ST. CROSSING			03/25/2002 09:55				
BOD - Five Day	<5		mg/L	sld	04/01/2002 08:52	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	03/27/2002 10:50	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	jss	03/25/2002 14:30	SM3500CrD	<0.010
COD	<10.		mg/L	tpd	03/26/2002 10:00	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	03/27/2002 08:30		Complete
Cyanide, Total	<0.005		mg/L	dsp	03/28/2002 13:18	EPA 335.4	<0.005
Nitrogen, Ammonia	4.3		mg/L	dsp	03/28/2002 15:36	EPA 350.1	<0.10
Nitrogen, Kjeldahl	1.1		mg/L	dsp	04/04/2002 08:51	EPA 351.2	<0.30
Nitrogen, Nitrate	2.2	d1x10	mg/L	dsp	03/26/2002 13:33	EPA 353.2	<0.20
Nitrogen, Organic	<0.10		mg/L	sld	04/10/2002	EPA 351-EPA	<0.10
Nitrogen, Total	3.3		mg/L	sld	04/10/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl	04/01/2002 14:30	EPA 1664A	<5.
pH	7.5		S.U.	jss	03/25/2002 14:00	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	03/29/2002 09:30		Complete
Phenol	<0.010		mg/L	dsp	04/01/2002 13:38	EPA 420.2	<0.010
Phosphorus, Dissolved	<0.05		mg/L	tpd	03/27/2002 09:40	EPA 365.2	<0.05
Phosphorus, Total - Prep	Complete			tpd	03/27/2002 09:40		Complete
Solids, Dissolved	390		mg/L	lng	03/27/2002 13:16	EPA 160.1	<20.
Solids, Suspended	11		mg/L	lng	03/27/2002 13:03	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	04/02/2002 08:30		Complete
Antimony, ICP	<0.10		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.005
Cadmium, ICP	<0.030		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.030

TestAmerica
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ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
3445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

04/15/2002

Job No.: 02.01331

Date Received: 03/25/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
316475 186TH ST. CROSSING			03/25/2002 09:55				
Chromium, ICP	<0.040		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.040
Copper, ICP	<0.020		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	03/28/2002 07:16	EPA 245.1	<0.0002
Nickel, ICP	<0.010		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	03/28/2002 13:16	EPA 200.7	<0.50
Zinc, ICP	<0.050		mg/L	400	03/27/2002 12:20	EPA 200.7	<0.050
E. coli	900		/100 mL	out	03/29/2002	SM9222G	<1
Fecal Streptococcus	<10		/100 mL	out	03/29/2002	SM9230C	<10

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KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED
Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250
Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ________

Client Name: CLARK DIETZ Client #: ________
Address: 8445 KEYSTONE CROSSING SUITE 105
City/State/Zip Code: INDIANAPOLIS IN 46240
Project Manager: HANS PETERSON
Telephone Number: 317-259-4644 Fax: 317-259-4660
Sampler Name: (Print Name) WES CHRISTMAS
Sampler Signature: W. C[signature]

Project Name: COOL CREEK WATERSHED STUDY
Project #: H21010
Site/Location ID: 3-186TH STREET CROSSING State: IN
Report To: HANS PETERSON
Invoice To: CLARK DIETZ
Quote #: 01.0122 PO#: ________

TAT
___ Standard
___ Rush (surcharges may apply)
Date Needed: ________
Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ________

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	PHENOL	E. COLI, FECAL, STREP	TKN, NH_4, ORG. N, COD, TOTAL N	CN	METALS	pH, TDS, TSS, BOD, NITRATE, Cr^{6+}	DISS. PHOS	OIL + GREASE			REMARKS
3a-186TH ST. CROSSING	3/25/02	9:55			STREAM				1				X										(AMBER GLASS)
3b-186TH ST. CROSSING	3/25/02	9:55			STREAM							3		X									
3c-186TH ST. CROSSING	3/25/02	9:55			STREAM				1						X								
3d-186TH ST. CROSSING	3/25/02	9:55			STREAM			1								X							
3e-186TH ST. CROSSING	3/25/02	9:55			STREAM	1											X						
3f-186TH ST. CROSSING	3/25/02	9:55			STREAM						2							X	X				LAB FILTER
3g-186TH ST. CROSSING	3/25/02	9:55			STREAM				1											X			

Special Instructions:

Relinquished By	Date	Time	Received By	Date	Time
W. C[signature]	3/25/02	10:50	[signature]	3-25-02	1050

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 4.2°C
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment: Client

DRY WEATHER SAMPLING EVENT

JUNE 21, 2002

TestAmerica
INCORPORATED

JUL - 3 2002

ANALYTICAL AND QUALITY CONTROL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Enclosed is the Analytical and Quality Control reports for the following samples submitted to the TestAmerica, Inc. Indianapolis Division.
Project Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
322191	2A-G 146TH ST CROSSING	06/21/2002	10:37	06/21/2002
322213	3A-G 186 TH ST CROSSING	06/21/2002	10:15	06/21/2002
322214	1A-G 116TH ST CROSSING	06/21/2002	11:00	06/21/2002

The Quality Control report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Reproduction of this analytical report is permitted only in its entirety.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Client Project ID: COOL CREEK WATERSHED STUDY/H21010

yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference

\MPLE NO. SAMPLE DESCRIPTION DATE-TIME TAKEN
:2191 2A-G 146TH ST CROSSING 06/21/2002 10:37

- Five Day	<5		mg/L	<5.	06/26/2002 13:25	lng	1341	1995	EPA 405.1
- Five Day (Prep)	Complete			Complete	06/21/2002 13:00	lng	1341		EPA 405.1
mium, Hexavalent	<0.010		mg/L	<0.010	06/22/2002 08:30	sdh		1305	SM3500CrD
	<10.		mg/L	<10.	06/25/2002 09:15	tpd		1116	EPA 410.4
ide - Prep	Complete			Complete	06/24/2002 08:30	mhl	729		
ide, Total	<0.005		mg/L	<0.005	06/24/2002 13:30	jss	729	1051	EPA 335.4
ogen, Ammonia	<0.10		mg/L	<0.10	06/27/2002 13:03	jss		1164	EPA 350.1
ogen, Kjeldahl	0.84		mg/L	<0.30	06/25/2002 11:57	jss	635	703	EPA 351.2
ogen, Nitrate	0.85		mg/L	<0.02	06/21/2002 15:32	jss		1067	EPA 353.2
ogen, Organic	0.84		mg/L	<0.10	06/27/2002 15:00	jss		1165	EPA 351-EPA 350
ogen, Total	1.7		mg/L	<0.10	06/27/2002 15:00	jss		704	EPA 351+EPA 353
& Grease	<5.	1	mg/L	<5.	06/25/2002 09:45	sdh		1682	EPA 1664A
	8.0		S.U.	<0.1	06/21/2002 14:15	sdh		3155	EPA 150.1
ol - Prep	Complete			Complete	06/25/2002 09:00	mhl	440		
ol	<0.010		mg/L	<0.010	06/29/2002 10:45	jss	440	700	SW 9066
phorus, Dissolved	<0.05		mg/L	<0.05	06/26/2002 09:30	tpd		8	EPA 365.2
phorus, Total - Prep	Complete			Complete	06/26/2002 09:30	tpd	223		
ds, Dissolved	390		mg/L	<20.	06/24/2002 15:25	lng		897	EPA 160.1
ds, Suspended	<5		mg/L	<5.	06/25/2002 10:56	lng		1925	EPA 160.2
le Filtration	Complete			Complete	06/21/2002	sld		409	
stion, TKN	Complete			Complete	06/24/2002 09:30	mhl	635		
METALS AQUEOUS	Complete			Complete	06/27/2002 14:59	401		5462	
mony, ICP	<0.10		mg/L	<0.10	06/27/2002 14:59	400	3859	4550	EPA 200.7
nic, ICP	<0.10		mg/L	<0.10	06/27/2002 14:59	400	3859	4714	EPA 200.7
llium, ICP	<0.005		mg/L	<0.005	06/27/2002 14:59	400	3859	4671	EPA 200.7
ium, ICP	<0.030		mg/L	<0.030	06/27/2002 14:59	400	3859	4918	EPA 200.7

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ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
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07/01/2002

Job Number: 02.02893

Client Project ID: COOL CREEK WATERSHED STUDY/H21010

yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
ıMPLE NO. :2191	**SAMPLE DESCRIPTION 2A-G 146TH ST CROSSING**						**DATE-TIME TAKEN 06/21/2002 10:37**		
mium, ICP	<0.040		mg/L	<0.040	06/27/2002 14:59	400	3859	5105	EPA 200.7
er, ICP	<0.020		mg/L	<0.020	06/27/2002 14:59	400	3859	5045	EPA 200.7
, ICP	<0.080		mg/L	<0.080	06/27/2002 14:59	400	3859	5058	EPA 200.7
ury, CVAA	<0.0002		mg/L	<0.0002	06/26/2002 09:51	400	3151	1464	EPA 245.1
el, ICP	<0.010		mg/L	<0.010	06/27/2002 14:59	400	3859	4981	EPA 200.7
nium, ICP	<0.10		mg/L	<0.10	06/27/2002 14:59	400	3859	4641	EPA 200.7
er, ICP	<0.040		mg/L	<0.040	06/27/2002 14:59	400	3859	4668	EPA 200.7
lium, ICP	<0.50		mg/L	<0.50	06/27/2002 14:59	400	3859	4630	EPA 200.7
, ICP	<0.050		mg/L	<0.050	06/27/2002 14:59	400	3859	5109	EPA 200.7
Metals Digestion-Aqueous	Complete			Complete	06/25/2002 10:40	400	3859		EPA 200.2
ury-Aqueous Digestion	Complete			Complete	06/24/2002 21:00	400	3151		EPA 245.1
oli	220		/100 mL	<1	06/25/2002	635		617	SM9222G
l Streptococcus	12		/mL	<1	06/25/2002	635		4	SM9230C
ıMPLE NO. :2213	**SAMPLE DESCRIPTION 3A-G 186 TH ST CROSSING**						**DATE-TIME TAKEN 06/21/2002 10:15**		
- Five Day	<5		mg/L	<5.	06/26/2002 13:25	lng	1341	1995	EPA 405.1
- Five Day (Prep)	Complete			Complete	06/21/2002 13:00	lng	1341		EPA 405.1
mium, Hexavalent	<0.010		mg/L	<0.010	06/22/2002 08:30	sdh		1305	SM3500CrD
	<10.		mg/L	<10.	06/25/2002 09:15	tpd		1116	EPA 410.4
ide - Prep	Complete			Complete	06/24/2002 08:30	mhl	729		
ide, Total	<0.005		mg/L	<0.005	06/24/2002 13:30	jss	729	1051	EPA 335.4

TestAmerica
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ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Client Project ID: COOL CREEK WATERSHED STUDY/H21010

.yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
ɅMPLE NO. 22213	SAMPLE DESCRIPTION 3A-G 186 TH ST CROSSING						DATE-TIME TAKEN 06/21/2002 10:15		
·ogen, Ammonia	<0.10		mg/L	<0.10	06/27/2002 13:03	jss		1164	EPA 350.1
·ogen, Kjeldahl	0.73		mg/L	<0.30	06/25/2002 11:57	jss	635	703	EPA 351.2
·ogen, Nitrate	1.8		mg/L	<0.02	06/21/2002 15:32	jss		1067	EPA 353.2
·ogen, Organic	0.73		mg/L	<0.10	06/27/2002 15:00	jss		1165	EPA 351-EPA 350
·ogen, Total	2.5		mg/L	<0.10	06/27/2002 15:00	jss		704	EPA 351+EPA 353
& Grease	<5.	1	mg/L	<5.	06/25/2002 09:45	sdh		1682	EPA 1664A
	7.9		S.U.	<0.1	06/21/2002 14:15	sdh		3155	EPA 150.1
ıol - Prep	Complete			Complete	06/25/2002 09:00	mhl	440		
ıol	<0.010		mg/L	<0.010	06/29/2002 10:45	jss	440	700	SW 9066
;phorus, Dissolved	0.067		mg/L	<0.05	06/26/2002 09:30	tpd		8	EPA 365.2
;phorus, Total - Prep	Complete			Complete	06/26/2002 09:30	tpd	223		
.ds, Dissolved	360		mg/L	<20.	06/24/2002 15:25	lng		897	EPA 160.1
.ds, Suspended	<5		mg/L	<5.	06/25/2002 10:56	lng		1925	EPA 160.2
·le Filtration	Complete			Complete	06/21/2002	sld		409	
:stion, TKN	Complete			Complete	06/24/2002 09:30	mhl	635		
METALS AQUEOUS	Complete			Complete	06/27/2002 15:02	401		5462	
mony, ICP	<0.10		mg/L	<0.10	06/27/2002 15:02	400	3859	4550	EPA 200.7
:nic, ICP	<0.10		mg/L	<0.10	06/27/2002 15:02	400	3859	4714	EPA 200.7
·llium, ICP	<0.005		mg/L	<0.005	06/27/2002 15:02	400	3859	4671	EPA 200.7
ıium, ICP	<0.030		mg/L	<0.030	06/27/2002 15:02	400	3859	4918	EPA 200.7
·mium, ICP	<0.040		mg/L	<0.040	06/27/2002 15:02	400	3859	5105	EPA 200.7
·er, ICP	<0.020		mg/L	<0.020	06/27/2002 15:02	400	3859	5045	EPA 200.7
., ICP	<0.080		mg/L	<0.080	06/27/2002 15:02	400	3859	5058	EPA 200.7
·ury, CVAA	<0.0002		mg/L	<0.0002	06/26/2002 09:53	400	3151	1464	EPA 245.1
.el, ICP	<0.010		mg/L	<0.010	06/27/2002 15:02	400	3859	4981	EPA 200.7
nium, ICP	<0.10		mg/L	<0.10	06/27/2002 15:02	400	3859	4641	EPA 200.7

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07/01/2002

Job Number: 02.02893

Client Project ID: COOL CREEK WATERSHED STUDY/H21010

yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference

ıMPLE NO. :2213 — SAMPLE DESCRIPTION 3A-G 186 TH ST CROSSING — DATE-TIME TAKEN 06/21/2002 10:15

yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
er, ICP	<0.040		mg/L	<0.040	06/27/2002 15:02	400	3859	4668	EPA 200.7
lium, ICP	<0.50		mg/L	<0.50	06/27/2002 15:02	400	3859	4630	EPA 200.7
, ICP	<0.050		mg/L	<0.050	06/27/2002 15:02	400	3859	5109	EPA 200.7
Metals Digestion-Aqueous	Complete			Complete	06/25/2002 10:40	400	3859		EPA 200.2
ıry-Aqueous Digestion	Complete			Complete	06/24/2002 21:00	400	3151		EPA 245.1
oli	170		/100 mL	<1	06/25/2002	635		617	SM9222G
l Streptococcus	5		/mL	<1	06/25/2002	635		4	SM9230C

ıMPLE NO. 2214 — SAMPLE DESCRIPTION 1A-G 116TH ST CROSSING — DATE-TIME TAKEN 06/21/2002 11:00

yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
- Five Day	<5		mg/L	<5.	06/26/2002 13:25	lng	1341	1995	EPA 405.1
- Five Day (Prep)	Complete			Complete	06/21/2002 13:00	lng	1341		EPA 405.1
nium, Hexavalent	0.010		mg/L	<0.010	06/22/2002 08:30	sdh		1305	SM3500CrD
	<10.		mg/L	<10.	06/25/2002 09:15	tpd		1116	EPA 410.4
ide - Prep	Complete			Complete	06/24/2002 08:30	mhl	729		
ide, Total	0.029		mg/L	<0.005	06/24/2002 13:30	jss	729	1051	EPA 335.4
ogen, Ammonia	<0.10		mg/L	<0.10	06/27/2002 13:03	jss		1164	EPA 350.1
ogen, Kjeldahl	0.56		mg/L	<0.30	06/25/2002 11:57	jss	635	703	EPA 351.2
ogen, Nitrate	0.65		mg/L	<0.02	06/21/2002 15:32	jss		1067	EPA 353.2
ogen, Organic	0.56		mg/L	<0.10	06/27/2002 15:00	jss		1165	EPA 351-EPA 350
ogen, Total	1.2		mg/L	<0.10	06/27/2002 15:00	jss		704	EPA 351+EPA 353
& Grease	11	1	mg/L	<5.	06/25/2002 09:45	sdh		1682	EPA 1664A

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Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Client Project ID: COOL CREEK WATERSHED STUDY/H21010

yte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
AMPLE NO. :2214	SAMPLE DESCRIPTION 1A-G 116TH ST CROSSING					DATE-TIME TAKEN 06/21/2002 11:00			
	7.9		S.U.	<0.1	06/21/2002 14:15	sdh		3155	EPA 150.1
ol - Prep	Complete			Complete	06/25/2002 09:00	mhl	440		
ol	0.012		mg/L	<0.010	06/29/2002 10:45	jss	440	700	SW 9066
phorus, Dissolved	<0.05		mg/L	<0.05	06/26/2002 09:30	tpd		8	EPA 365.2
phorus, Total - Prep	Complete			Complete	06/26/2002 09:30	tpd	223		
ds, Dissolved	440		mg/L	<20.	06/24/2002 15:25	lng		897	EPA 160.1
ds, Suspended	<5		mg/L	<5.	06/25/2002 10:56	lng		1925	EPA 160.2
le Filtration	Complete			Complete	06/21/2002	sld		409	
stion, TKN	Complete			Complete	06/24/2002 09:30	mhl	635		
METALS AQUEOUS	Complete			Complete	06/27/2002 15:05	401		5462	
mony, ICP	<0.10		mg/L	<0.10	06/27/2002 15:05	400	3859	4550	EPA 200.7
nic, ICP	<0.10		mg/L	<0.10	06/27/2002 15:05	400	3859	4714	EPA 200.7
llium, ICP	<0.005		mg/L	<0.005	06/27/2002 15:05	400	3859	4671	EPA 200.7
ium, ICP	<0.030		mg/L	<0.030	06/27/2002 15:05	400	3859	4918	EPA 200.7
mium, ICP	<0.040		mg/L	<0.040	06/27/2002 15:05	400	3859	5105	EPA 200.7
er, ICP	<0.020		mg/L	<0.020	06/27/2002 15:05	400	3859	5045	EPA 200.7
, ICP	<0.080		mg/L	<0.080	06/27/2002 15:05	400	3859	5058	EPA 200.7
ury, CVAA	<0.0002		mg/L	<0.0002	06/26/2002 09:56	400	3151	1464	EPA 245.1
el, ICP	<0.010		mg/L	<0.010	06/27/2002 15:05	400	3859	4981	EPA 200.7
nium, ICP	<0.10		mg/L	<0.10	06/27/2002 15:05	400	3859	4641	EPA 200.7
er, ICP	<0.040		mg/L	<0.040	06/27/2002 15:05	400	3859	4668	EPA 200.7
lium, ICP	<0.50		mg/L	<0.50	06/27/2002 15:05	400	3859	4630	EPA 200.7
, ICP	<0.050		mg/L	<0.050	06/27/2002 15:05	400	3859	5109	EPA 200.7
Metals Digestion-Aqueous	Complete			Complete	06/25/2002 10:40	400	3859		EPA 200.2
ury-Aqueous Digestion	Complete			Complete	06/24/2002 21:00	400	3151		EPA 245.1
oli	170		/100 mL	<1	06/25/2002	635		617	SM9222G

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ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Client Project ID: COOL CREEK WATERSHED STUDY/H21010

ʼte	Wet Wt. Result	Flag	Units	Reporting Limit	Date/Time Analyzed	Analyst Initials	Prep Batch No.	Run Batch No.	Method Reference
MPLE NO. 2214	SAMPLE DESCRIPTION 1A-G 116TH ST CROSSING							DATE-TIME TAKEN 06/21/2002 11:00	
L Streptococcus	13		/mL	<1	06/25/2002	635		4	SM9230C

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QUALITY CONTROL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

The following samples were submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
322191	2A-G 146TH ST CROSSING	06/21/2002	10:37	06/21/2002
322213	3A-G 186 TH ST CROSSING	06/21/2002	10:15	06/21/2002
322214	1A-G 116TH ST CROSSING	06/21/2002	11:00	06/21/2002

Approved by:

TestAmerica
INCORPORATED

QUALITY CONTROL REPORT
CONTINUING CALIBRATION VERIFICATION

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Analyte	Prep Batch No.	Run Batch No.	CCV True Value	CCV Conc Found	CCV % Rec	Flag	Date Analyzed
Chromium, Hexavalent		1305	0.10	0.102	102		06/22/2002
Chromium, Hexavalent		1305	0.10	0.110	110		06/22/2002
Cyanide, Total		1051	0.250	0.254	102		06/24/2002
Cyanide, Total		1051	0.250	0.257	103		06/24/2002
Cyanide, Total		1051	0.250	0.254	102		06/24/2002
Nitrogen, Ammonia		1164	5.00	5.05	101		06/27/2002
Nitrogen, Ammonia		1164	5.00	5.03	101		06/27/2002
Nitrogen, Ammonia		1164	5.00	4.98	100		06/27/2002
Nitrogen, Kjeldahl		703	3.00	3.28	109		06/25/2002
Nitrogen, Kjeldahl		703	3.00	3.16	105		06/25/2002
Nitrogen, Nitrate		1067	0.50	0.505	101		06/21/2002
Nitrogen, Nitrate		1067	0.50	0.496	99		06/21/2002
pH		3155	7.0	7.03	100		06/21/2002
Phenol		700	0.100	0.100	100		06/29/2002
Phenol		700	0.100	0.100	100		06/29/2002
Phenol		700	0.100	0.0996	100		06/29/2002
Phosphorus, Dissolved		8	0.45	0.490	109		06/26/2002
Copper, ICP		5045	1.00	0.97	97		06/27/2002
Lead, ICP		5058	1.00	1.06	106		06/27/2002
Mercury, CVAA		1464	0.00500	0.00505	101		06/26/2002
Nickel, ICP		4981	1.00	1.08	108		06/27/2002
Silver, ICP		4668	1.00	1.03	103		06/27/2002
Thallium, ICP		4630	6.00	5.61	94		06/27/2002
Zinc, ICP		5109	1.00	1.05	105		06/27/2002

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QUALITY CONTROL REPORT
BLANKS

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Analyte	Prep Batch No.	Run Batch No.	Blank Value	Flag	Units	Reporting Limit	Date Analyzed
BOD - Five Day	1341	1670	<5		mg/L	<5.	08/15/2000
BOD - Five Day	1341	1670	<5		mg/L	<5.	08/15/2000
BOD - Five Day		1995	<5		mg/L	<5.	06/26/2002
BOD - Five Day		1995	<5		mg/L	<5.	06/26/2002
BOD - Five Day		1995	<5		mg/L	<5.	06/26/2002
BOD - Five Day		1995	<5		mg/L	<5.	06/26/2002
Chromium, Hexavalent		1305	<0.010		mg/L	<0.010	06/22/2002
Chromium, Hexavalent		1305	<0.010		mg/L	<0.010	06/22/2002
COD		1116	<10		mg/L	<10.	06/25/2002
COD		1116	<10		mg/L	<10.	06/25/2002
Cyanide, Total	729	1051	<0.005		mg/L	<0.005	06/24/2002
Nitrogen, Ammonia		1164	<0.10		mg/L	<0.10	06/27/2002
Nitrogen, Ammonia		1164	<0.10		mg/L	<0.10	06/27/2002
Nitrogen, Ammonia		1164	<0.10		mg/L	<0.10	06/27/2002
Nitrogen, Ammonia		1164	<0.10		mg/L	<0.10	06/27/2002
Nitrogen, Kjeldahl	635	703	<0.30		mg/L	<0.30	06/25/2002
Nitrogen, Nitrate		1067	<0.020		mg/L	<0.02	06/21/2002
Nitrogen, Nitrate		1067	<0.020		mg/L	<0.02	06/21/2002
Nitrogen, Nitrate		1067	<0.020		mg/L	<0.02	06/21/2002
Nitrogen, Nitrate		1067	<0.020		mg/L	<0.02	06/21/2002
Oil & Grease		1682	<5		mg/L	<5.	06/25/2002
Phenol	440	700	<0.010		mg/L	<0.010	06/29/2002
Phosphorus, Dissolved		8	<0.050		mg/L	<0.05	06/26/2002
Phosphorus, Dissolved		8	<0.050		mg/L	<0.05	06/26/2002
Solids, Dissolved		897	<20		mg/L	<20.	06/24/2002
Solids, Suspended		1925	<5		mg/L	<5.	06/25/2002
Copper, ICP		5045	<0.020		mg/L	<0.020	06/27/2002
Lead, ICP	3859	5058	<0.080		mg/L	<0.080	06/27/2002
Lead, ICP		5058	<0.080		mg/L	<0.080	06/27/2002
Mercury, CVAA	3151	1464	<0.0002		mg/L	<0.0002	06/26/2002
Nickel, ICP	3859	4981	<0.010		mg/L	<0.010	06/27/2002
Nickel, ICP		4981	<0.010		mg/L	<0.010	06/27/2002
Silver, ICP	3859	4668	<0.040		mg/L	<0.040	06/27/2002
Silver, ICP		4668	<0.040		mg/L	<0.040	06/27/2002

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QUALITY CONTROL REPORT
BLANKS

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Analyte	Prep Batch No.	Run Batch No.	Blank Value	Flag	Units	Reporting Limit	Date Analyzed
Thallium, ICP	3859	4630	<0.50		mg/L	<0.50	06/27/2002
Thallium, ICP		4630	<0.50		mg/L	<0.50	06/27/2002
Zinc, ICP	3859	5109	<0.050		mg/L	<0.050	06/27/2002
Zinc, ICP		5109	<0.050		mg/L	<0.050	06/27/2002

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QUALITY CONTROL REPORT
LABORATORY CONTROL STANDARD

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

nalyte	Prep Batch No.	Run Batch No.	LCS True Conc	LCS Conc Found	LCS % Rec.	LCS Dup. Conc Found	LCS Dup. % Rec.	RPD	Flag	Date Analyzed
IOD - Five Day		1995	19.8	18.48	93					06/26/2002
IOD - Five Day		1995	198	176.3	89					06/26/2002
:OD		1116	50.	47.2	94	43.0	86	9.3		06/25/2002
:yanide, Total	729	1051	0.100	0.103	103					06/24/2002
Iitrogen, Ammonia		1164	5.00	4.77	95					06/27/2002
Iitrogen, Kjeldahl	635	703	2.50	2.81	112					06/25/2002
Iitrogen, Nitrate		1067	0.500	0.480	96					06/21/2002
)il & Grease		1682	40.0	36	90	43	108	18		06/25/2002
)H		3155	7.0	6.96	99					06/21/2002
?henol		700	0.100	0.106	106					06/29/2002
?hosphorus, Dissolved		8	0.450	0.471	105					06/26/2002
3olids, Dissolved		897	100	95	95					06/24/2002
3olids, Suspended		1925	100	90	90					06/25/2002
;ead, ICP	3859	5058	1.00	1.01	101					06/27/2002
4ercury, CVAA	3151	1464	0.00200	0.00201	101					06/26/2002
Vickel, ICP	3859	4981	1.00	1.04	104					06/27/2002
3ilver, ICP	3859	4668	1.00	0.98	98					06/27/2002
Thallium, ICP	3859	4630	1.00	0.90	90					06/27/2002
Zinc, ICP	3859	5109	1.00	0.99	99					06/27/2002

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QUALITY CONTROL REPORT
MATRIX SPIKE/MATRIX SPIKE DUPLICATE

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

ılyte	Prep Batch No.	Run Batch No.	Conc. Spike Added	Sample Result	Conc. MS Result	MS % Rec.	Conc. MSD Result	MSD % Rec.	RPD	Flag	Date Analyzed	Sample Spiked
:omium, Hexavalent		1305	0.10	<0.010	0.098	98	0.102	102	4		06/22/2002	322191
)		1116	50	<5	50.3	101	45.7	91	9.6		06/25/2002	322117
ınide, Total	729	1051	0.200	<0.005	0.196	98	0.195	98	0.5		06/24/2002	322191
:rogen, Ammonia		1164	5.00	<0.10	3.65	73	3.66	73	0.3		06/27/2002	322191
:rogen, Kjeldahl		703	2.50	0.78	2.93	86	2.90	85	1		06/25/2002	322117
:rogen, Nitrate		1067	0.50	0.033	0.477	89	0.466	87	2.3		06/21/2002	322218
ɜnol	440	700	0.10	<0.010	0.112	112	0.106	106	5.5		06/29/2002	322191
›sphorus, Dissolved		8	0.450	0.22	0.716	110	0.689	104	3.8		06/26/2002	322125
:imony, ICP	3859	4550	2.00	<0.20	1.10	55	1.11	56	0.9	q	06/27/2002	-2218
:yllium, ICP	3859	4671	2.00	<0.01	1.13	57	1.12	56	0.9	q	06/27/2002	-2218
:omium, ICP	3859	5105	1.00	<0.040	0.96	96	1.00	100	4.1		06/27/2002	322042
›per, ICP	3859	5045	1.00	<0.020	0.88	88	0.89	89	1.1		06/27/2002	322042
ıd, ICP	3859	5058	1.00	<0.080	0.96	96	0.98	98	2.1		06/27/2002	322042
:cury, CVAA	3151	1464	0.00100	<0.0002	0.00112	112	0.00114	114	1.8		06/26/2002	-2217
:cury, CVAA	3151	1465	0.00100	<0.0002	0.00112	112	0.00114	114	1.8		06/26/2002	-2223
:kel, ICP	3859	4981	1.00	<0.010	0.96	96	1.00	100	4.1		06/27/2002	322042
.ver, ICP	3859	4668	1.00	<0.040	0.96	96	0.97	97	1		06/27/2002	322042
ıllium, ICP	3859	4630	2.00	<1.0	<1.0	0	<1.0	0		q	06/27/2002	-2218
ıllium, ICP	3859	4630	1.00	<0.50	0.83	83	0.88	88	5.8		06/27/2002	322042
ıc, ICP	3859	5109	1.00	<0.050	0.97	97	1.00	100	3		06/27/2002	322042

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QUALITY CONTROL REPORT
DUPLICATES

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

07/01/2002

Job Number: 02.02893

Analyte	Prep Batch No.	Run Batch No.	Sample Result	Duplicate Sample Result	Units	RPD	Flag	Date Analyzed	Duplicate Sample Number
BOD - Five Day	1341	1995	<5	<5	mg/L			06/26/2002	322214
pH		3155	8.0	8.1	S.U.	1.2		06/21/2002	322191
Solids, Dissolved		897	390	410	mg/L	5.0		06/24/2002	322191
Solids, Dissolved		897	510	510	mg/L	0.0		06/24/2002	322227
Solids, Suspended		1925	110	100	mg/L	9.5		06/25/2002	322334

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KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED
Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250
Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ____________

Client Name: Clark Dietz Client #: ____
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644 Fax: 317-259-4660
Sampler Name: (Print Name) Emily Wehmeyer
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 1-116th ST. crossing State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: ____ PO#: ____

TAT
___ Standard
___ Rush (surcharges may apply)
Date Needed: ____
Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ____

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Phenol	E.coli, Fecal, Strep	TKN, NH4, ORG. N, COD, Total N	CN	METALS	pH, TDS, TSS, BOD, NITRATE, Cr6+	Diss. Phos.	Oil + Grease			REMARKS
1a - 116th ST. Crossing	6/21/02	11:00			Stream				1				X										(Amber Glass)
1b - 116th ST. Crossing	6/21/02	11:00			Stream							3		X									
1c - 116th ST. Crossing	6/21/02	11:00			Stream				1						X								
1d - 116th ST. Crossing	6/21/02	11:00			Stream			1								X							
1e - 116th ST. Crossing	6/21/02	11:00			Stream	1											X						
1F - 116th ST Crossing	6/21/02	11:00			Stream						2							X	X				LAB Filter
1g - 116th ST Crossing	6/21/02	11:00			Stream				1											X			

Special Instructions:

Relinquished By: [signature]	Date: 6/21/02	Time: 1120	Received By: [signature]	Date: 6-21-02	Time: 1120
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp:
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

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Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ______

Client Name: Clark Dietz
Client #: ______
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644
Fax: 317-259-4660
Sampler Name: (Print Name) Emily Wehmeyer
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 3-186th St Crossing
State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: ______
PO#: ______

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ______

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ______

Matrix: SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix	HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Phenol	E Coli, Fecal, Strep	TKN, NH_4, Org N., COD, Total N	CN	Metals	pH, TDS, TSS, BOD,	Nitrate, Cr^{6+}	Diss. Phos	Oil + Grease		REMARKS
3a-186th St Crossing	6/21/02	10:15			Stream				1				X										(Amber Glass)
3b-186th St Crossing	6/21/02	10:15			Stream							3		X									
3c-186th St Crossing	6/21/02	10:15			Stream				1						X								
3d-186th St Crossing	6/21/02	10:15			Stream			1								X							
3e-186th St Crossing	6/21/02	10:15			Stream	1											X						
3f-186th St Crossing	6/21/02	10:15			Stream						2							X	X				LAB FILTER
3g-186th St Crossing	10/21/02	10:15			Stream				1											X			

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
[signature]	6/21/02	1120	[signature]	6-21-02	1120

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 3.2
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment: Client

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ____________

Client Name: Clark Dietz
Client #: ____________
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644
Fax: 317-259-4660
Sampler Name: (Print Name) Emily Wehmeyer
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 2-146th Street Crossing
State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: ____________
PO#: ____________

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ____________

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ________

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	Preservation & # of Containers: HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Analyze For: Phenol	E Coli, Fecal, Strep	TKN, NH_4, Org N, COD, Total N	CN	Metals	pH, TDS, TSS, BOD,	Nitrate, Cr^{6+}	Diss Phos	Oil + Grease		REMARKS
2a-146th St Crossing	6/21/02	10:37			Stream				1				X										
2b-146th St Crossing	6/21/02	10:37			Stream							3		X									
2c-146th St Crossing	6/21/02	10:37			Stream				1						X								
2d-146th St Crossing	6/21/02	10:37			Stream			1								X							
2e-146th St Crossing	6/21/02	10:37			Stream	1											X						
2f-146th St Crossing	6/21/02	10:37			Stream						2							X	X				
2g-146th St Crossing	6/21/02	10:37			Stream				1											X			

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
[signature]	6/21/02	1120	[signature]	6-21-02	1120

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 3.2 °C
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment: Client

WET WEATHER SAMPLING EVENT

AUGUST 19, 2002

TestAmerica
INCORPORATED

SEP 09 2002

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/03/2002

Job Number: 02.03861

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
326011	116TH ST CROSSING	08/19/2002	09:30	08/19/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/03/2002

Job No.: 02.03861

Date Received: 08/19/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst Date & Time Analyzed	Method	Reporting Limit
326011 116TH ST CROSSING			08/19/2002 09:30			
BOD - Five Day	5.5		mg/L	lng 08/26/2002 10:55	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng 08/21/2002 08:45	EPA 405.1	Complete
Chromium, Hexavalent	0.015		mg/L	sld 08/20/2002 08:12	SM3500CrD	<0.010
COD	59		mg/L	tpd 08/20/2002 09:42	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl 08/21/2002 10:00		Complete
Cyanide, Total	<0.005		mg/L	jss 08/22/2002 10:10	EPA 335.4	<0.005
Nitrogen, Ammonia	0.14		mg/L	jss 08/23/2002 11:52	EPA 350.1	<0.10
Nitrogen, Kjeldahl	3.0		mg/L	jss 08/22/2002 13:26	EPA 351.2	<0.30
Nitrogen, Nitrate	0.69	q	mg/L	jss 08/21/2002 09:01	EPA 353.2	<0.02
Nitrogen, Organic	2.9		mg/L	jss 08/27/2002 08:30	EPA 351-EPA	<0.10
Nitrogen, Total	3.7		mg/L	sld 08/28/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl 09/03/2002 09:30	EPA 1664A	<5.
pH	8.0		S.U.	sld 08/19/2002 14:40	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl 08/19/2002 14:00		Complete
Phenol	0.025		mg/L	jss 08/20/2002 11:54	EPA 420.2	<0.010
Phosphorus, Total	0.56		mg/L	tpd 08/21/2002 09:00	EPA 365.2	<0.05
Phosphorus, Dissolved	0.15		mg/L	tpd 08/21/2002 09:00	EPA 365.2	<0.05
Phosphorus, Total - Prep	Complete			tpd 08/21/2002 09:00		Complete
Solids, Dissolved	120		mg/L	lng 08/20/2002 10:19	EPA 160.1	<20.
Solids, Suspended	490		mg/L	lng 08/20/2002 09:47	EPA 160.2	<5.
Digestion, TKN	Complete			mhl 08/21/2002 08:30		Complete
Antimony, ICP	<0.10		mg/L	400 08/22/2002 19:07	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400 08/22/2002 14:54	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400 08/22/2002 14:54	EPA 200.7	<0.005

TestAmerica
INCORPORATED

ANALYTICAL REPORT

ír. Hans J. Peterson
:LARK DIETZ, INC.
445 Keystone Crossing
Suite 105
ndianapolis, IN 46240

09/03/2002

Job No.: 02.03861
Page 3 of 6

Date Received: 08/19/2002
Job Description: COOL CREEK WATERSHED STUDY

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
326011 116TH ST CROSSING			08/19/2002 09:30				
Cadmium, ICP	<0.030		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.030
Chromium, ICP	<0.040		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.040
Copper, ICP	0.033		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	08/22/2002 11:30	EPA 245.1	<0.0002
Nickel, ICP	0.018		mg/L	400	08/22/2002 16:56	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.50
Zinc, ICP	0.095		mg/L	400	08/22/2002 14:54	EPA 200.7	<0.050
E. coli	1600		/100 mL	635	08/23/2002	SM9222G	<1
Coliform, Fecal	2		/100 mL	635	08/23/2002	SM9222D	<1
Fecal Streptococcus	920			635	08/23/2002	SM9230C	<1

TestAmerica
INCORPORATED

PROJECT NARRATIVE

JOB NUMBER: 02.03861

SAMPLE: 326011

ANALYSIS: Nitrate

MS/MSD recovery values are below the acceptable limits. Matrix interference may be suppressing analyte recovery. Concentration values for this sample may be biased low due to the suspected matrix interference. All other quality control indicators are within acceptable limits.
jss 8/21/02.

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica
KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

6964 Hillsdale Ct. / Indianapolis, IN 46250 / 317-842-4261 / Fax: 317-842-4286

TestAmerica
INCORPORATED

SUBCONTRACTED LABORATORY CODES

1	MISC
75	A & L GREATLAKES LABS
175	TESTAMERICA-NASHVILLE
200	TESTAMERICA-CEDAR FALLS
250	TESTAMERICA-ORLANDO
400	TESTAMERICA-DAYTON
401	TESTAMERICA-DAYTON/NO UTC
425	EARTH EXPLORATION
430	HOOSIER MICROBIOLOGICAL LAB
440	ECCS
475	EMSL
635	TOWNSEND RESEARCH LABS
645	TRIANGLE LABS
700	TESTAMERICA-WATERTOWN

CHAIN OF CUSTODY IS ATTACHED

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED
Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250
Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ______

Client Name: Clark Dietz, Inc. Client #: ______
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644 Fax: 317-259-4660
Sampler Name: (Print Name) Wes Christmas
Sampler Signature: W Christmas

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 1-116th Street Crossing State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01-0122 PO#: ______

TAT
___ Standard
___ Rush (surcharges may apply)
Date Needed: ______
Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ______

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Phenol	EColi, Fecal, Strep	TKN, NH4, ORG.N, COD, TOTAL N.	CN	Metals	PH, TDS, TSS, BOD, Nitrate, Cr 6+, Diss PHOS	OIL + GREASE				REMARKS
1a-116th St Crossing	8/19/02	9:30			Stream				1				X										
1b-116th St Crossing	8/19/02	9:30			Stream							2		X									
1c-116th St Crossing	8/19/02	9:30			Stream				1						X								
1d-116th St Crossing	8/19/02	9:30			Stream			1								X							
1e-116th St Crossing	8/19/02	9:30			Stream	1											X						
1f-116th St Crossing	8/19/02	9:30			Stream						1							X					
1g-116th St Crossing	8/19/02	9:30			Stream				1										X				

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
W Christmas	8/19/02	10:30	[illegible signature]	8/19/02	10:30

LABORATORY COMMENTS:
Init Lab Temp: 19.6°C
Rec Lab Temp: on ice
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/03/2002

Job Number: 02.03862

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: 2-146TH ST CROSSING

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
326012	146TH CROSSING	08/19/2002	09:00	08/19/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

r. Hans J. Peterson
LARK DIETZ, INC.
445 Keystone Crossing
uite 105
ndianapolis, IN 46240

09/03/2002

Job No.: 02.03862

ate Received: 08/19/2002
ob Description: 2-146TH ST CROSSING

ample Number / Sample I.D. arameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
326012 146TH CROSSING			08/19/2002 09:00				
BOD - Five Day	6.9		mg/L	lng	08/26/2002 10:55	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	08/21/2002 08:45	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	sld	08/20/2002 08:12	SM3500CrD	<0.010
COD	81		mg/L	tpd	08/20/2002 09:42	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	08/21/2002 10:00		Complete
Cyanide, Total	<0.005		mg/L	jss	08/22/2002 10:10	EPA 335.4	<0.005
Nitrogen, Ammonia	0.16		mg/L	jss	08/23/2002 11:52	EPA 350.1	<0.10
Nitrogen, Kjeldahl	3.6		mg/L	jss	08/22/2002 13:26	EPA 351.2	<0.30
Nitrogen, Nitrate	0.81		mg/L	jss	08/21/2002 08:49	EPA 353.2	<0.02
Nitrogen, Organic	3.4		mg/L	jss	08/27/2002 08:30	EPA 351-EPA	<0.10
Nitrogen, Total	4.4		mg/L	sld	08/28/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl	09/03/2002 09:30	EPA 1664A	<5.
pH	7.6		S.U.	sld	08/19/2002 14:40	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	08/19/2002 14:00		Complete
Phenol	0.017		mg/L	jss	08/20/2002 11:54	EPA 420.2	<0.010
Phosphorus, Total	0.72		mg/L	tpd	08/21/2002 09:00	EPA 365.2	<0.05
Phosphorus, Dissolved	0.21		mg/L	tpd	08/21/2002 09:00	EPA 365.2	<0.05
Phosphorus, Total - Prep	Complete			tpd	08/21/2002 09:00		Complete
Solids, Dissolved	210		mg/L	lng	08/20/2002 10:19	EPA 160.1	<20.
Solids, Suspended	580		mg/L	lng	08/20/2002 09:47	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	08/21/2002 08:30		Complete
Antimony, ICP	<0.10		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.005

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/03/2002

Job No.: 02.03862

Date Received: 08/19/2002
Job Description: 2-146TH ST CROSSING

Sample Number / Sample I.D. Parameters		Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
326012	146TH CROSSING			08/19/2002 09:00				
Cadmium, ICP		<0.030		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.030
Chromium, ICP		<0.040		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.040
Copper, ICP		0.025		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.020
Lead, ICP		<0.080		mg/L	400	08/22/2002 16:14	EPA 200.7	<0.080
Mercury, CVAA		<0.0002		mg/L	400	08/22/2002 11:37	EPA 245.1	<0.0002
Nickel, ICP		<0.010		mg/L	400	08/22/2002 16:14	EPA 200.7	<0.010
Selenium, ICP		<0.10		mg/L	400	08/22/2002 16:14	EPA 200.7	<0.10
Silver, ICP		<0.040		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.040
Thallium, ICP		<0.50		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.50
Zinc, ICP		<0.050		mg/L	400	08/22/2002 14:53	EPA 200.7	<0.050
E. coli		1600		/100 mL	635	08/23/2002	SM9222G	<1
Coliform, Fecal		8		/100 mL	635	08/23/2002	SM9222D	<1
Fecal Streptococcus		960		/100 mL	635	08/23/2002	SM9230C	<1

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

TestAmerica
INCORPORATED

SUBCONTRACTED LABORATORY CODES

1	MISC
75	A & L GREATLAKES LABS
175	TESTAMERICA-NASHVILLE
200	TESTAMERICA-CEDAR FALLS
250	TESTAMERICA-ORLANDO
400	TESTAMERICA-DAYTON
401	TESTAMERICA-DAYTON/NO UTC
425	EARTH EXPLORATION
430	HOOSIER MICROBIOLOGICAL LAB
440	ECCS
475	EMSL
635	TOWNSEND RESEARCH LABS
645	TRIANGLE LABS
700	TESTAMERICA-WATERTOWN

CHAIN OF CUSTODY IS ATTACHED

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ________

Client Name: Clark Dietz Client #: ________
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-46[redacted]44 Fax: 317-259-4660
Sampler Name: (Print Name) Wes Christmas
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 2-146th St Crossing State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01-0122 PO#: ________

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ________

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ________

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix: SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other	Preservation & # of Containers: HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Analyze For: Phenol	E Coli, Fecal, Strep	TKN, NH4, Org N, COD, Total N.	CN	Metals	pH, TDS, TSS, BOD, Nitrate, Cr6+, Diss Phos	Oil & Grease				REMARKS
2a-146th St Crossing	8/19/02	9:00											X										
2b-146th St Crossing	8/19/02	9:00												X									
2c-146th St Crossing	8/19/02	9:00													X								
2d-146th St Crossing	8/19/02	9:00														X							
2e-146th St Crossing	8/19/02	9:00															X						
2f-146th St Crossing	8/19/02	9:00																X					
2g-146th St Crossing	8/19/02	9:00																	X				

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
[signature]	8/19/02	10:30	[signature]	8/19/02	10:30

LABORATORY COMMENTS:
Init Lab Temp: 19.6°C
Rec Lab Temp: On ice
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/03/2002

Job Number: 02.03863

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: 3-186TH ST CROSSING

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
326013	186TH ST CROSSING	08/19/2002	08:45	08/19/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/03/2002

Job No.: 02.03863

Date Received: 08/19/2002
Job Description: 3-186TH ST CROSSING

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
326013 186TH ST CROSSING			08/19/2002 08:45				
BOD - Five Day	5.4		mg/L	lng	08/26/2002 10:55	EPA 405.1	<5.
BOD - Five Day (Prep)	complete			lng	08/21/2002 08:45	EPA 405.1	Complete
Chromium, Hexavalent	0.012		mg/L	sld	08/20/2002 08:12	SM3500CrD	<0.010
COD	32		mg/L	tpd	08/20/2002 09:42	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	08/21/2002 10:00		Complete
Cyanide, Total	<0.005		mg/L	jss	08/22/2002 10:10	EPA 335.4	<0.005
Nitrogen, Ammonia	0.28		mg/L	jss	08/23/2002 11:52	EPA 350.1	<0.10
Nitrogen, Kjeldahl	2.1		mg/L	jss	08/22/2002 13:26	EPA 351.2	<0.30
Nitrogen, Nitrate	1.2	h	mg/L	jss	08/21/2002 08:50	EPA 353.2	<0.02
Nitrogen, Organic	1.8		mg/L	jss	08/27/2002 08:30	EPA 351-EPA	<0.10
Nitrogen, Total	3.3		mg/L	sld	08/28/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	l	mg/L	mhl	09/03/2002 09:30	EPA 1664A	<5.
pH	7.4		S.U.	sld	08/19/2002 14:40	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	08/19/2002 14:00		Complete
Phenol	0.018		mg/L	jss	08/20/2002 11:54	EPA 420.2	<0.010
Phosphorus, Total	0.52	d1x10	mg/L	tpd	08/21/2002 09:00	EPA 365.2	<0.50
Phosphorus, Dissolved	0.28		mg/L	tpd	08/21/2002 09:00	EPA 365.2	<0.05
Phosphorus, Total - Prep	Complete			tpd	08/21/2002 09:00		Complete
Solids, Dissolved	140		mg/L	lng	08/20/2002 10:19	EPA 160.1	<20.
Solids, Suspended	160		mg/L	lng	08/20/2002 09:47	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	08/21/2002 08:30		Complete
Antimony, ICP	<0.10		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.005

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ANALYTICAL REPORT

r. Hans J. Peterson
LARK DIETZ, INC.
445 Keystone Crossing
uite 105
ndianapolis, IN 46240

09/03/2002

Job No.: 02.03863

ate Received: 08/19/2002
ob Description: 3-186TH ST CROSSING

ample Number / Sample I.D. arameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
326013 186TH ST CROSSING			08/19/2002 08:45				
Cadmium, ICP	<0.030		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.030
Chromium, ICP	<0.040		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.040
Copper, ICP	<0.020		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	08/22/2002 16:17	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	08/22/2002 11:39	EPA 245.1	<0.0002
Nickel, ICP	<0.010		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.50
Zinc, ICP	<0.050		mg/L	400	08/22/2002 14:58	EPA 200.7	<0.050
E. coli	>1600		/100 mL	635	08/23/2002	SM9222G	<1
Coliform, Fecal	7		/100 mL	635	08/23/2002	SM9222D	<1
Fecal Streptococcus	1700		/100 mL	635	08/23/2002	SM9230C	<1

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PROJECT NARRATIVE

JOB NUMBER: 02.03863

SAMPLE: 326013

ANALYSIS: Nitrate

Due to QC problems sample 326013 was analyzed 4 minutes past recommended hold time.
jss 8/21/02.

KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*****	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

SUBCONTRACTED LABORATORY CODES

1	MISC
75	A & L GREATLAKES LABS
175	TESTAMERICA-NASHVILLE
200	TESTAMERICA-CEDAR FALLS
250	TESTAMERICA-ORLANDO
400	TESTAMERICA-DAYTON
401	TESTAMERICA-DAYTON/NO UTC
425	EARTH EXPLORATION
430	HOOSIER MICROBIOLOGICAL LAB
440	ECCS
475	EMSL
635	TOWNSEND RESEARCH LABS
645	TRIANGLE LABS
700	TESTAMERICA-WATERTOWN

CHAIN OF CUSTODY IS ATTACHED

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ________

Client Name: Clark Dietz — Client #: ________
Address: 8445 Keystone Crossing Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644 — Fax: 317-259-46660
Sampler Name: (Print Name) Wes Christmas
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 3-186th St Crossing — State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01-0122 — PO#: ________

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ________

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ________

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix: SL - Sludge DW - Drinking Water GW - Groundwater S - Soil/Solid WW - Wastewater Specify Other	Preservation & # of Containers: HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Analyze For: Phenol	E Coli, Fecal, Strep	TKN, NH_4 Org N, COD, Total N	CN	Metals	pH, TDS, TSS, BOD, Nitrate, Cr^{+6}, Diss Phos	Oil & Grease				REMARKS
3a-186th St Crossing	8/19/02	8:45a.m.											X										
3b-186th St Crossing	8/19/02	8:45												X									
3c-186th St Crossing	8/19/02	8:45													X								
3d-186th St Crossing	8/19/02	8:45														X							
3e-186th St Crossing	8/19/02	8:45															X						
3f-186th St Crossing	8/19/02	8:45																X					
3g-186th St Crossing	8/19/02	8:45																	X				

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
[signature]	8/19/02	10:30	Melissa White	8/19	10:30

LABORATORY COMMENTS:
Init Lab Temp: 19.6°C
Rec Lab Temp: on ice
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

DRY WEATHER SAMPLING EVENT

SEPTEMBER 9, 2002

TestAmerica
INCORPORATED

OCT - 1 2002

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/19/2002

Job Number: 02.04229

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
327739	1A-1G 116TH ST CROSSING	09/09/2002	11:20	09/09/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Ir. Hans J. Peterson
:LARK DIETZ, INC.
I445 Keystone Crossing
;uite 105
:ndianapolis, IN 46240

09/19/2002

Job No.: 02.04229

Date Received: 09/09/2002
Job Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
327739 1A-1G 116TH ST CROSSING			09/09/2002 11:20				
BOD - Five Day	<5		mg/L	lng	09/16/2002 09:30	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	09/11/2002 08:10	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	bsb	09/10/2002 08:40	SM3500CrD	<0.010
COD	<10.		mg/L	tpd	09/11/2002 08:54	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	09/13/2002 09:15		Complete
Cyanide, Total	<0.005		mg/L	jss	09/16/2002 10:51	EPA 335.4	<0.005
Nitrogen, Ammonia	<0.10		mg/L	jss	09/13/2002 15:13	EPA 350.1	<0.10
Nitrogen, Kjeldahl	0.30		mg/L	jss	09/12/2002 12:47	EPA 351.2	<0.30
Nitrogen, Nitrate	0.47		mg/L	jss	09/10/2002 09:34	EPA 353.2	<0.02
Nitrogen, Organic	0.30		mg/L	sld	09/17/2002	EPA 351-EPA	<0.10
Nitrogen, Total	0.77		mg/L	sld	09/17/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl	09/16/2002 09:00	EPA 1664A	<5.
pH	7.5		S.U.	bsb	09/09/2002 17:34	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	09/10/2002 09:00		Complete
Phenol	0.022		mg/L	jss	09/11/2002 14:26	EPA 420.2	<0.010
Phosphorus, Dissolved	<0.05		mg/L	tpd	09/11/2002 09:40	EPA 365.2	<0.05
Solids, Dissolved	530		mg/L	sld	09/11/2002 15:10	EPA 160.1	<20.
Solids, Suspended	<5		mg/L	lng	09/11/2002 13:15	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	09/11/2002 09:00		Complete
Antimony, ICP	<0.10		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.005
Cadmium, ICP	<0.030		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.030
Chromium, ICP	<0.040		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.040

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/19/2002

Job No.: 02.04229

Date Received: 09/09/2002
Job Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number / Sample I.D. Parameters		Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
327739	1A-1G 116TH ST CROSSING			09/09/2002 11:20				
Copper, ICP		<0.020		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.020
Lead, ICP		<0.080		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.080
Mercury, CVAA		<0.0002		mg/L	400	09/13/2002 10:49	EPA 245.1	<0.0002
Nickel, ICP		<0.010		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.010
Selenium, ICP		<0.10		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.10
Silver, ICP		<0.040		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.040
Thallium, ICP		<0.50		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.50
Zinc, ICP		<0.050		mg/L	400	09/12/2002 21:34	EPA 200.7	<0.050
E. coli		>1600		/100 mL	out	09/13/2002	SM9222G	<1
Coliform, Fecal		>1600		/100 mL	out	09/13/2002	SM9222D	<1
Fecal Streptococcus		3		/100 mL	out	09/13/2002	SM9230C	<1

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KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

SUBCONTRACTED LABORATORY CODES

1	MISC
75	A & L GREATLAKES LABS
175	TESTAMERICA-NASHVILLE
200	TESTAMERICA-CEDAR FALLS
250	TESTAMERICA-ORLANDO
400	TESTAMERICA-DAYTON
401	TESTAMERICA-DAYTON/NO UTC
425	EARTH EXPLORATION
430	HOOSIER MICROBIOLOGICAL LAB
440	ECCS
475	EMSL
635	TOWNSEND RESEARCH LABS
645	TRIANGLE LABS
700	TESTAMERICA-WATERTOWN

CHAIN OF CUSTODY IS ATTACHED

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TestAmerica INCORPORATED
Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250
Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ________

Client Name: Clark Dietz
Client #: ________
Address: 8445 Keystone Crossing, Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644
Fax: 317-259-4660
Sampler Name: (Print Name) Emily Wehmeyer
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 1-116th St Crossing
State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01-0122
PO#: ________

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ________

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ________

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix (SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other)	HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Phenol	E Coli, Fecal, Strep	TKN, NH_4, Org N, COD, Total N	CN	Metals	pH, TDS, TSS, BOD, Nitrate, Cl, Diss Phos	Oil + Grease				REMARKS
1a-116th St Crossing	9/9/02	11:20							1				X										
1b-116th St Crossing	9/9/02	11:20										2		X									
1c-116th St Crossing	9/9/02	11:20							1						X								
1d-116th St Crossing	9/9/02	11:20						1								X							
1e-116th St Crossing	9/9/02	11:20				1											X						
1f-116th St Crossing	9/9/02	11:20									1							X					
1g-116th St Crossing	9/9/02	11:20							1										X				

Special Instructions:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
[signature]	9/9/02	11:55	[signature]	9-9-02	1155

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 13.3 on ice
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

TestAmerica
INCORPORATED

OCT - 1 2002

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/20/2002

Job Number: 02.04230
Page 1 of 5

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
327740	2A-2G 146TH ST CROSSING	09/09/2002	11:00	09/09/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Reproduction of this analytical report is permitted only in its entirety.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/20/2002

Job No.: 02.04230

Date Received: 09/09/2002
Job Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
327740 2A-2G 146TH ST CROSSING			09/09/2002 11:00				
BOD - Five Day	<5		mg/L	lng	09/16/2002 09:30	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	09/11/2002 08:10	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	bsb	09/10/2002 08:40	SM3500CrD	<0.010
COD	9.8		mg/L	tpd	09/11/2002 08:54	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	09/13/2002 09:15		Complete
Cyanide, Total	<0.005		mg/L	jss	09/16/2002 10:51	EPA 335.4	<0.005
Nitrogen, Ammonia	<0.10		mg/L	jss	09/13/2002 15:13	EPA 350.1	<0.10
Nitrogen, Kjeldahl	0.54		mg/L	jss	09/18/2002 11:58	EPA 351.2	<0.30
Nitrogen, Nitrate	0.16		mg/L	jss	09/10/2002 09:34	EPA 353.2	<0.02
Nitrogen, Organic	0.49		mg/L	sld	09/20/2002 13:27	EPA 351-EPA	<0.10
Nitrogen, Total	0.70		mg/L	sld	09/20/2002 13:27	EPA 351+EPA	<0.10
Oil & Grease	<5.	1	mg/L	mhl	09/16/2002 09:00	EPA 1664A	<5.
pH	7.7		S.U.	bsb	09/09/2002 17:34	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	09/10/2002 09:00		Complete
Phenol	<0.010		mg/L	jss	09/11/2002 14:26	EPA 420.2	<0.010
Phosphorus, Dissolved	<0.05		mg/L	tpd	09/11/2002 09:40	EPA 365.2	<0.05
Solids, Dissolved	430		mg/L	sld	09/11/2002 15:10	EPA 160.1	<20.
Solids, Suspended	<5		mg/L	lng	09/11/2002 13:15	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	09/17/2002 09:30		Complete
Antimony, ICP	<0.10		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.005
Cadmium, ICP	<0.030		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.030
Chromium, ICP	<0.040		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.040

6964 Hillsdale Ct. / Indianapolis, IN 46250 / 317-842-4261 / Fax: 317-842-4286

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/20/2002

Job No.: 02.04230
Page 3 of 5

Date Received: 09/09/2002
Job Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
327740 2A-2G 146TH ST CROSSING			09/09/2002 11:00				
Copper, ICP	<0.020		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	09/13/2002 11:09	EPA 245.1	<0.0002
Nickel, ICP	<0.010		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.50
Zinc, ICP	<0.050		mg/L	400	09/12/2002 21:45	EPA 200.7	<0.050
E. coli	>1600		/100 mL	out	09/13/2002	SM9222G	<1
Coliform, Fecal	>1600		/100 mL	out	09/13/2002	SM9222D	<1
Fecal Streptococcus	<1		/100 mL	out	09/13/2002	SM9230C	<1

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KEY TO ABBREVIATIONS

<	Less than; when appearing in the result column, indicates analyte not detected at or above the Reporting Limit.
%	Percent; To convert ppm to %, divide result by 10,000. To convert % to ppm, multiply the result by 10,000.
*	Indicates the Reporting Limit is elevated due to insufficient sample volume.
mg/L	Part per million; Concentration in units of milligrams of analyte per Liter of aqueous sample.
ug/L	Part per billion; Concentration in units of micrograms of analyte per Liter of aqueous sample.
mg/kg	Part per million; Concentration in units of milligrams of analyte per kilogram of non-aqueous sample.
ug/kg	Part per billion; Concentration in units of micrograms of analyte per kilogram of non-aqueous sample.
a	Indicates the sample concentration was quantitated using a diesel fuel standard.
b	Indicates the analyte of interest was also found in the method blank.
c	Sample resembles unknown Hydrocarbon.
dw	When indicated, the result is reported on a dry weight basis. The contribution of the moisture content in the sample has been subtracted when calculating the concentration.
d1	Indicates the analyte has elevated Reporting Limit due to high concentration.
d2	Indicates the analyte has elevated Reporting Limit due to matrix.
e	Indicates the reported concentration is estimated.
g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
u	Indicates the sample was received improperly preserved and/or improperly contained.
uj	Indicates the result is below the Reporting Limit and is considered estimated.
z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

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SUBCONTRACTED LABORATORY CODES

1	MISC
75	A & L GREATLAKES LABS
175	TESTAMERICA-NASHVILLE
200	TESTAMERICA-CEDAR FALLS
250	TESTAMERICA-ORLANDO
400	TESTAMERICA-DAYTON
401	TESTAMERICA-DAYTON/NO UTC
425	EARTH EXPLORATION
430	HOOSIER MICROBIOLOGICAL LAB
440	ECCS
475	EMSL
635	TOWNSEND RESEARCH LABS
645	TRIANGLE LABS
700	TESTAMERICA-WATERTOWN

CHAIN OF CUSTODY IS ATTACHED

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ______

Client Name: Clark Dietz
Client #: ______
Address: 8445 Keystone Crossing, Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644
Fax: 317-259-4660
Sampler Name: (Print Name) Emily Wehmeyer
Sampler Signature: [signature]

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 2-146th St Crossing
State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01-0122
PO#: ______

TAT
___ Standard
___ Rush (surcharges may apply)

Date Needed: ______

Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ______

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix: SL - Sludge, DW - Drinking Water, GW - Groundwater, S - Soil/Solid, WW - Wastewater, Specify Other	Preservation & # of Containers: HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Analyze For: Phenol	E Coli, Fecal, Strep	TKN, NH4, Org. N, COD, Total N	CN	Metals	pH, TDS, TSS, BOD, Nitrate, Cl, Diss Phos	Oil & Grease				REMARKS
2a-146th St Crossing	9/9/02	11:00							1				X										
2b-146th St Crossing	9/9/02	11:00										2		X									
2c-146th St Crossing	9/9/02	11:00							1						X								
2d-146th St Crossing	9/9/02	11:00						1								X							
2e-146th St Crossing	9/9/02	11:00				1											X						
2f-146th St Crossing	9/9/02	11:00									1							X					
2g-146th St Crossing	9/9/02	11:00							1										X				

Special Instructions:

Relinquished By: [signature]	Date: 9/9/02	Time: 11:55	Received By: [signature]	Date: 9-9-02	Time: 11:55
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 13.3 on ice
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

TestAmerica
INCORPORATED

OCT - 1 2002

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/19/2002

Job Number: 02.04228

Enclosed are the Analytical Results for the following samples submitted to TestAmerica, Inc. Indianapolis Division for analysis:

Project Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number	Sample Description	Date Taken	Time Taken	Date Received
327738	3A-3G 186TH ST CROSSING	09/09/2002	10:45	09/09/2002

TestAmerica, Inc. certifies that the analytical results contained herein apply only to the specific samples analyzed.

TestAmerica Incorporated-Indianapolis Division is in compliance with the National Environmental Laboratory Accreditation Program (NELAP) Standards.

Project Representative

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/19/2002

Job No.: 02.04228

Date Received: 09/09/2002
Job Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
327738 3A-3G 186TH ST CROSSING			09/09/2002 10:45				
BOD - Five Day	<5		mg/L	lng	09/16/2002 09:30	EPA 405.1	<5.
BOD - Five Day (Prep)	Complete			lng	09/11/2002 08:10	EPA 405.1	Complete
Chromium, Hexavalent	<0.010		mg/L	bsb	09/10/2002 08:40	SM3500CrD	<0.010
COD	11		mg/L	tpd	09/11/2002 08:54	EPA 410.4	<10.
Cyanide - Prep	Complete			mhl	09/13/2002 09:15		Complete
Cyanide, Total	<0.005		mg/L	jss	09/16/2002 10:51	EPA 335.4	<0.005
Nitrogen, Ammonia	<0.10	q	mg/L	jss	09/13/2002 15:13	EPA 350.1	<0.10
Nitrogen, Kjeldahl	0.69		mg/L	jss	09/12/2002 12:47	EPA 351.2	<0.30
Nitrogen, Nitrate	0.65	q	mg/L	jss	09/10/2002 09:34	EPA 353.2	<0.02
Nitrogen, Organic	0.66		mg/L	sld	09/17/2002	EPA 351-EPA	<0.10
Nitrogen, Total	1.3		mg/L	sld	09/17/2002	EPA 351+EPA	<0.10
Oil & Grease	<5.	l	mg/L	mhl	09/16/2002 09:00	EPA 1664A	<5.
pH	7.7		S.U.	bsb	09/09/2002 17:34	EPA 150.1	<0.1
Phenol - Prep	Complete			mhl	09/10/2002 09:00		Complete
Phenol	<0.010		mg/L	jss	09/11/2002 14:26	EPA 420.2	<0.010
Phosphorus, Dissolved	0.070		mg/L	tpd	09/11/2002 09:40	EPA 365.2	<0.05
Solids, Dissolved	490		mg/L	sld	09/11/2002 15:10	EPA 160.1	<20.
Solids, Suspended	10		mg/L	lng	09/11/2002 13:15	EPA 160.2	<5.
Digestion, TKN	Complete			mhl	09/11/2002 09:00		Complete
Antimony, ICP	<0.10		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.10
Arsenic, ICP	<0.10		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.10
Beryllium, ICP	<0.005		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.005
Cadmium, ICP	<0.030		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.030
Chromium, ICP	<0.040		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.040

TestAmerica
INCORPORATED

ANALYTICAL REPORT

Mr. Hans J. Peterson
CLARK DIETZ, INC.
8445 Keystone Crossing
Suite 105
Indianapolis, IN 46240

09/19/2002

Job No.: 02.04228
Page 3 of 6

Date Received: 09/09/2002
Job Description: COOL CREEK WATERSHED STUDY/H21010

Sample Number / Sample I.D. Parameters	Wet Wt. Result	Flag	Sample Date/ Units	Analyst	Date & Time Analyzed	Method	Reporting Limit
327738 3A-3G 186TH ST CROSSING			09/09/2002 10:45				
Copper, ICP	<0.020		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.020
Lead, ICP	<0.080		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.080
Mercury, CVAA	<0.0002		mg/L	400	09/13/2002 11:06	EPA 245.1	<0.0002
Nickel, ICP	<0.010		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.010
Selenium, ICP	<0.10		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.10
Silver, ICP	<0.040		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.040
Thallium, ICP	<0.50		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.50
Zinc, ICP	<0.050		mg/L	400	09/12/2002 21:42	EPA 200.7	<0.050
E. coli	>1600		/100 mL	out	09/13/2002	SM9222G	<1
Coliform, Fecal	>1600		/100 mL	out	09/13/2002	SM9222D	<1
Fecal Streptococcus	4		/100 mL	out	09/13/2002	SM9230C	<1

TestAmerica
INCORPORATED

PROJECT NARRATIVE

JOB NUMBER: 02.04228

SAMPLE: 327738

ANALYSIS: Ammonia

MS/MSD recovery values are below the acceptable limits. Matrix interference may be suppressing analyte recovery. Concentration values for this sample may be biased low due to the suspected matrix interference. All other quality control indicators are within acceptable limits.
jss 9/13/02.

[illegible] IN 46250 / 317-842-4261 / FAX: 317-842-4286

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KEY TO ABBREVIATIONS

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g	Indicates the sample concentration was quantitated using a gasoline standard.
h	Indicates the sample was analyzed past recommended holding time.
i	Insufficient spike concentration due to high analyte concentration in the sample.
j	Indicates the reported concentration is below the Reporting Limit.
k	Indicates the sample concentration was quantitated using a kerosene standard.
l	Indicates an MS/MSD was not analyzed due to insufficient sample. An LCS / LCS Duplicate provided for precision.
m	Indicates the sample concentration was quantitated using a mineral spirits standard.
o	Indicates the sample concentration was quantitated using a motor oil standard.
p	Indicates the sample was post spiked due to sample matrix.
q	Indicates MS/MSD exceeded control limits. The associated sample may exhibit similar matrix bias. All other quality control indicators are in control.
r	Indicates the sample was received past recommended holding time.
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z	Indicates the BOD dilution water blank depletion was between 0.2 and 0.5 mg/L.

6964 HILLSDALE CT. / INDIANAPOLIS, IN 46250 / 317-842-4261 / FAX: 317-842-4286

SUBCONTRACTED LABORATORY CODES

1	MISC
75	A & L GREATLAKES LABS
175	TESTAMERICA-NASHVILLE
200	TESTAMERICA-CEDAR FALLS
250	TESTAMERICA-ORLANDO
400	TESTAMERICA-DAYTON
401	TESTAMERICA-DAYTON/NO UTC
425	EARTH EXPLORATION
430	HOOSIER MICROBIOLOGICAL LAB
440	ECCS
475	EMSL
635	TOWNSEND RESEARCH LABS
645	TRIANGLE LABS
700	TESTAMERICA-WATERTOWN

CHAIN OF CUSTODY IS ATTACHED

TestAmerica INCORPORATED

Indianapolis Division
69640 Hillsdale Court
Indianapolis, IN 46250

Phone: 317-842-4261
Fax: 317-842-4286

To assist us in using the proper analytical methods, is this work being conducted for regulatory purposes?
Compliance Monitoring ______

Client Name: Clark Dietz
Client #: ______
Address: 8445 Keystone Crossing, Suite 105
City/State/Zip Code: Indianapolis, IN 46240
Project Manager: Hans Peterson
Telephone Number: 317-259-4644
Fax: 317-259-4660
Sampler Name: (Print Name) Emily Wehmeyer
Sampler Signature:

Project Name: Cool Creek Watershed Study
Project #: H21010
Site/Location ID: 3-186th St Crossing
State: IN
Report To: Hans Peterson
Invoice To: Clark Dietz
Quote #: 01-0122
PO#: ______

TAT
___ Standard
___ Rush (surcharges may apply)
Date Needed: ______
Fax Results: Y N

QC Deliverables
___ None
___ Level 2 (Batch QC)
___ Level 3
___ Level 4
Other: ______

SAMPLE ID	Date Sampled	Time Sampled	G = Grab, C = Composite	Field Filtered	Matrix: SL - Sludge DW - Drinking Water GW - Groundwater S - Soil/Solid WW - Wastewater Specify Other	Preservation & # of Containers: HNO_3	HCl	NaOH	H_2SO_4	Methanol	None	Other (Specify)	Analyze For: Phenol	E Coli, Fecal, Strep	TKN, NH_4, Org N, COD, Total N	CN	Metals	pH, TDS, TSS, BOD, Nitrate, Cr^{6+}, Diss Phos	Oil & Grease				REMARKS
3a-186th St Crossing	9/9/02	10:45							1				X										
3b-186th St Crossing	9/9/02	10:45										2		X									
3c-186th St Crossing	9/9/02	10:45							1						X								
3d-186th St Crossing	9/9/02	10:45						1								X							
3e-186th St Crossing	9/9/02	10:45				1											X						
3f-186th St Crossing	9/9/02	10:45									1							X					
3g-186th St Crossing	9/9/02	10:45							1										X				

Special Instructions:

Relinquished By:	Date: 9/9/02	Time: 11:55	Received By:	Date: 9-9-02	Time: 11:55
Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

LABORATORY COMMENTS:
Init Lab Temp:
Rec Lab Temp: 13.3 ON ICE
Custody Seals: Y N N/A
Bottles Supplied by TestAmerica: Y N
Method of Shipment:

APPENDIX E

HEC-HMS MODEL

Cool Creek Watershed
HEC-HMS Summary Output
100-year, 24-hour Rainfall Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
C28	100.39		63.875	0.240
CM28	100.39		63.875	0.240
LR28	100.37		63.875	0.240
C20	300.51		204.12	0.780
CM20	300.51		204.12	0.780
C22	78.690		49.721	0.190
CM22	78.690		49.721	0.190
LR22	78.665		49.721	0.190
C23	232.82		161.56	0.650
CM22,23	304.62		211.28	0.840
CM20,23	605.11		415.40	1.620
LR20	605.05		415.40	1.620
C21	229.26		151.78	0.580
CM20,21	819.74		567.18	2.200
LR21	819.66		567.18	2.200
C16	78.164		49.721	0.190
CM16	78.164		49.721	0.190
LR16	78.155		49.721	0.190
C17	95.222		61.745	0.240
CM17	95.222		61.745	0.240
LR17	95.222		61.745	0.240
C10	470.35		313.13	1.000
	434.09		309.05	1.000
	396.24		306.72	1.000
CM10	396.24		306.72	1.000
LR10	396.08		306.65	1.000
C9	320.62		225.05	0.860
CM9,10	716.05		531.70	1.860
LR9,10	716.05		531.50	1.860
C8A	68.448		47.104	0.180
CM8A	68.448		47.104	0.180
LR8A	68.446		47.104	0.180
C5	610.64		459.76	1.950
CM5	610.64		459.76	1.950
LR5	610.60		459.76	1.950
C6-Split	114.73		73.276	0.300
Conrail	685.02		533.03	2.250
C4	331.51		228.97	0.890
CM4,5	982.84		762.00	3.140
LR4,5	982.80		762.00	3.140
C1	691.49		491.97	1.880

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CM1	691.49	02 Nov 01 0510	491.97	1.880
LR1	691.38	02 Nov 01 0610	491.97	1.880
C2	393.32	02 Nov 01 0615	308.79	1.180
CM1,2	1084.7	02 Nov 01 0610	800.77	3.060
LR2	1084.5	02 Nov 01 0710	800.77	3.060
C6	35.280	02 Nov 01 0500	24.425	0.100
C3	395.98	02 Nov 01 0535	293.29	1.140
CM2,3,6	2444.7	02 Nov 01 0635	1880.5	7.440
LR6	2444.6	02 Nov 01 0800	1880.5	7.440
C8	231.22	02 Nov 01 0405	144.20	0.670
C7	536.89	02 Nov 01 0600	409.68	1.620
CM7,8	3043.3	02 Nov 01 0735	2481.5	9.910
LR8	3043.3	02 Nov 01 0800	2481.5	9.910
C11	61.372	02 Nov 01 0405	38.665	0.170
CM8,11	3555.8	02 Nov 01 0745	3051.6	11.940
LR11	3555.2	02 Nov 01 0810	3051.4	11.940
C12	79.399	02 Nov 01 0445	51.849	0.260
C13	237.23	02 Nov 01 0430	156.59	0.630
CM11,12,13	3704.5	02 Nov 01 0810	3259.8	12.830
LR13	3704.5	02 Nov 01 0825	3259.6	12.830
C14	366.77	02 Nov 01 0350	239.42	0.870
CM13,14	3820.0	02 Nov 01 0825	3499.0	13.700
LR14	3819.7	02 Nov 01 0850	3498.7	13.700
C18	81.887	02 Nov 01 0350	52.196	0.210
C15	262.41	02 Nov 01 0445	175.13	0.770
CM14-18	4011.1	02 Nov 01 0845	3837.5	15.110
LR18	4011.1	02 Nov 01 0855	3837.4	15.110
C24	187.14	02 Nov 01 0420	120.43	0.520
C19	60.616	02 Nov 01 0335	38.590	0.150
CM18,19,24	4524.6	02 Nov 01 0650	4563.6	17.980
LR24	4524.4	02 Nov 01 0715	4563.2	17.980
C25	184.94	02 Nov 01 0430	123.49	0.480
CM24,25	4640.3	02 Nov 01 0705	4686.7	18.460
LR25	4640.2	02 Nov 01 0730	4686.4	18.460
C26	123.45	02 Nov 01 0335	76.741	0.350
CM25,26	4694.1	02 Nov 01 0720	4763.2	18.810
LR26	4693.9	02 Nov 01 0755	4762.7	18.810
C27	150.08	02 Nov 01 0450	101.38	0.430
CM26,27	4783.9	02 Nov 01 0750	4864.1	19.240
LR27	4783.9	02 Nov 01 0800	4863.9	19.240
C29	128.86	02 Nov 01 0335	80.400	0.360
CM27,29	4868.0	02 Nov 01 0755	5008.2	19.840
LR29	4867.9	02 Nov 01 0835	5007.6	19.840
C30	352.61	02 Nov 01 0425	228.70	0.970
CM29,30	5004.0	02 Nov 01 0825	5236.3	20.810
LR30	5003.6	02 Nov 01 0835	5236.1	20.810
C31	110.36	02 Nov 01 0415	70.732	0.300
CM31	110.36	02 Nov 01 0415	70.732	0.300
LR31	110.35	02 Nov 01 0440	70.732	0.300
C32	200.73	02 Nov 01 0415	129.46	0.530
CM30,32	5117.9	02 Nov 01 0830	5436.3	21.640

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
LR32	5117.6	02 Nov 01 0910	5435.6	21.640
C33	109.19	02 Nov 01 0335	68.233	0.300
CM33	109.19	02 Nov 01 0335	68.233	0.300
LR33	109.18	02 Nov 01 0410	68.233	0.300
C34	176.15	02 Nov 01 0435	118.34	0.460
CM33,34	285.04	02 Nov 01 0435	186.58	0.760
LR34	284.99	02 Nov 01 0500	186.58	0.760
C35	177.63	02 Nov 01 0430	115.79	0.500
CM34,35	5284.7	02 Nov 01 0900	5738.0	22.900

Cool Creek Watershed
HEC-HMS Summary Output
50-year, 24-hour Rainfall Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
C28	85.290		53.265	0.240
CM28	85.290		53.265	0.240
LR28	85.284		53.265	0.240
C20	252.68		169.89	0.780
CM20	252.68		169.89	0.780
C22	66.780		41.384	0.190
CM22	66.780		41.384	0.190
LR22	66.732		41.384	0.190
C23	194.50		133.73	0.650
CM22,23	254.45		175.12	0.840
CM20,23	507.14		345.01	1.620
LR20	506.96		345.01	1.620
C21	192.85		126.33	0.580
CM20,21	687.93		471.34	2.200
LR21	687.77		471.34	2.200
C16	66.229		41.384	0.190
CM16	66.229		41.384	0.190
LR16	66.220		41.384	0.190
C17	79.992		51.297	0.240
CM17	79.992		51.297	0.240
LR17	79.984		51.297	0.240
C10	409.31		266.38	1.000
	347.74		262.45	1.000
	312.99		260.19	1.000
CM10	312.99		260.19	1.000
LR10	312.89		260.12	1.000
C9	269.56		187.32	0.860
CM9,10	577.55		447.44	1.860
LR9,10	577.55		447.25	1.860
C8A	57.557		39.206	0.180
CM8A	57.557		39.206	0.180
LR8A	57.544		39.206	0.180
C5	507.51		378.55	1.950
CM5	507.51		378.55	1.950
LR5	507.45		378.55	1.950
C6-Split	95.738		60.547	0.300
Conrail	568.01		439.10	2.250
C4	278.16		190.23	0.890
CM4,5	806.72		629.32	3.140
LR4,5	806.30		629.32	3.140
C1	581.44		409.49	1.880

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CM1	581.44	02 Nov 01 0510	409.49	1.880
LR1	581.41	02 Nov 01 0610	409.49	1.880
C2	330.84	02 Nov 01 0615	257.02	1.180
CM1,2	912.02	02 Nov 01 0610	666.50	3.060
LR2	912.01	02 Nov 01 0710	666.50	3.060
C6	29.415	02 Nov 01 0505	20.182	0.100
C3	332.36	02 Nov 01 0540	243.66	1.140
CM2,3,6	2042.3	02 Nov 01 0650	1559.7	7.440
LR6	2041.9	02 Nov 01 0810	1559.7	7.440
C8	189.98	02 Nov 01 0350	117.72	0.670
C7	449.76	02 Nov 01 0605	339.74	1.620
CM7,8	2511.7	02 Nov 01 0800	2056.3	9.910
LR8	2511.7	02 Nov 01 0825	2056.3	9.910
C11	50.753	02 Nov 01 0400	31.726	0.170
CM8,11	2897.4	02 Nov 01 0820	2535.3	11.940
LR11	2896.4	02 Nov 01 0850	2535.0	11.940
C12	64.764	02 Nov 01 0445	42.055	0.260
C13	198.20	02 Nov 01 0430	129.62	0.630
CM11,12,13	2998.1	02 Nov 01 0845	2706.7	12.830
LR13	2997.4	02 Nov 01 0905	2706.5	12.830
C14	311.73	02 Nov 01 0345	200.41	0.870
CM13,14	3075.9	02 Nov 01 0905	2906.9	13.700
LR14	3075.1	02 Nov 01 0930	2906.6	13.700
C18	68.645	02 Nov 01 0345	43.206	0.210
C15	216.92	02 Nov 01 0445	143.70	0.770
CM14-18	3203.1	02 Nov 01 0930	3186.2	15.110
LR18	3203.1	02 Nov 01 0940	3186.1	15.110
C24	155.04	02 Nov 01 0420	98.983	0.520
C19	51.183	02 Nov 01 0330	32.061	0.150
CM18,19,24	3785.0	02 Nov 01 0705	3788.5	17.980
LR24	3784.9	02 Nov 01 0730	3788.2	17.980
C25	155.18	02 Nov 01 0430	102.59	0.480
CM24,25	3876.3	02 Nov 01 0725	3890.8	18.460
LR25	3876.2	02 Nov 01 0745	3890.5	18.460
C26	102.28	02 Nov 01 0330	62.755	0.350
CM25,26	3915.2	02 Nov 01 0740	3953.3	18.810
LR26	3915.0	02 Nov 01 0810	3952.9	18.810
C27	124.59	02 Nov 01 0450	83.475	0.430
CM26,27	3983.7	02 Nov 01 0805	4036.3	19.240
LR27	3983.5	02 Nov 01 0820	4036.1	19.240
C29	106.91	02 Nov 01 0330	65.858	0.360
CM27,29	4046.0	02 Nov 01 0815	4155.3	19.840
LR29	4045.8	02 Nov 01 0855	4154.7	19.840
C30	292.73	02 Nov 01 0420	188.30	0.970
CM29,30	4146.3	02 Nov 01 0850	4343.0	20.810
LR30	4146.1	02 Nov 01 0900	4342.8	20.810
C31	91.635	02 Nov 01 0410	58.239	0.300
CM31	91.635	02 Nov 01 0410	58.239	0.300
LR31	91.634	02 Nov 01 0440	58.239	0.300
C32	167.42	02 Nov 01 0410	106.97	0.530
CM30,32	4230.0	02 Nov 01 0855	4508.0	21.640

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
LR32	4229.6	02 Nov 01 0935	4507.4	21.640
C33	90.797	02 Nov 01 0330	55.987	0.300
CM33	90.797	02 Nov 01 0330	55.987	0.300
LR33	90.787	02 Nov 01 0405	55.987	0.300
C34	147.79	02 Nov 01 0435	98.319	0.460
CM33,34	237.71	02 Nov 01 0430	154.31	0.760
LR34	237.71	02 Nov 01 0455	154.31	0.760
C35	147.15	02 Nov 01 0430	95.176	0.500
CM34,35	4354.2	02 Nov 01 0925	4756.8	22.900

Cool Creek Watershed
HEC-HMS Summary Output
25-year, 24-hour Rainfall Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
C28	71.204		44.010	0.240
CM28	71.204		44.010	0.240
LR28	71.188		44.010	0.240
C20	210.71		140.09	0.780
CM20	210.71		140.09	0.780
C22	55.600		34.124	0.190
CM22	55.600		34.124	0.190
LR22	55.577		34.124	0.190
C23	161.12		109.61	0.650
CM22,23	210.97		143.74	0.840
CM20,23	421.68		283.82	1.620
LR20	421.62		283.82	1.620
C21	160.85		104.17	0.580
CM20,21	572.69		387.99	2.200
LR21	572.67		387.99	2.200
C16	55.137		34.124	0.190
CM16	55.137		34.124	0.190
LR16	55.131		34.124	0.190
C17	66.573		42.212	0.240
CM17	66.573		42.212	0.240
LR17	66.571		42.212	0.240
C10	350.46		225.07	1.000
	257.03		221.29	1.000
	228.97		219.12	1.000
CM10	228.97		219.12	1.000
LR10	228.87		219.06	1.000
C9	224.83		154.45	0.860
CM9,10	439.96		373.51	1.860
LR9,10	439.96		373.33	1.860
C8A	47.999		32.328	0.180
CM8A	47.999		32.328	0.180
LR8A	47.995		32.328	0.180
C5	417.44		308.51	1.950
CM5	417.44		308.51	1.950
LR5	417.44		308.51	1.950
C6-Split	79.166		49.531	0.300
Conrail	444.52		358.04	2.250
C4	231.42		156.54	0.890
CM4,5	611.19		514.58	3.140
LR4,5	610.40		514.58	3.140
C1	484.87		337.64	1.880

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CM1	484.87	02 Nov 01 0515	337.64	1.880
LR1	484.80	02 Nov 01 0615	337.64	1.880
C2	275.71	02 Nov 01 0620	211.93	1.180
CM1,2	760.41	02 Nov 01 0615	549.57	3.060
LR2	760.35	02 Nov 01 0715	549.57	3.060
C6	24.310	02 Nov 01 0505	16.510	0.100
C3	276.45	02 Nov 01 0545	200.51	1.140
CM2,3,6	1606.5	02 Nov 01 0735	1281.2	7.440
LR6	1605.4	02 Nov 01 0900	1281.2	7.440
C8	154.91	02 Nov 01 0405	95.082	0.670
C7	373.18	02 Nov 01 0605	279.01	1.620
CM7,8	1930.0	02 Nov 01 0855	1687.6	9.910
LR8	1930.0	02 Nov 01 0920	1687.6	9.910
C11	41.627	02 Nov 01 0405	25.761	0.170
CM8,11	2243.4	02 Nov 01 0735	2086.7	11.940
LR11	2243.4	02 Nov 01 0800	2086.4	11.940
C12	52.351	02 Nov 01 0445	33.738	0.260
C13	164.21	02 Nov 01 0430	106.24	0.630
CM11,12,13	2357.3	02 Nov 01 0745	2226.4	12.830
LR13	2357.2	02 Nov 01 0805	2226.2	12.830
C14	261.64	02 Nov 01 0345	166.29	0.870
CM13,14	2456.7	02 Nov 01 0750	2392.5	13.700
LR14	2456.5	02 Nov 01 0815	2392.2	13.700
C18	56.813	02 Nov 01 0350	35.414	0.210
C15	177.79	02 Nov 01 0450	116.68	0.770
CM14-18	2625.1	02 Nov 01 0800	2620.7	15.110
LR18	2625.1	02 Nov 01 0810	2620.6	15.110
C24	127.35	02 Nov 01 0420	80.520	0.520
C19	42.518	02 Nov 01 0335	26.382	0.150
CM18,19,24	3107.7	02 Nov 01 0725	3115.4	17.980
LR24	3107.7	02 Nov 01 0750	3115.2	17.980
C25	129.12	02 Nov 01 0435	84.424	0.480
CM24,25	3177.4	02 Nov 01 0745	3199.6	18.460
LR25	3177.2	02 Nov 01 0805	3199.3	18.460
C26	83.286	02 Nov 01 0330	50.774	0.350
CM25,26	3206.0	02 Nov 01 0805	3250.1	18.810
LR26	3205.8	02 Nov 01 0835	3249.7	18.810
C27	102.53	02 Nov 01 0455	68.030	0.430
CM26,27	3256.1	02 Nov 01 0835	3317.7	19.240
LR27	3256.1	02 Nov 01 0845	3317.6	19.240
C29	87.252	02 Nov 01 0335	53.380	0.360
CM27,29	3301.8	02 Nov 01 0840	3414.9	19.840
LR29	3301.5	02 Nov 01 0920	3414.4	19.840
C30	240.99	02 Nov 01 0425	153.46	0.970
CM29,30	3374.3	02 Nov 01 0915	3567.8	20.810
LR30	3374.2	02 Nov 01 0925	3567.7	20.810
C31	75.450	02 Nov 01 0415	47.463	0.300
CM31	75.450	02 Nov 01 0415	47.463	0.300
LR31	75.435	02 Nov 01 0445	47.463	0.300
C32	138.43	02 Nov 01 0415	87.505	0.530
CM30,32	3435.2	02 Nov 01 0920	3702.6	21.640

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
LR32	3435.0	02 Nov 01 0955	3702.0	21.640
C33	74.249	02 Nov 01 0335	45.460	0.300
CM33	74.249	02 Nov 01 0335	45.460	0.300
LR33	74.237	02 Nov 01 0410	45.460	0.300
C34	122.96	02 Nov 01 0440	80.906	0.460
CM33,34	196.82	02 Nov 01 0435	126.37	0.760
LR34	196.82	02 Nov 01 0500	126.37	0.760
C35	120.85	02 Nov 01 0430	77.423	0.500
CM34,35	3532.7	02 Nov 01 0915	3905.8	22.900

Cool Creek Watershed
HEC-HMS Summary Output
10-year, 24-hour Rainfall Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
C28	55.339		33.619	0.240
CM28	55.339		33.619	0.240
LR28	55.330		33.619	0.240
C20	162.26		106.69	0.780
CM20	162.26		106.69	0.780
C22	43.085		25.988	0.190
CM22	43.085		25.988	0.190
LR22	43.052		25.988	0.190
C23	122.83		82.762	0.650
CM22,23	160.98		108.75	0.840
CM20,23	323.25		215.44	1.620
LR20	323.20		215.44	1.620
C21	123.88		79.332	0.580
CM20,21	439.90		294.77	2.200
LR21	439.79		294.77	2.200
C16	42.677		25.988	0.190
CM16	42.677		25.988	0.190
LR16	42.674		25.988	0.190
C17	51.115		32.054	0.240
CM17	51.115		32.054	0.240
LR17	51.109		32.054	0.240
C10	283.93		177.82	1.000
	143.54		174.25	1.000
	128.14		172.20	1.000
CM10	128.14		172.20	1.000
LR10	128.12		172.14	1.000
C9	173.14		117.63	0.860
CM9,10	267.82		289.77	1.860
LR9,10	267.82		289.59	1.860
C8A	36.963		24.620	0.180
CM8A	36.963		24.620	0.180
LR8A	36.957		24.620	0.180
C5	315.70		231.04	1.950
CM5	315.70		231.04	1.950
LR5	315.69		231.04	1.950
C6-Split	60.158		37.294	0.300
Conrail	217.23		268.34	2.250
C4	177.62		118.87	0.890
CM4,5	353.54		387.20	3.140
LR4,5	353.53		387.20	3.140
C1	373.44		257.15	1.880

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CM1	373.44	02 Nov 01 0515	257.15	1.880
LR1	373.43	02 Nov 01 0615	257.15	1.880
C2	212.52	02 Nov 01 0625	161.40	1.180
CM1,2	585.80	02 Nov 01 0620	418.55	3.060
LR2	585.71	02 Nov 01 0715	418.55	3.060
C6	18.475	02 Nov 01 0510	12.431	0.100
C3	212.29	02 Nov 01 0550	152.26	1.140
CM2,3,6	1140.7	02 Nov 01 0650	970.44	7.440
LR6	1140.6	02 Nov 01 0810	970.44	7.440
C8	115.12	02 Nov 01 0400	70.314	0.670
C7	285.76	02 Nov 01 0610	211.26	1.620
CM7,8	1456.8	02 Nov 01 0740	1276.6	9.910
LR8	1456.8	02 Nov 01 0805	1276.6	9.910
C11	31.224	02 Nov 01 0405	19.193	0.170
CM8,11	1720.3	02 Nov 01 0750	1585.4	11.940
LR11	1720.2	02 Nov 01 0815	1585.2	11.940
C12	38.526	02 Nov 01 0450	24.719	0.260
C13	125.15	02 Nov 01 0430	80.216	0.630
CM11,12,13	1800.0	02 Nov 01 0805	1690.1	12.830
LR13	1799.8	02 Nov 01 0820	1689.9	12.830
C14	204.30	02 Nov 01 0345	127.81	0.870
CM13,14	1869.5	02 Nov 01 0810	1817.8	13.700
LR14	1869.4	02 Nov 01 0840	1817.5	13.700
C18	43.392	02 Nov 01 0345	26.739	0.210
C15	133.38	02 Nov 01 0450	86.931	0.770
CM14-18	1985.6	02 Nov 01 0815	1989.2	15.110
LR18	1985.6	02 Nov 01 0825	1989.1	15.110
C24	95.810	02 Nov 01 0420	60.143	0.520
C19	32.763	02 Nov 01 0330	20.034	0.150
CM18,19,24	2318.6	02 Nov 01 0735	2364.1	17.980
LR24	2318.6	02 Nov 01 0805	2363.8	17.980
C25	99.089	02 Nov 01 0435	64.107	0.480
CM24,25	2374.0	02 Nov 01 0730	2427.9	18.460
LR25	2373.9	02 Nov 01 0755	2427.7	18.460
C26	62.353	02 Nov 01 0330	37.640	0.350
CM25,26	2397.2	02 Nov 01 0745	2465.3	18.810
LR26	2397.2	02 Nov 01 0820	2464.9	18.810
C27	77.402	02 Nov 01 0455	50.948	0.430
CM26,27	2440.8	02 Nov 01 0805	2515.9	19.240
LR27	2440.8	02 Nov 01 0815	2515.7	19.240
C29	65.474	02 Nov 01 0330	39.669	0.360
CM27,29	2483.3	02 Nov 01 0800	2589.0	19.840
LR29	2483.3	02 Nov 01 0840	2588.5	19.840
C30	181.88	02 Nov 01 0425	114.93	0.970
CM29,30	2555.8	02 Nov 01 0825	2703.4	20.810
LR30	2555.7	02 Nov 01 0835	2703.3	20.810
C31	56.947	02 Nov 01 0415	35.545	0.300
CM31	56.947	02 Nov 01 0415	35.545	0.300
LR31	56.935	02 Nov 01 0445	35.545	0.300
C32	105.16	02 Nov 01 0415	65.886	0.530
CM30,32	2619.2	02 Nov 01 0825	2804.7	21.640

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
LR32	2619.1	02 Nov 01 0905	2804.1	21.640
C33	55.899	02 Nov 01 0330	33.869	0.300
CM33	55.899	02 Nov 01 0330	33.869	0.300
LR33	55.894	02 Nov 01 0405	33.869	0.300
C34	94.362	02 Nov 01 0440	61.436	0.460
CM33,34	149.69	02 Nov 01 0435	95.306	0.760
LR34	149.68	02 Nov 01 0500	95.306	0.760
C35	90.926	02 Nov 01 0435	57.830	0.500
CM34,35	2714.4	02 Nov 01 0850	2957.3	22.900

Cool Creek Watershed
HEC-HMS Summary Output
2-year, 24-hour Rainfall Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
C28	32.094		19.267	0.240
CM28	32.094		19.267	0.240
LR28	32.088		19.267	0.240
C20	94.670		60.757	0.780
CM20	94.670		60.757	0.780
C22	24.753		14.800	0.190
CM22	24.753		14.800	0.190
LR22	24.743		14.800	0.190
C23	70.133		46.291	0.650
CM22,23	92.281		61.091	0.840
CM20,23	186.95		121.85	1.620
LR20	186.91		121.85	1.620
C21	72.387		45.178	0.580
CM20,21	255.25		167.03	2.200
LR21	255.21		167.03	2.200
C16	24.680		14.800	0.190
CM16	24.680		14.800	0.190
LR16	24.680		14.800	0.190
C17	29.699		18.142	0.240
CM17	29.699		18.142	0.240
LR17	29.692		18.142	0.240
C10	179.66		109.92	1.000
	82.024		107.57	1.000
	81.043		106.43	1.000
CM10	81.043		106.43	1.000
LR10	81.043		106.40	1.000
C9	100.91		66.988	0.860
CM9,10	173.82		173.39	1.860
LR9,10	173.82		173.29	1.860
C8A	21.557		14.021	0.180
CM8A	21.557		14.021	0.180
LR8A	21.555		14.021	0.180
C5	176.53		127.11	1.950
CM5	176.53		127.11	1.950
LR5	176.51		127.11	1.950
C6-Split	34.324		20.742	0.300
Conrail	164.30		147.85	2.250
C4	102.83		67.275	0.890
CM4,5	238.56		215.13	3.140
LR4,5	238.56		215.13	3.140
C1	217.52		146.44	1.880

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CM1	217.52	02 Nov 01 0525	146.44	1.880
LR1	217.50	02 Nov 01 0625	146.44	1.880
C2	123.47	02 Nov 01 0630	91.914	1.180
CM1,2	340.87	02 Nov 01 0625	238.35	3.060
LR2	340.86	02 Nov 01 0725	238.35	3.060
C6	10.480	02 Nov 01 0515	6.9140	0.100
C3	122.64	02 Nov 01 0555	86.173	1.140
CM2,3,6	698.86	02 Nov 01 0705	546.57	7.440
LR6	698.78	02 Nov 01 0825	546.57	7.440
C8	63.439	02 Nov 01 0415	37.736	0.670
C7	163.84	02 Nov 01 0620	118.85	1.620
CM7,8	876.01	02 Nov 01 0755	717.18	9.910
LR8	876.01	02 Nov 01 0820	717.18	9.910
C11	17.431	02 Nov 01 0420	10.451	0.170
CM8,11	1032.7	02 Nov 01 0805	900.92	11.940
LR11	1032.7	02 Nov 01 0835	900.78	11.940
C12	20.630	02 Nov 01 0455	13.033	0.260
C13	71.627	02 Nov 01 0440	44.867	0.630
CM11,12,13	1077.0	02 Nov 01 0825	958.68	12.830
LR13	1076.9	02 Nov 01 0840	958.59	12.830
C14	121.84	02 Nov 01 0410	74.228	0.870
CM13,14	1118.7	02 Nov 01 0830	1032.8	13.700
LR14	1118.7	02 Nov 01 0855	1032.7	13.700
C18	24.889	02 Nov 01 0415	14.956	0.210
C15	73.987	02 Nov 01 0500	47.335	0.770
CM14-18	1183.9	02 Nov 01 0835	1127.9	15.110
LR18	1183.9	02 Nov 01 0845	1127.8	15.110
C24	53.588	02 Nov 01 0430	32.916	0.520
C19	18.910	02 Nov 01 0410	11.339	0.150
CM18,19,24	1382.5	02 Nov 01 0735	1339.1	17.980
LR24	1382.4	02 Nov 01 0805	1339.0	17.980
C25	57.450	02 Nov 01 0445	36.283	0.480
CM24,25	1413.6	02 Nov 01 0800	1375.3	18.460
LR25	1413.6	02 Nov 01 0820	1375.1	18.460
C26	34.392	02 Nov 01 0410	20.296	0.350
CM25,26	1426.1	02 Nov 01 0820	1395.4	18.810
LR26	1426.0	02 Nov 01 0850	1395.2	18.810
C27	43.414	02 Nov 01 0505	28.029	0.430
CM26,27	1447.8	02 Nov 01 0845	1423.2	19.240
LR27	1447.7	02 Nov 01 0900	1423.2	19.240
C29	36.311	02 Nov 01 0410	21.494	0.360
CM27,29	1467.1	02 Nov 01 0855	1463.9	19.840
LR29	1467.0	02 Nov 01 0935	1463.6	19.840
C30	102.26	02 Nov 01 0435	63.229	0.970
CM29,30	1497.4	02 Nov 01 0930	1526.9	20.810
LR30	1497.4	02 Nov 01 0940	1526.8	20.810
C31	32.062	02 Nov 01 0425	19.555	0.300
CM31	32.062	02 Nov 01 0425	19.555	0.300
LR31	32.057	02 Nov 01 0455	19.555	0.300
C32	59.916	02 Nov 01 0425	36.644	0.530
CM30,32	1523.9	02 Nov 01 0920	1583.0	21.640

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
LR32	1523.8	02 Nov 01 1000	1582.7	21.640
C33	31.129	02 Nov 01 0410	18.442	0.300
CM33	31.129	02 Nov 01 0410	18.442	0.300
LR33	31.127	02 Nov 01 0445	18.442	0.300
C34	54.689	02 Nov 01 0450	34.772	0.460
CM33,34	85.811	02 Nov 01 0445	53.214	0.760
LR34	85.806	02 Nov 01 0510	53.214	0.760
C35	50.796	02 Nov 01 0440	31.650	0.500
CM34,35	1570.8	02 Nov 01 0920	1667.5	22.900

APPENDIX F

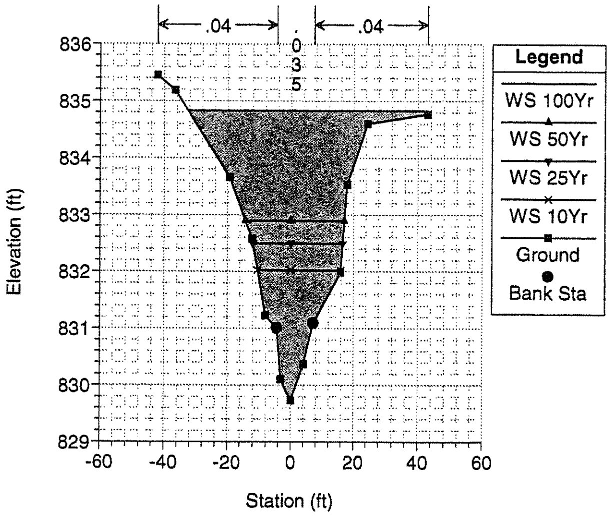
HEC-RAS MODELS

MARY WILSON DRAIN

HEC-RAS CROSS-SECTIONS AND PROFILE SUMMARY TABLE

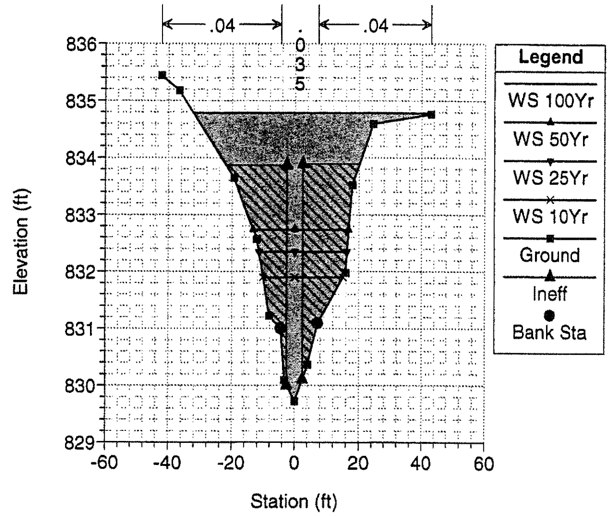
Mary Wilson Drain

River = Mary Wilson Drai Reach = Mary Wilson RS = 3740 Copied Cross Section #18 Upstream of 3' CMP Structure #8



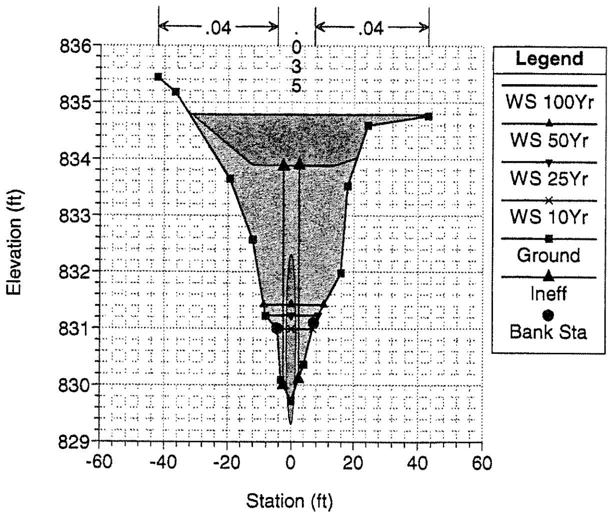
Mary Wilson Drain

River = Mary Wilson Drai Reach = Mary Wilson RS = 3737 Copied Cross Section #18 Upstream of 3' CMP Structure #8



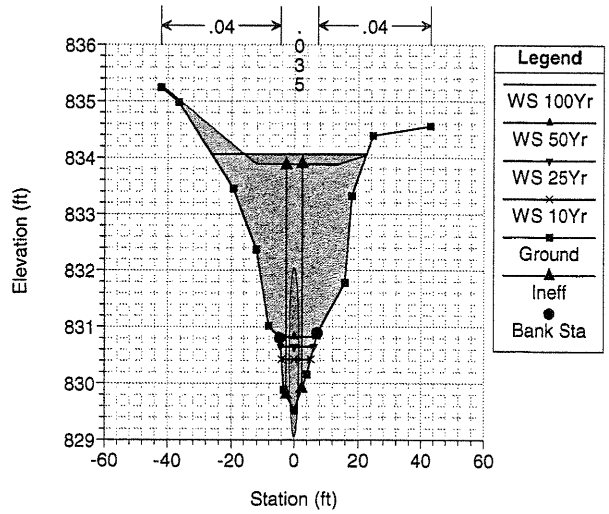
Mary Wilson Drain

River = Mary Wilson Drai Reach = Mary Wilson RS = 3721 Structure #8 - 36" RCP



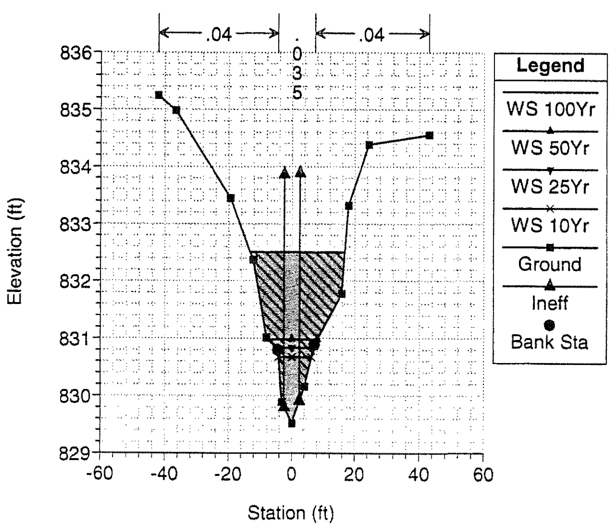
Mary Wilson Drain

River = Mary Wilson Drai Reach = Mary Wilson RS = 3721 Structure #8 - 36" RCP



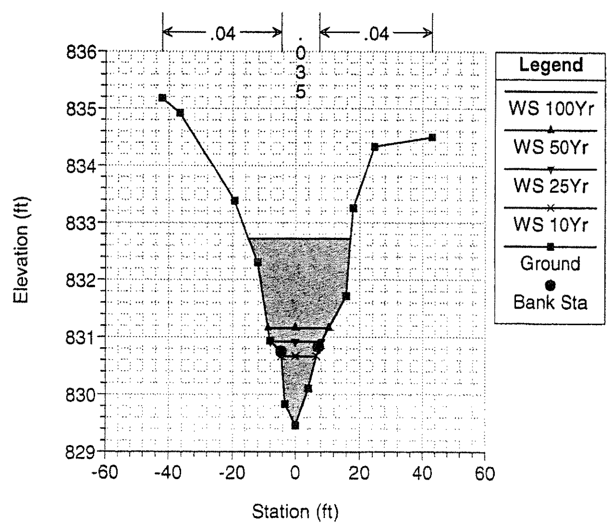
Mary Wilson Drain

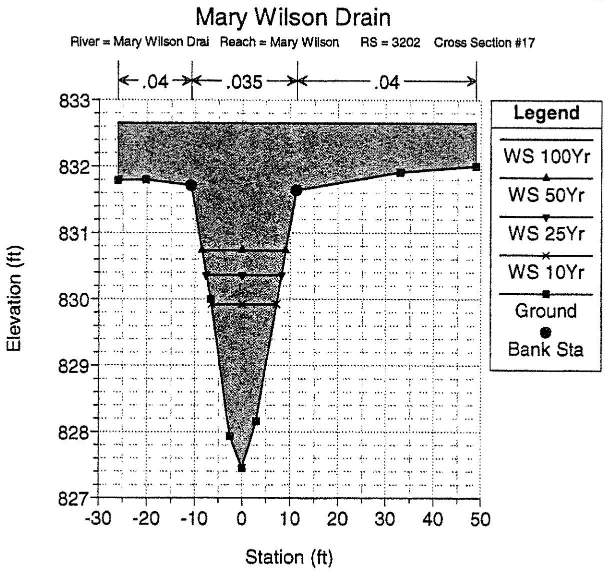
River = Mary Wilson Drai Reach = Mary Wilson RS = 3705 Cross Section #18 Downstream of 3' CMP Structure #8

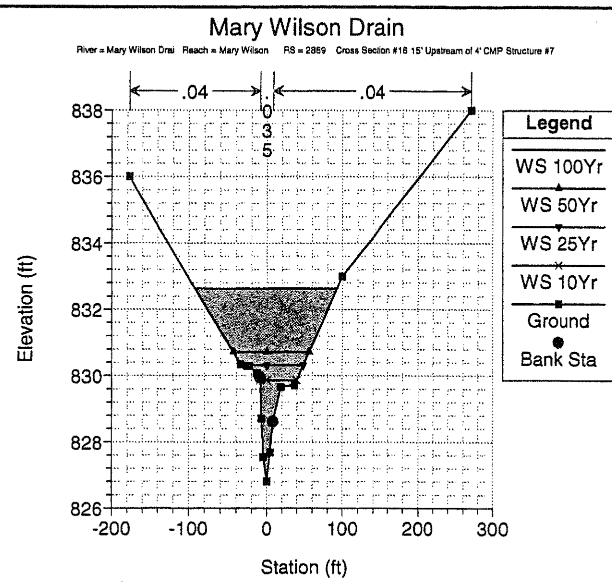


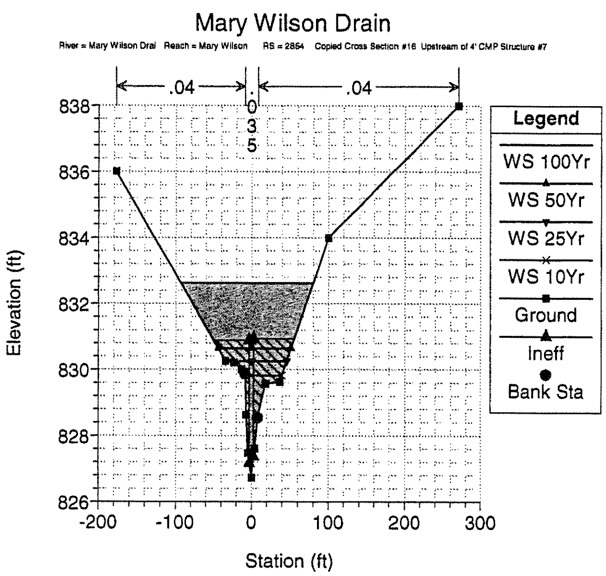
Mary Wilson Drain

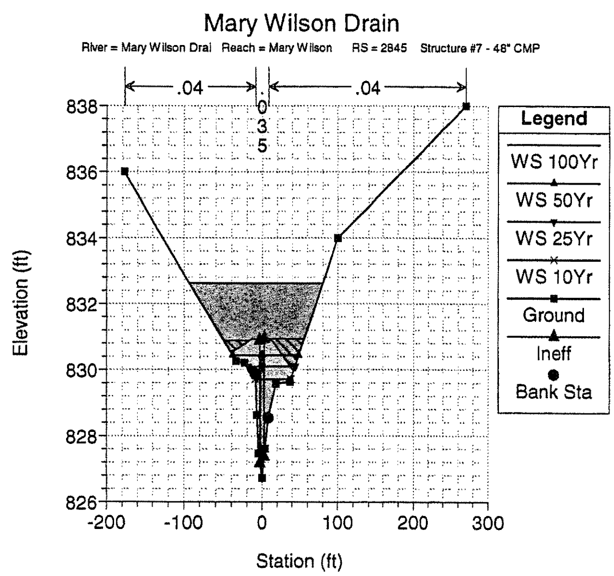
River = Mary Wilson Drai Reach = Mary Wilson RS = 3693 Copied Cross Section #18 12' Downstream of 3' CMP Structure #8

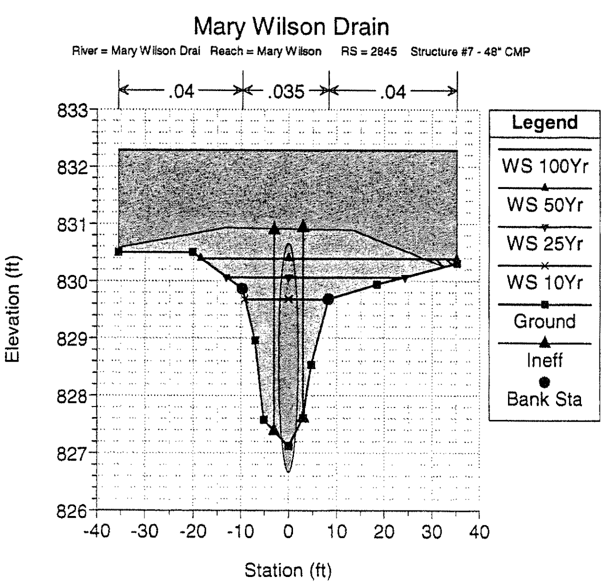


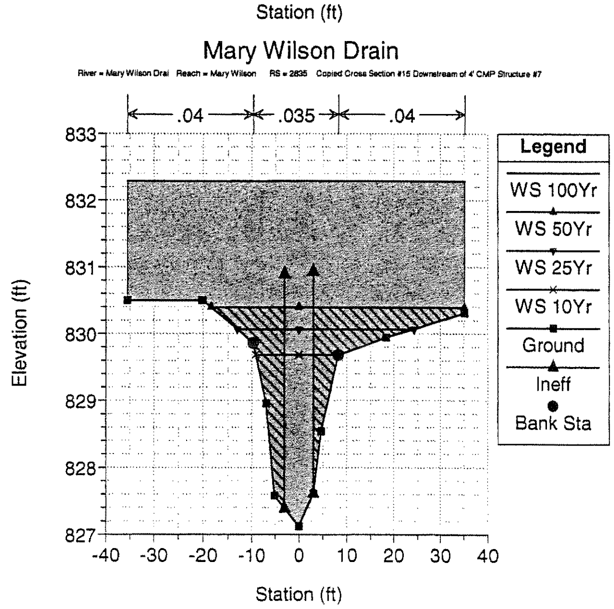

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 3202 Cross Section #17
.04
.035
.04
Elevation (ft)
833
832
831
830
829
828
827
-30 -20 -10 0 10 20 30 40 50
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta

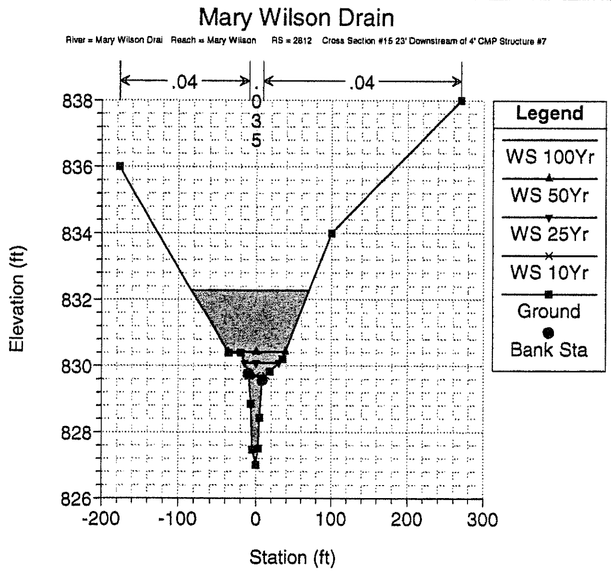

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2869 Cross Section #16 15' Upstream of 4' CMP Structure #7
.04
.035
.04
Elevation (ft)
838
836
834
832
830
828
826
-200 -100 0 100 200 300
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2864 Copied Cross Section #16 Upstream of 4' CMP Structure #7
.04
.035
.04
Elevation (ft)
838
836
834
832
830
828
826
-200 -100 0 100 200 300
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

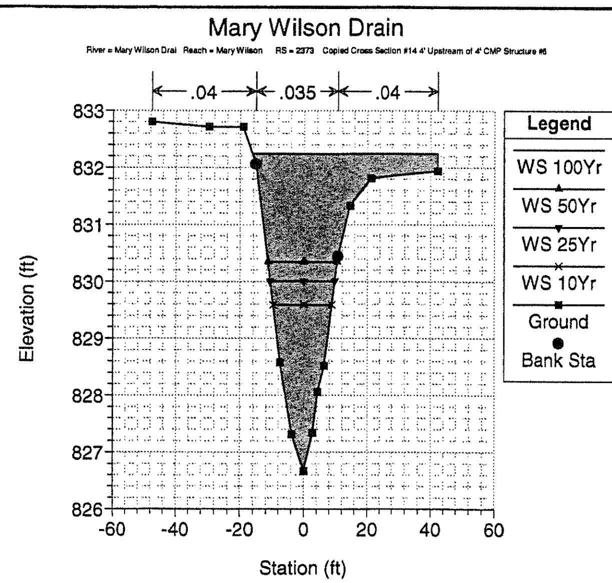

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2845 Structure #7 - 48" CMP
.04
.035
.04
Elevation (ft)
838
836
834
832
830
828
826
-200 -100 0 100 200 300
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2845 Structure #7 - 48" CMP
.04
.035
.04
Elevation (ft)
833
832
831
830
829
828
827
826
-40 -30 -20 -10 0 10 20 30 40
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

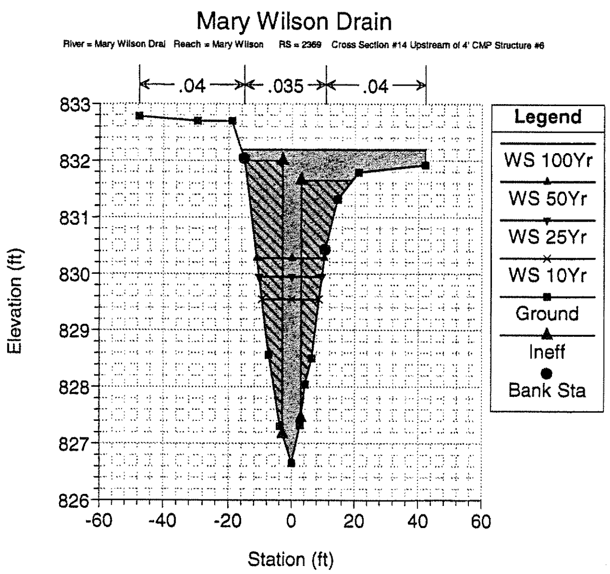

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2835 Copied Cross Section #15 Downstream of 4' CMP Structure #7
.04
.035
.04
Elevation (ft)
833
832
831
830
829
828
827
-40 -30 -20 -10 0 10 20 30 40
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta



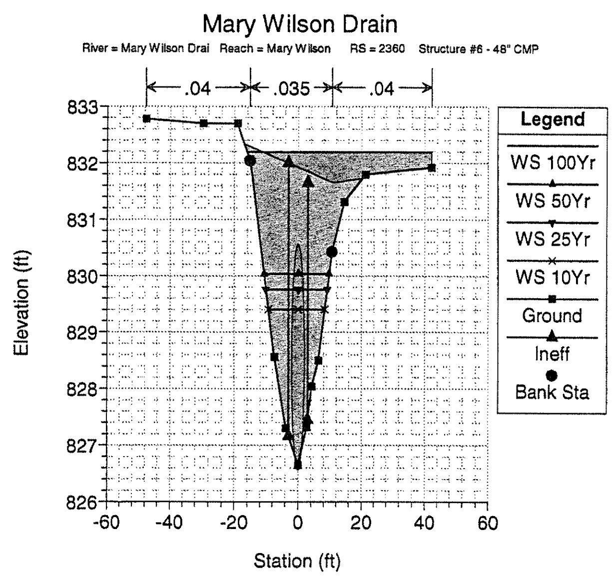
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2812 Cross Section #15 23' Downstream of 4' CMP Structure #7
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta



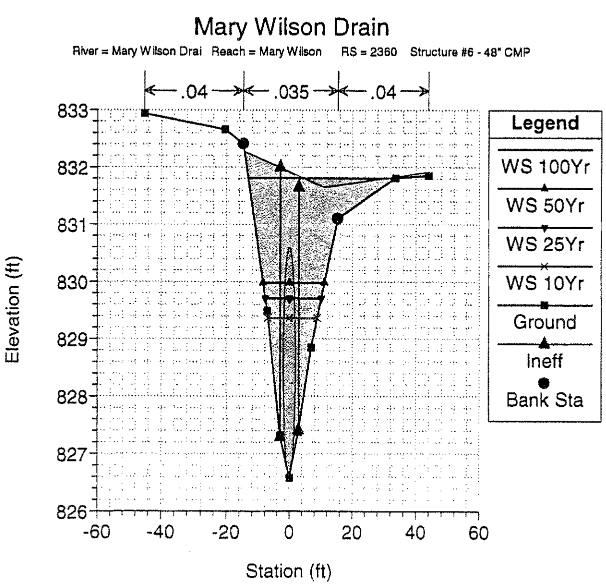
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2373 Copied Cross Section #14 4' Upstream of 4' CMP Structure #6
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta



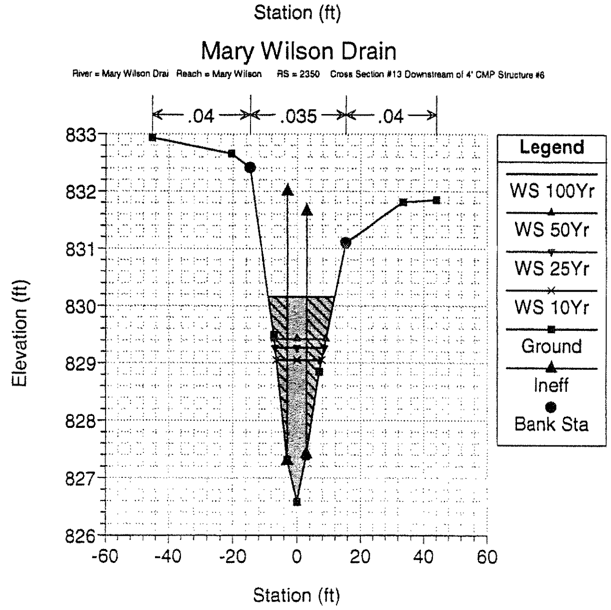
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2369 Cross Section #14 Upstream of 4' CMP Structure #6
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta



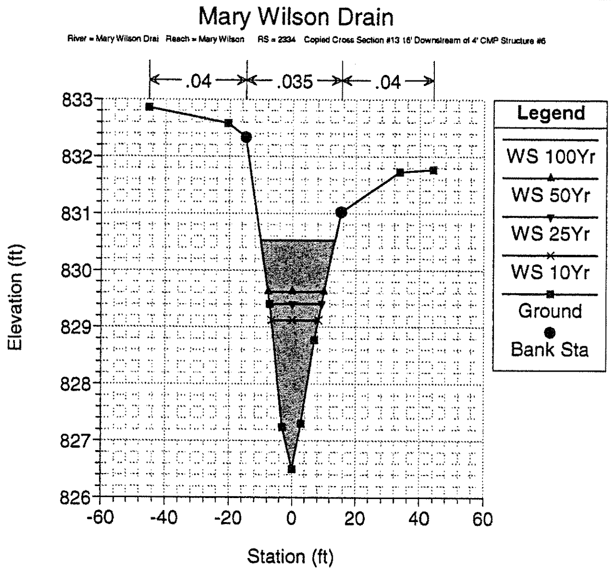
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2360 Structure #6 - 48" CMP
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

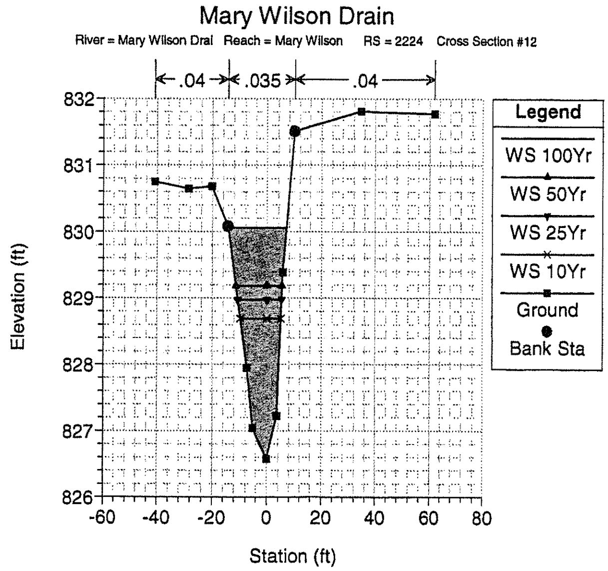


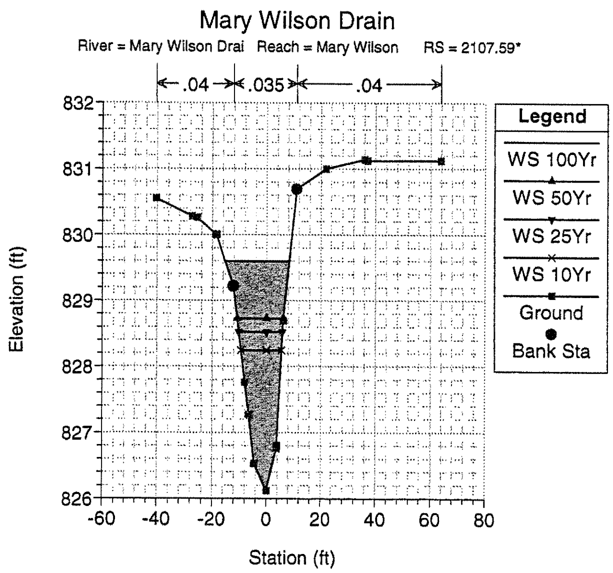
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2360 Structure #6 - 48" CMP
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

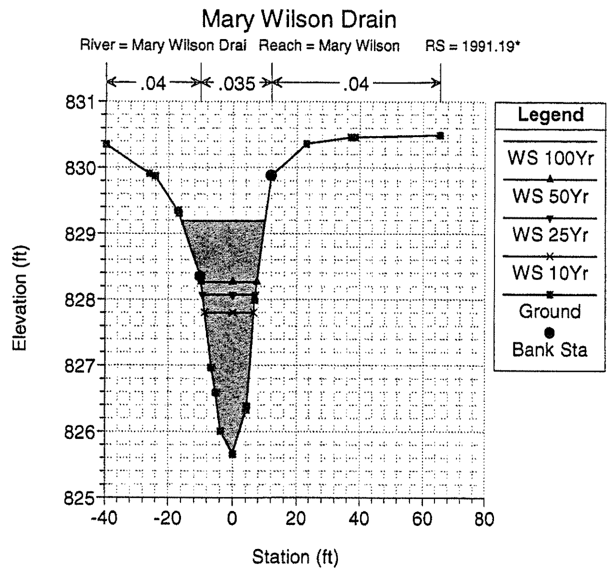


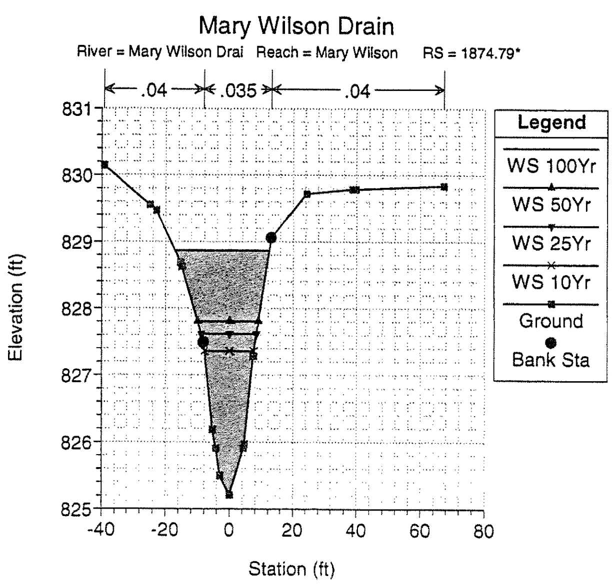
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2350 Cross Section #13 Downstream of 4' CMP Structure #6
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

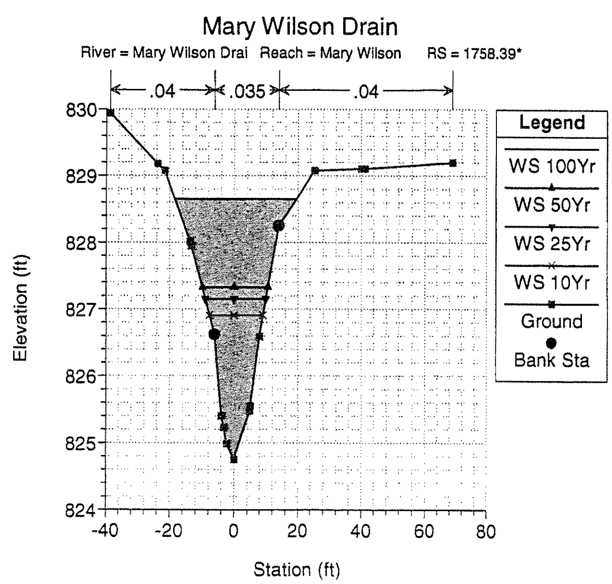

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2334 Copied Cross Section #13 16' Downstream of 4' CMP Structure #6
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
833
832
831
830
829
828
827
826
-60
-40
-20
0
20
40
60
Station (ft)

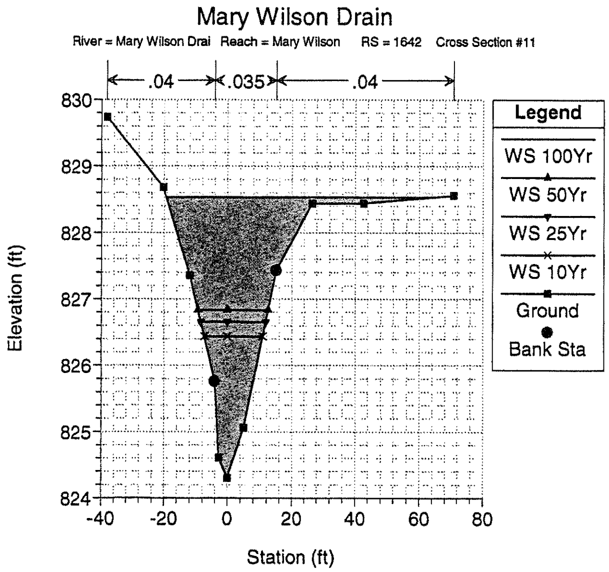

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2224 Cross Section #12
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
832
831
830
829
828
827
826
-60
-40
-20
0
20
40
60
80
Station (ft)

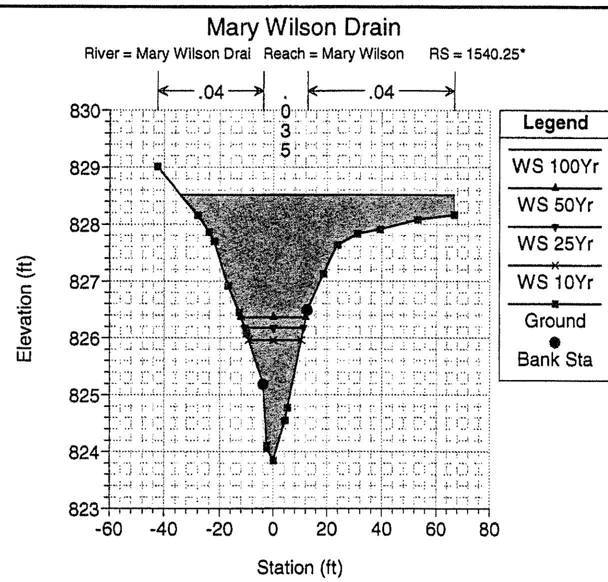

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 2107.59*
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
832
831
830
829
828
827
826
-60
-40
-20
0
20
40
60
80
Station (ft)

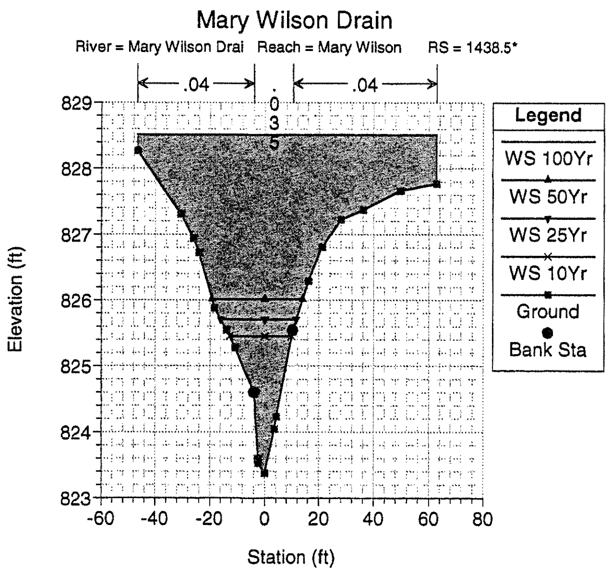

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1991.19*
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
831
830
829
828
827
826
825
-40
-20
0
20
40
60
80
Station (ft)

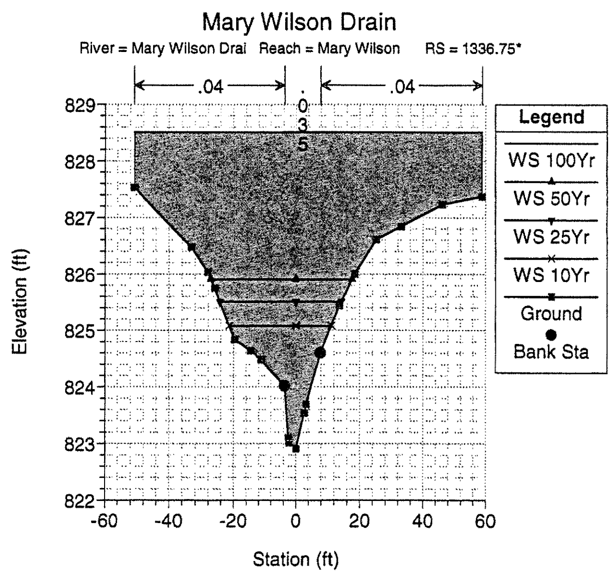

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1874.79*
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
831
830
829
828
827
826
825
-40
-20
0
20
40
60
80
Station (ft)

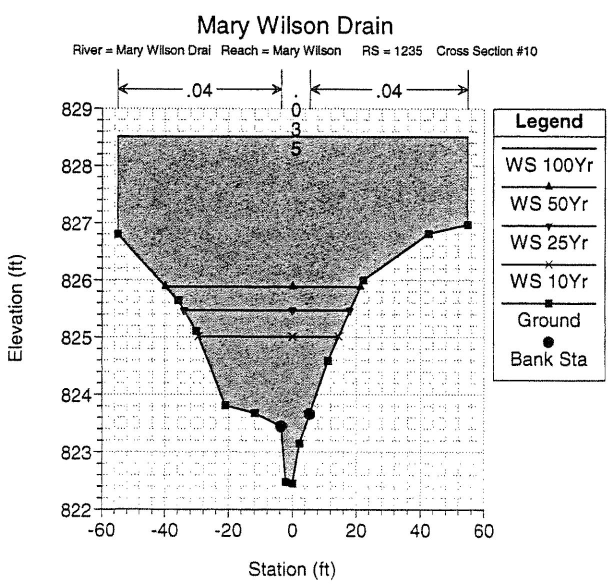

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1758.39*
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
830
829
828
827
826
825
824
-40
-20
0
20
40
60
80
Station (ft)

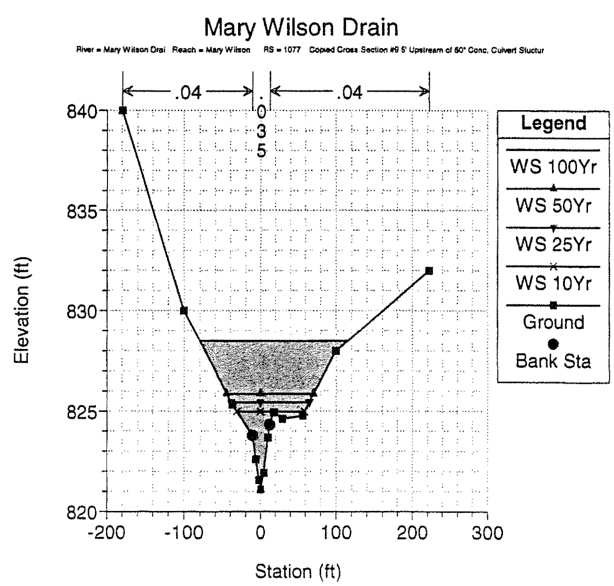

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1642 Cross Section #11
.04 .035 .04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

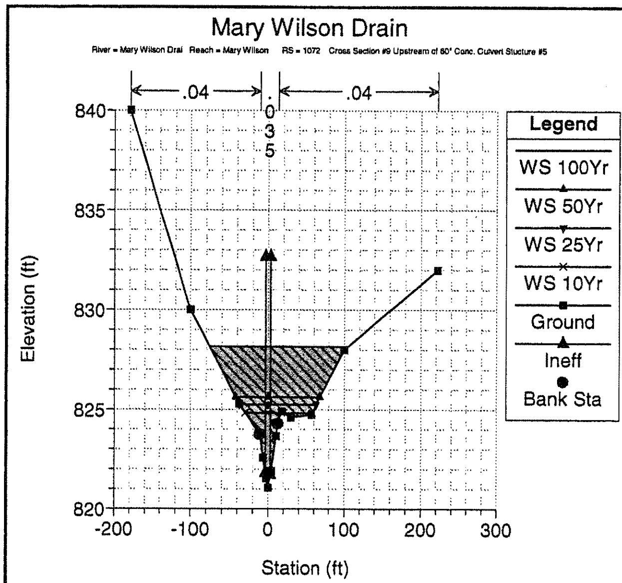

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1540.25*
.04 .035 .04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1438.5*
.04 .035 .04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

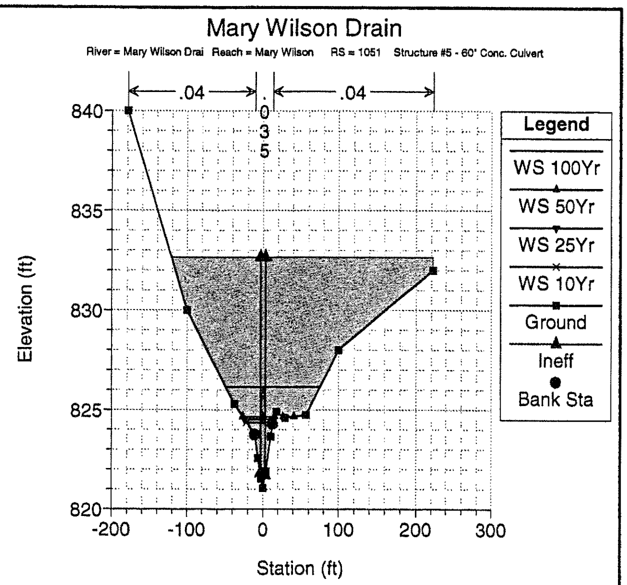

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1336.75*
.04 .035 .04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1235 Cross Section #10
.04 .035 .04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

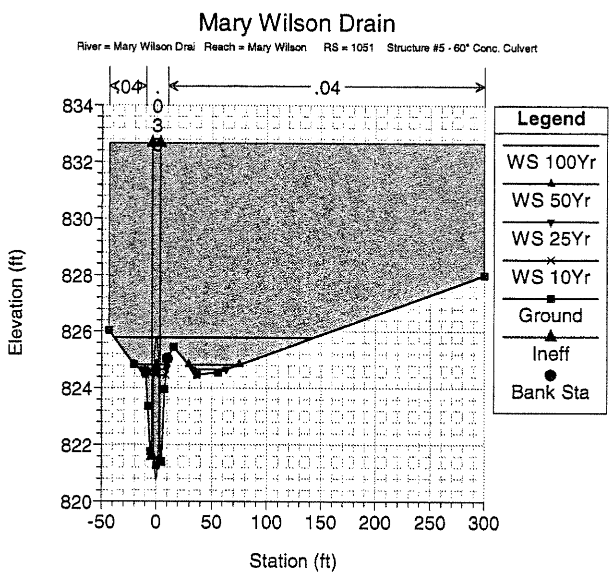

Mary Wilson Drain
.04 .035 .04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



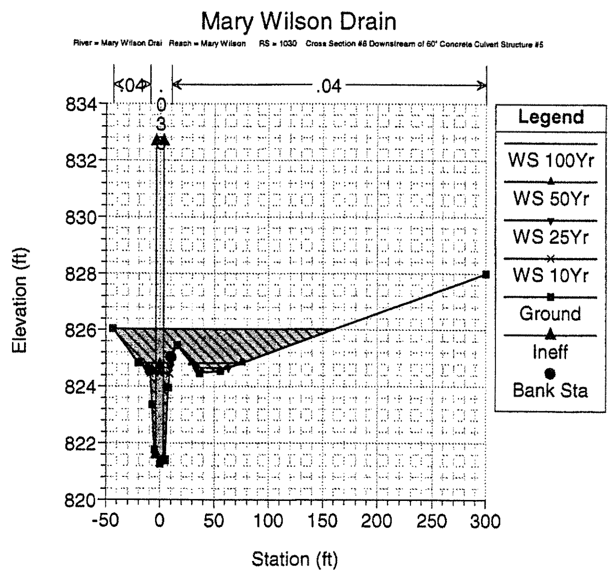
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1072 Cross Section #9 Upstream of 60" Conc. Culvert Stucture #5
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



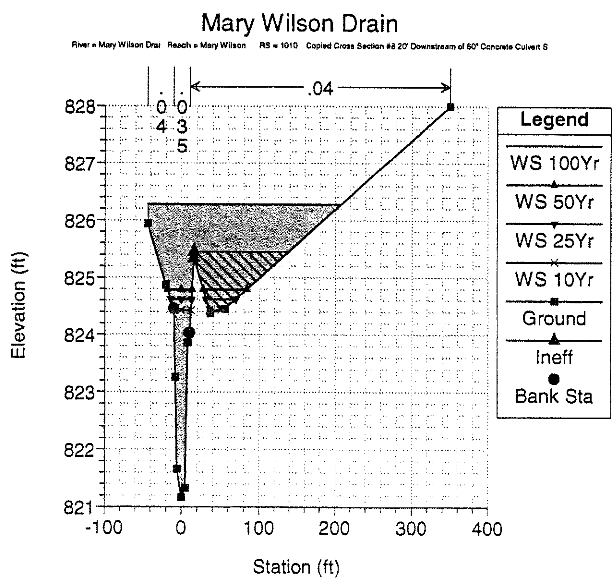
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1051 Structure #5 - 60" Conc. Culvert
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



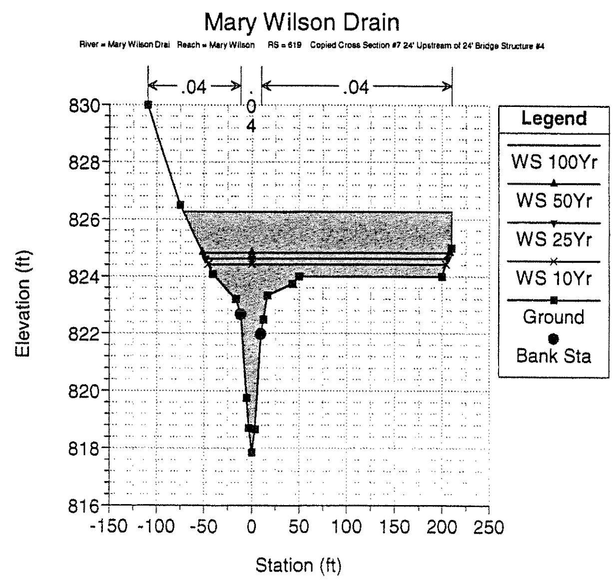
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1051 Structure #5 - 60" Conc. Culvert
.04
.03
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



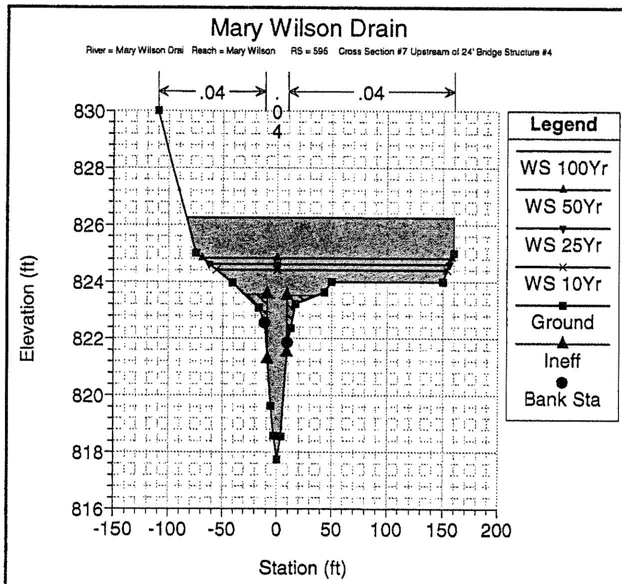
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1030 Cross Section #8 Downstream of 60" Concrete Culvert Structure #5
.04
.03
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

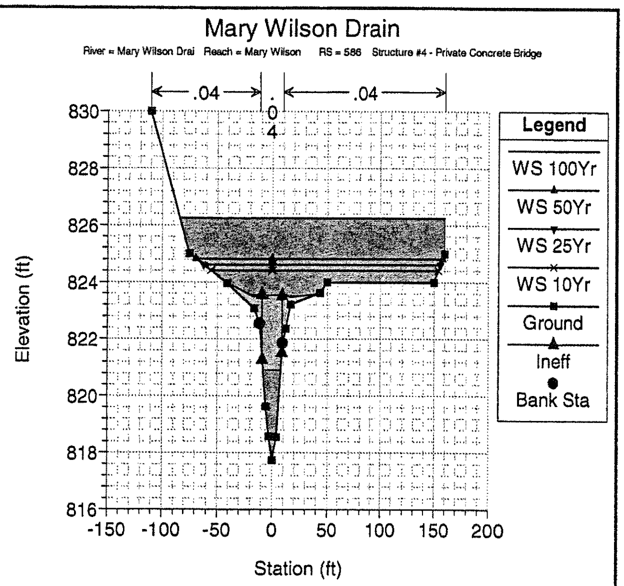


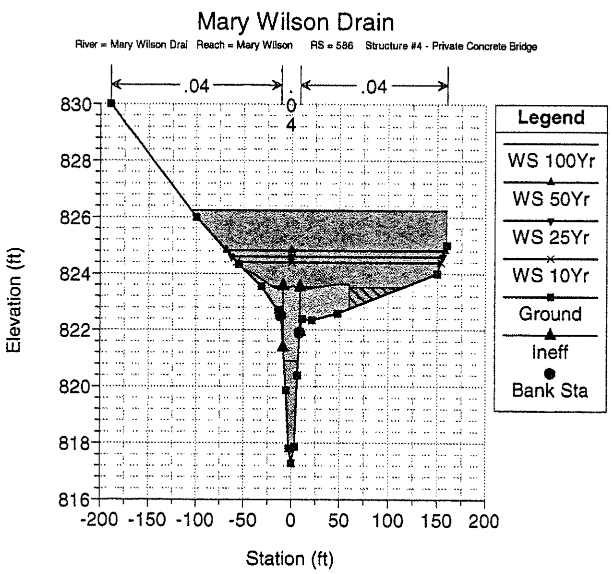
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 1010 Copied Cross Section #8 20' Downstream of 60" Concrete Culvert S
.04
.035
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

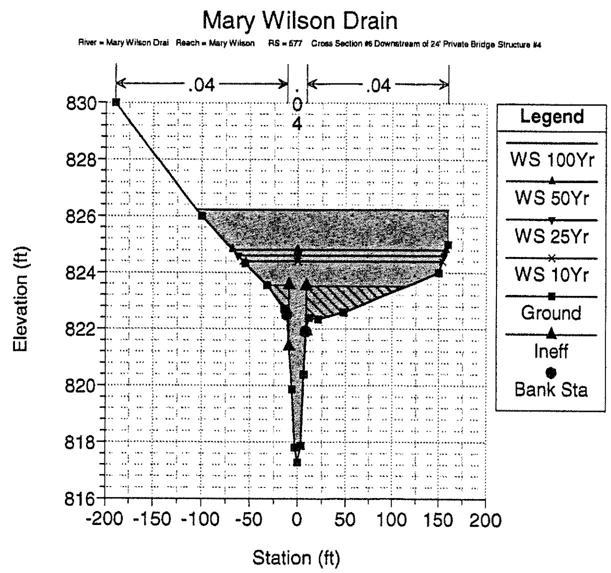


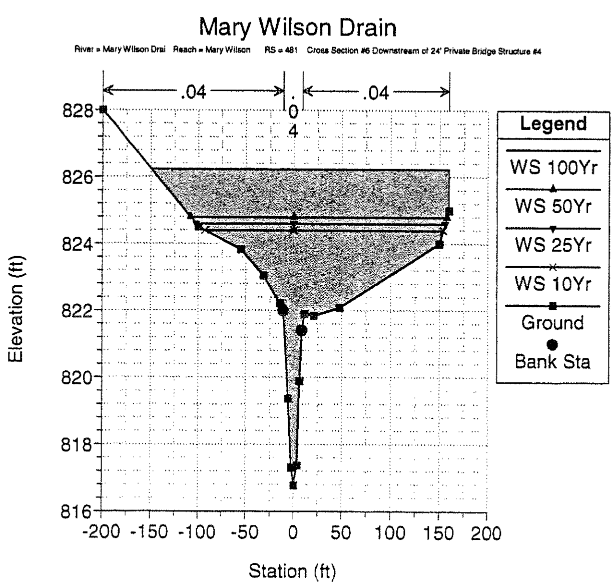
Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 619 Copied Cross Section #7 24' Upstream of 24' Bridge Structure #4
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

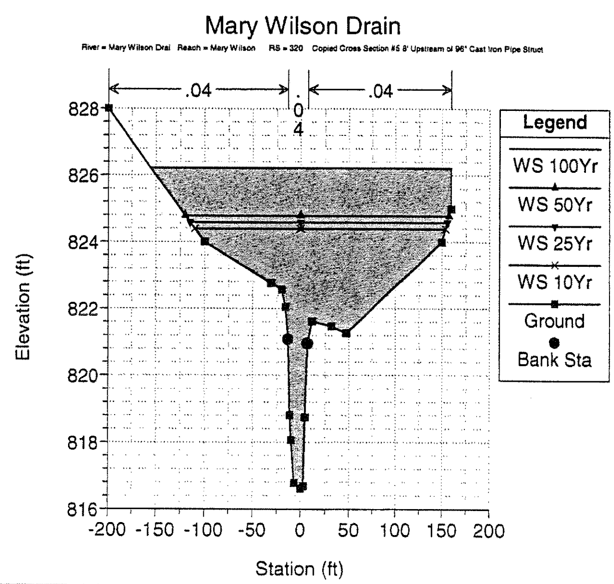

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 595 Cross Section #7 Upstream of 24' Bridge Structure #4
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

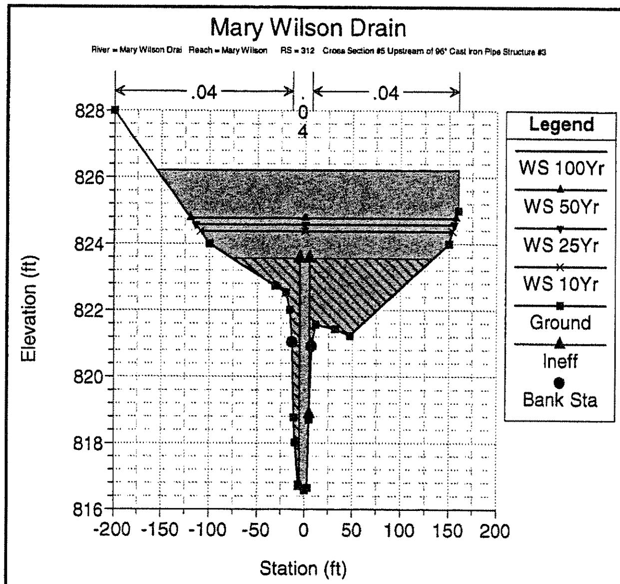

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 586 Structure #4 - Private Concrete Bridge
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

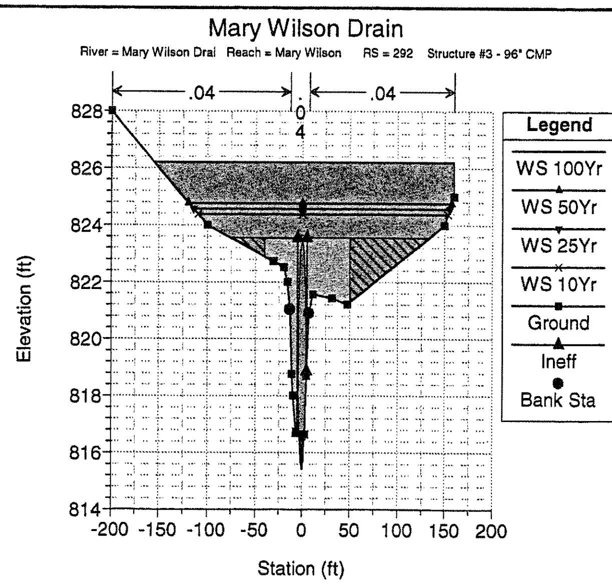

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 586 Structure #4 - Private Concrete Bridge
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

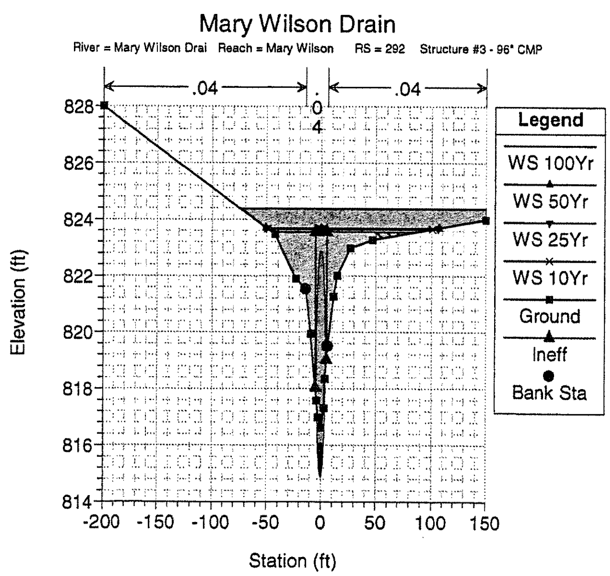

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 577 Cross Section #6 Downstream of 24' Private Bridge Structure #4
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta

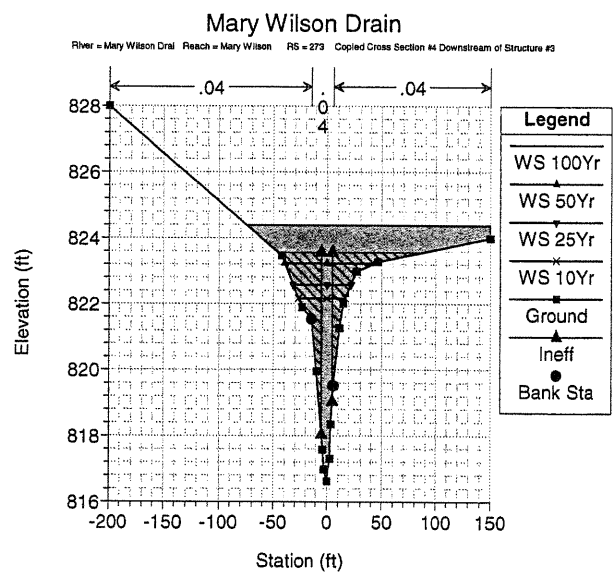

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 481 Cross Section #6 Downstream of 24' Private Bridge Structure #4
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta

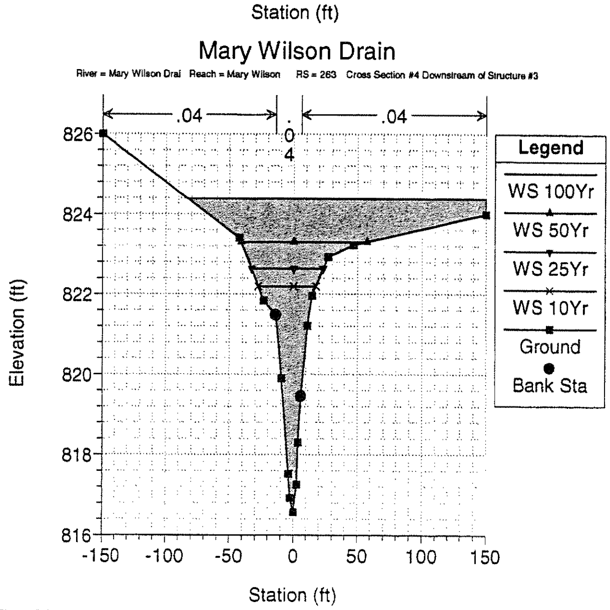

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 320 Copied Cross Section #5 8' Upstream of 96" Cast Iron Pipe Struct
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta

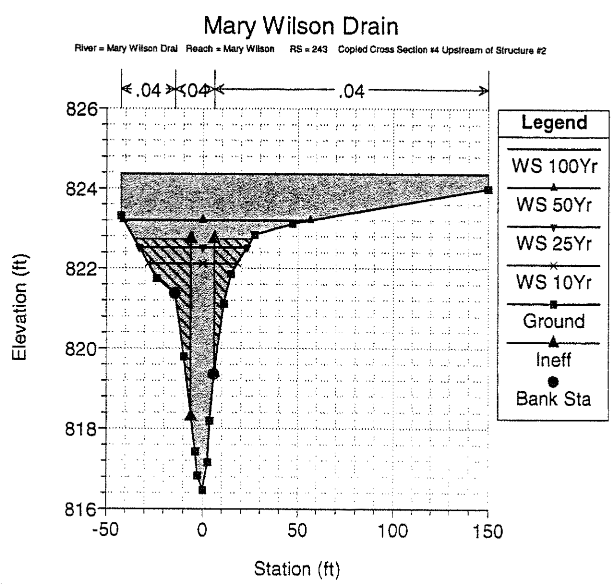

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 312 Cross Section #5 Upstream of 96" Cast Iron Pipe Structure #3
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

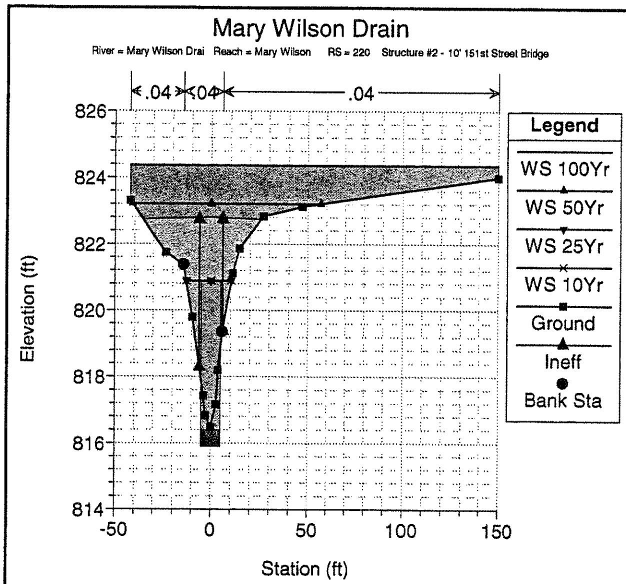

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 292 Structure #3 - 96" CMP
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

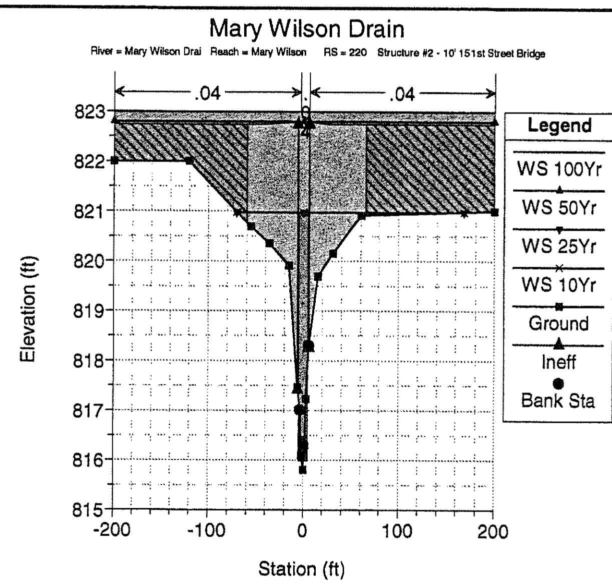

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 292 Structure #3 - 96" CMP
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

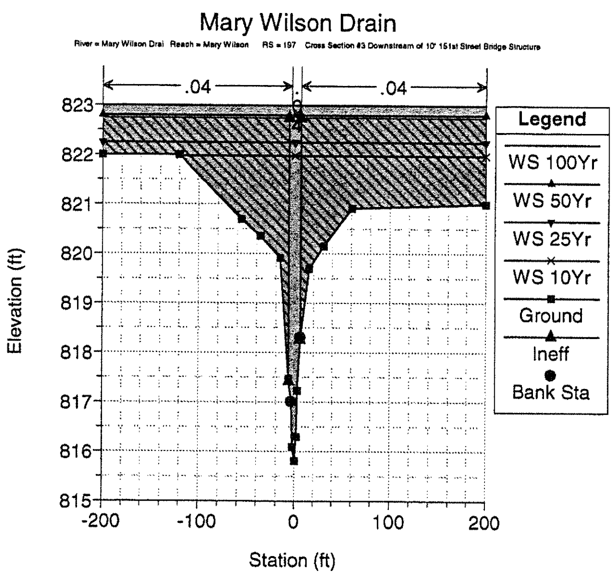

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 273 Copied Cross Section #4 Downstream of Structure #3
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

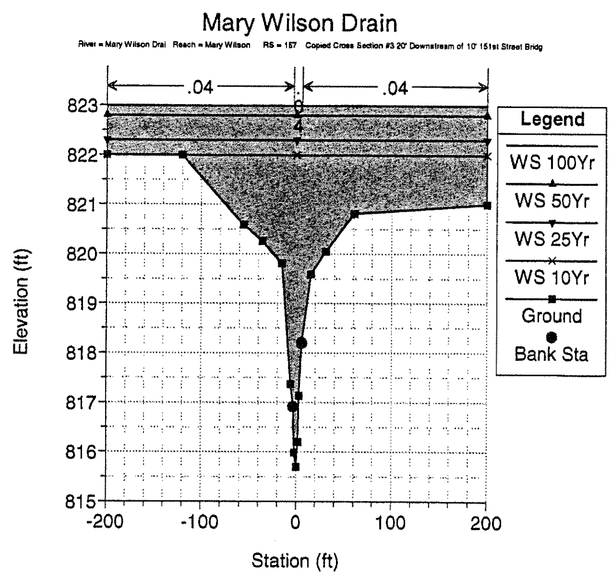

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 263 Cross Section #4 Downstream of Structure #3
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

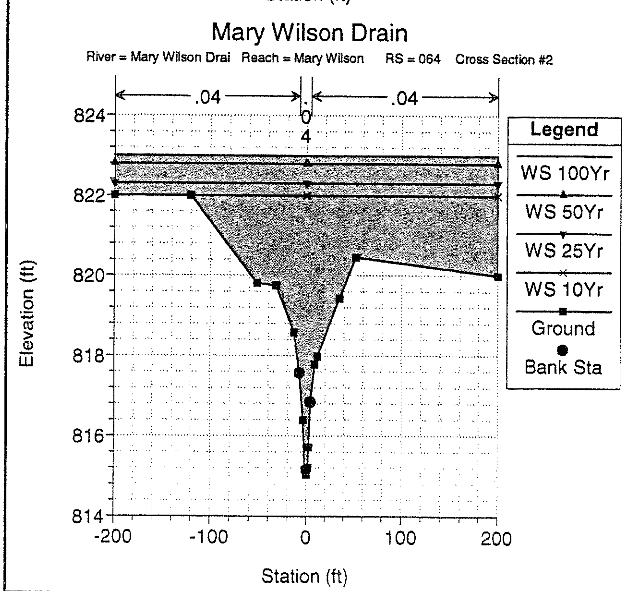

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 243 Copied Cross Section #4 Upstream of Structure #2
.04
.04
.04
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

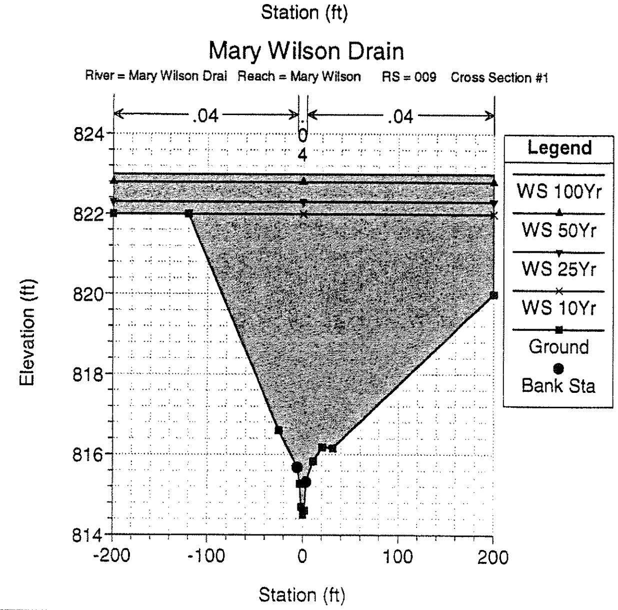

Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 220 Structure #2 - 10' 151st Street Bridge
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 220 Structure #2 - 10' 151st Street Bridge
.04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 197 Cross Section #3 Downstream of 10' 151st Street Bridge Structure
.04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Ineff
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 157 Copied Cross Section #3 20' Downstream of 10' 151st Street Bridg
.04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 064 Cross Section #2
.04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Mary Wilson Drain
River = Mary Wilson Drai Reach = Mary Wilson RS = 009 Cross Section #1
.04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta

HEC-RAS Plan: Plan 01 River: Mary Wilson Drai Reach: Mary Wilson

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Mary Wilson	3740	80.00	829.73	834.83		834.84	0.000063	0.91	139.93	75.58	0.07
Mary Wilson	3740	42.00	829.73	832.90		832.91	0.000151	0.97	54.35	31.46	0.11
Mary Wilson	3740	35.00	829.73	832.50		832.51	0.000205	1.02	42.36	28.55	0.12
Mary Wilson	3740	27.00	829.73	832.02		832.04	0.000329	1.10	29.34	26.50	0.15
Mary Wilson	3737	80.00	829.72	834.79	831.88	834.83	0.000592	1.90	65.50	75.20	0.21
Mary Wilson	3737	42.00	829.72	832.74	831.18	832.87	0.001209	2.95	14.24	30.24	0.31
Mary Wilson	3737	35.00	829.72	832.35	831.04	832.48	0.001366	2.84	12.31	27.95	0.32
Mary Wilson	3737	27.00	829.72	831.90	830.85	832.01	0.001597	2.69	10.05	25.32	0.33
Mary Wilson	3721	Culvert									
Mary Wilson	3705	80.00	829.52	832.51	831.68	833.01	0.004506	5.66	14.13	30.06	0.59
Mary Wilson	3705	42.00	829.52	830.99	830.98	831.64	0.016567	6.47	6.50	15.87	1.00
Mary Wilson	3705	35.00	829.52	830.84	830.84	831.41	0.017304	6.09	5.75	12.19	1.00
Mary Wilson	3705	27.00	829.52	830.67	830.65	831.14	0.017314	5.49	4.92	10.67	0.98
Mary Wilson	3693	80.00	829.46	832.73		832.77	0.000470	1.76	57.60	32.26	0.19
Mary Wilson	3693	42.00	829.46	831.16		831.28	0.003955	2.90	15.67	19.30	0.47
Mary Wilson	3693	35.00	829.46	830.92	830.59	831.07	0.006168	3.13	11.48	16.07	0.57
Mary Wilson	3693	27.00	829.46	830.67	830.46	830.84	0.009328	3.29	8.21	11.01	0.67
Mary Wilson	3202	80.00	827.45	832.65		832.66	0.000102	0.90	116.42	74.90	0.09
Mary Wilson	3202	42.00	827.45	830.74		830.76	0.000448	1.29	32.54	17.61	0.17
Mary Wilson	3202	35.00	827.45	830.36		830.39	0.000549	1.33	26.28	15.82	0.18
Mary Wilson	3202	27.00	827.45	829.92		829.95	0.000696	1.37	19.78	13.75	0.20
Mary Wilson	2869	80.00	826.81	832.64		832.65	0.000009	0.35	385.94	185.66	0.03
Mary Wilson	2869	42.00	826.81	830.72		830.72	0.000047	0.57	110.31	100.30	0.06
Mary Wilson	2869	35.00	826.81	830.32		830.32	0.000071	0.64	73.95	78.41	0.07
Mary Wilson	2869	27.00	826.81	829.87		829.87	0.000106	0.69	47.10	48.88	0.08
Mary Wilson	2854	80.00	826.73	832.63	828.76	832.64	0.000044	0.57	235.13	173.77	0.06
Mary Wilson	2854	42.00	826.73	830.65	828.15	830.70	0.000374	1.92	21.86	95.76	0.18
Mary Wilson	2854	35.00	826.73	830.26	828.02	830.31	0.000377	1.79	19.54	80.32	0.17
Mary Wilson	2854	27.00	826.73	829.82	827.85	829.86	0.000362	1.60	16.92	48.69	0.17
Mary Wilson	2845	Culvert									
Mary Wilson	2835	80.00	827.12	832.29	829.07	832.30	0.000031	0.59	185.20	70.70	0.05
Mary Wilson	2835	42.00	827.12	830.40	828.45	830.48	0.000642	2.27	18.52	53.60	0.23
Mary Wilson	2835	35.00	827.12	830.07	828.32	830.14	0.000649	2.11	16.55	37.30	0.22
Mary Wilson	2835	27.00	827.12	829.68	828.16	829.74	0.000636	1.90	14.25	17.59	0.22
Mary Wilson	2812	80.00	827.01	832.28		832.28	0.000021	0.48	274.45	153.95	0.04
Mary Wilson	2812	42.00	827.01	830.42		830.43	0.000148	0.88	61.30	75.35	0.10
Mary Wilson	2812	35.00	827.01	830.09		830.10	0.000201	0.93	42.81	45.33	0.11
Mary Wilson	2812	27.00	827.01	829.70		829.71	0.000260	0.92	29.68	22.76	0.13
Mary Wilson	2373	80.00	826.67	832.25		832.26	0.000075	0.82	110.20	58.49	0.08
Mary Wilson	2373	42.00	826.67	830.35		830.36	0.000181	0.91	46.40	21.91	0.11
Mary Wilson	2373	35.00	826.67	830.01		830.02	0.000200	0.89	39.18	20.39	0.11
Mary Wilson	2373	27.00	826.67	829.59		829.60	0.000225	0.87	31.08	18.53	0.12
Mary Wilson	2369	80.00	826.65	832.20	828.72	832.25	0.001282	1.88	50.44	58.31	0.27
Mary Wilson	2369	42.00	826.65	830.27	828.11	830.34	0.000522	2.12	19.84	21.66	0.21
Mary Wilson	2369	35.00	826.65	829.94	827.98	830.00	0.000514	1.96	17.87	20.20	0.20
Mary Wilson	2369	27.00	826.65	829.54	827.82	829.59	0.000496	1.75	15.46	18.41	0.19
Mary Wilson	2360	Culvert									
Mary Wilson	2350	196.00	826.58	830.16	830.16	831.78	0.012851	10.22	19.18	20.93	1.01
Mary Wilson	2350	104.00	826.58	829.42	829.06	830.19	0.008751	7.07	14.72	16.28	0.80
Mary Wilson	2350	87.00	826.58	829.27	828.83	829.88	0.007561	6.30	13.81	15.43	0.73
Mary Wilson	2350	67.00	826.58	829.05	828.53	829.50	0.006205	5.35	12.53	14.22	0.65
Mary Wilson	2334	196.00	826.50	830.53		830.78	0.003725	4.03	48.69	23.73	0.50
Mary Wilson	2334	104.00	826.50	829.62		829.81	0.003744	3.49	29.82	18.03	0.48
Mary Wilson	2334	87.00	826.50	829.41		829.58	0.003698	3.34	26.07	16.67	0.47
Mary Wilson	2334	67.00	826.50	829.12		829.27	0.003637	3.12	21.49	15.04	0.46

HEC-RAS Plan: Plan 01 River: Mary Wilson Drai Reach: Mary Wilson (Continued)

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Mary Wilson	2224	196.00	826.57	830.06		830.35	0.004125	4.31	45.53	21.29	0.52
Mary Wilson	2224	104.00	826.57	829.18		829.39	0.003901	3.60	28.86	16.94	0.49
Mary Wilson	2224	87.00	826.57	828.97		829.16	0.003875	3.42	25.41	16.07	0.48
Mary Wilson	2224	67.00	826.57	828.69		828.85	0.003876	3.19	21.03	14.89	0.47
Mary Wilson	2107.59*	196.00	826.12	829.60		829.88	0.003842	4.28	46.30	23.66	0.51
Mary Wilson	2107.59*	104.00	826.12	828.73		828.93	0.003878	3.59	29.00	17.22	0.49
Mary Wilson	2107.59*	87.00	826.12	828.52		828.70	0.003856	3.41	25.52	16.33	0.48
Mary Wilson	2107.59*	67.00	826.12	828.24		828.40	0.003891	3.18	21.09	15.17	0.47
Mary Wilson	1991.19*	196.00	825.66	829.20		829.46	0.003361	4.13	49.19	26.05	0.48
Mary Wilson	1991.19*	104.00	825.66	828.27		828.47	0.003930	3.58	29.04	17.61	0.49
Mary Wilson	1991.19*	87.00	825.66	828.07		828.25	0.003819	3.39	25.68	16.58	0.48
Mary Wilson	1991.19*	67.00	825.66	827.80		827.95	0.003762	3.13	21.37	15.37	0.47
Mary Wilson	1874.79*	196.00	825.21	828.87		829.09	0.002748	3.84	54.67	29.54	0.44
Mary Wilson	1874.79*	104.00	825.21	827.80		828.01	0.003903	3.61	29.02	19.09	0.49
Mary Wilson	1874.79*	87.00	825.21	827.62		827.80	0.003850	3.40	25.63	17.40	0.48
Mary Wilson	1874.79*	67.00	825.21	827.36		827.51	0.003781	3.13	21.39	15.53	0.47
Mary Wilson	1758.39*	196.00	824.75	828.66		828.82	0.001815	3.36	65.73	38.00	0.36
Mary Wilson	1758.39*	104.00	824.75	827.33		827.54	0.004027	3.67	29.25	20.62	0.50
Mary Wilson	1758.39*	87.00	824.75	827.15		827.34	0.003934	3.46	25.72	19.01	0.49
Mary Wilson	1758.39*	67.00	824.75	826.91		827.06	0.003832	3.17	21.33	16.82	0.47
Mary Wilson	1642	196.00	824.30	828.54		828.64	0.001056	2.82	87.54	84.42	0.29
Mary Wilson	1642	104.00	824.30	826.83		827.05	0.004537	3.78	29.14	21.91	0.53
Mary Wilson	1642	87.00	824.30	826.66		826.85	0.004515	3.60	25.39	20.29	0.52
Mary Wilson	1642	67.00	824.30	826.44		826.60	0.004284	3.28	21.15	18.29	0.50
Mary Wilson	1540.25*	196.00	823.84	828.52		828.57	0.000461	2.11	143.02	101.00	0.19
Mary Wilson	1540.25*	104.00	823.84	826.36		826.58	0.004733	3.82	29.84	24.36	0.54
Mary Wilson	1540.25*	87.00	823.84	826.18		826.38	0.004846	3.68	25.58	22.23	0.54
Mary Wilson	1540.25*	67.00	823.84	825.96		826.14	0.004669	3.39	21.03	19.76	0.52
Mary Wilson	1438.5*	196.00	823.38	828.52		828.54	0.000189	1.50	210.95	109.45	0.13
Mary Wilson	1438.5*	104.00	823.38	826.01		826.17	0.003134	3.41	36.79	33.30	0.45
Mary Wilson	1438.5*	87.00	823.38	825.71		825.89	0.004646	3.66	27.38	27.55	0.53
Mary Wilson	1438.5*	67.00	823.38	825.45		825.63	0.005387	3.54	21.03	22.55	0.56
Mary Wilson	1336.75*	196.00	822.91	828.51		828.52	0.000083	1.09	283.10	109.68	0.09
Mary Wilson	1336.75*	104.00	822.91	825.91		825.97	0.001056	2.35	59.93	44.95	0.27
Mary Wilson	1336.75*	87.00	822.91	825.51		825.59	0.001716	2.64	43.31	38.61	0.34
Mary Wilson	1336.75*	67.00	822.91	825.08		825.20	0.003130	3.01	28.12	32.60	0.43
Mary Wilson	1235	196.00	822.45	828.51		828.52	0.000042	0.83	357.47	109.90	0.06
Mary Wilson	1235	104.00	822.45	825.88		825.91	0.000345	1.56	98.54	61.19	0.16
Mary Wilson	1235	87.00	822.45	825.47		825.50	0.000470	1.65	75.41	52.21	0.18
Mary Wilson	1235	67.00	822.45	825.01		825.04	0.000694	1.75	53.24	44.10	0.22
Mary Wilson	1077	196.00	821.10	828.51		828.51	0.000015	0.54	580.21	195.70	0.04
Mary Wilson	1077	104.00	821.10	825.87		825.88	0.000085	0.86	177.34	116.32	0.08
Mary Wilson	1077	87.00	821.10	825.45		825.46	0.000120	0.94	130.97	105.12	0.10
Mary Wilson	1077	67.00	821.10	824.97		824.99	0.000175	1.01	84.22	91.05	0.11
Mary Wilson	1072	196.00	821.07	828.17	824.29	828.43	0.000763	4.14	47.34	180.82	0.28
Mary Wilson	1072	104.00	821.07	825.63	823.30	825.82	0.001031	3.52	29.57	110.56	0.30
Mary Wilson	1072	87.00	821.07	825.25	823.09	825.41	0.000985	3.23	26.93	100.45	0.29
Mary Wilson	1072	67.00	821.07	824.83	822.81	824.95	0.000857	2.79	24.01	84.79	0.27
Mary Wilson	1051	Culvert									
Mary Wilson	1030	196.00	821.27	826.04	824.27	826.60	0.002580	6.01	32.63	205.05	0.49
Mary Wilson	1030	104.00	821.27	824.82	823.27	825.11	0.001991	4.31	24.11	76.15	0.41
Mary Wilson	1030	87.00	821.27	824.66	823.06	824.88	0.001643	3.79	22.95	53.79	0.37
Mary Wilson	1030	67.00	821.27	824.45	822.79	824.60	0.001209	3.11	21.51	18.45	0.31
Mary Wilson	1010	392.00	821.17	826.29	824.58	826.33	0.000471	2.20	332.58	251.65	0.19
Mary Wilson	1010	208.00	821.17	824.79	823.53	825.04	0.002990	4.06	53.33	88.12	0.45

HEC-RAS Plan: Plan 01 River: Mary Wilson Drai Reach: Mary Wilson (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Mary Wilson	1010	174.00	821.17	824.62	823.30	824.83	0.002669	3.66	48.35	65.36	0.42
Mary Wilson	1010	134.00	821.17	824.43	823.01	824.58	0.002106	3.08	43.76	37.06	0.37
Mary Wilson	619	392.00	817.86	826.27		826.27	0.000052	0.88	724.99	281.74	0.06
Mary Wilson	619	208.00	817.86	824.83		824.84	0.000116	1.11	335.07	259.83	0.09
Mary Wilson	619	174.00	817.86	824.63		824.64	0.000119	1.10	281.67	254.83	0.09
Mary Wilson	619	134.00	817.86	824.42		824.44	0.000104	1.00	230.86	249.98	0.08
Mary Wilson	595	392.00	817.74	826.26	821.70	826.27	0.000069	1.00	626.99	243.83	0.07
Mary Wilson	595	208.00	817.74	824.83	820.73	824.84	0.000154	1.26	285.22	227.63	0.10
Mary Wilson	595	174.00	817.74	824.62	820.48	824.63	0.000156	1.23	238.66	218.70	0.10
Mary Wilson	595	134.00	817.74	824.42	820.18	824.43	0.000133	1.11	195.61	210.11	0.09
Mary Wilson	586	Bridge									
Mary Wilson	577	392.00	817.28	826.24	821.45	826.24	0.000039	0.77	774.22	265.37	0.05
Mary Wilson	577	208.00	817.28	824.81	820.33	824.81	0.000059	0.81	420.47	226.02	0.06
Mary Wilson	577	174.00	817.28	824.60	820.07	824.61	0.000056	0.77	374.95	218.47	0.06
Mary Wilson	577	134.00	817.28	824.40	819.72	824.41	0.000045	0.67	332.13	211.13	0.05
Mary Wilson	481	392.00	816.78	826.23		826.23	0.000025	0.65	936.52	309.47	0.04
Mary Wilson	481	208.00	816.78	824.79		824.80	0.000036	0.67	521.59	266.36	0.05
Mary Wilson	481	174.00	816.78	824.60		824.60	0.000033	0.63	469.38	258.69	0.05
Mary Wilson	481	134.00	816.78	824.40		824.40	0.000026	0.54	418.90	247.13	0.04
Mary Wilson	320	392.00	816.61	826.22		826.23	0.000016	0.57	1077.52	315.60	0.03
Mary Wilson	320	208.00	816.61	824.78		824.79	0.000018	0.53	648.89	277.40	0.04
Mary Wilson	320	174.00	816.61	824.59		824.59	0.000016	0.49	596.04	270.64	0.03
Mary Wilson	320	134.00	816.61	824.39		824.39	0.000012	0.42	543.04	263.70	0.03
Mary Wilson	312	392.00	816.57	826.22	820.49	826.22	0.000052	0.79	771.77	315.41	0.06
Mary Wilson	312	208.00	816.57	824.77	819.24	824.78	0.000140	1.08	342.21	276.98	0.09
Mary Wilson	312	174.00	816.57	824.58	818.97	824.59	0.000149	1.08	289.07	270.18	0.09
Mary Wilson	312	134.00	816.57	824.38	818.61	824.39	0.000139	1.02	236.18	263.24	0.09
Mary Wilson	292	Culvert									
Mary Wilson	273	392.00	816.62	824.40	820.99	824.44	0.000303	1.98	347.62	224.91	0.14
Mary Wilson	273	208.00	816.62	823.23	819.74	823.42	0.000972	3.55	58.67	83.90	0.26
Mary Wilson	273	174.00	816.62	822.58	819.46	822.75	0.001004	3.33	52.20	53.84	0.26
Mary Wilson	273	134.00	816.62	822.16	819.13	822.29	0.000787	2.79	48.02	43.54	0.22
Mary Wilson	263	392.00	816.57	824.39		824.43	0.000289	1.94	357.93	233.08	0.14
Mary Wilson	263	208.00	816.57	823.30		823.34	0.000317	1.77	160.96	98.90	0.14
Mary Wilson	263	174.00	816.57	822.64		822.69	0.000419	1.84	114.03	56.47	0.16
Mary Wilson	263	134.00	816.57	822.20		822.24	0.000398	1.67	91.61	45.64	0.15
Mary Wilson	243	392.00	816.47	824.37	820.66	824.42	0.000540	2.32	282.11	192.40	0.19
Mary Wilson	243	208.00	816.47	823.20	819.53	823.31	0.001059	2.70	95.60	98.16	0.25
Mary Wilson	243	174.00	816.47	822.52	819.30	822.65	0.000766	2.86	60.92	56.10	0.22
Mary Wilson	243	134.00	816.47	822.13	818.95	822.22	0.000595	2.39	56.16	46.31	0.19
Mary Wilson	220	Culvert									
Mary Wilson	197	392.00	815.81	823.00	820.02	823.00	0.000052	0.85	854.06	400.00	0.06
Mary Wilson	197	208.00	815.81	822.80	818.91	822.80	0.000020	0.51	774.20	400.00	0.04
Mary Wilson	197	174.00	815.81	822.25	818.69	822.36	0.000602	2.67	65.31	400.00	0.20
Mary Wilson	197	134.00	815.81	821.98	818.38	822.05	0.000424	2.16	62.05	318.87	0.17
Mary Wilson	157	392.00	815.70	823.00		823.00	0.000048	0.82	875.91	400.00	0.06
Mary Wilson	157	208.00	815.70	822.80		822.80	0.000018	0.50	795.76	400.00	0.04
Mary Wilson	157	174.00	815.70	822.30		822.30	0.000031	0.61	595.71	400.00	0.05
Mary Wilson	157	134.00	815.70	822.00		822.00	0.000029	0.58	475.71	319.97	0.04
Mary Wilson	064	392.00	815.04	823.00		823.00	0.000024	0.62	1073.71	400.00	0.04
Mary Wilson	064	208.00	815.04	822.80		822.80	0.000009	0.37	993.63	400.00	0.02
Mary Wilson	064	174.00	815.04	822.30		822.30	0.000012	0.41	793.60	400.00	0.03
Mary Wilson	064	134.00	815.04	822.00		822.00	0.000010	0.36	673.61	319.99	0.03
Mary Wilson	009	392.00	814.51	823.00	817.10	823.00	0.000006	0.34	1664.74	400.00	0.02

HEC-RAS Plan: Plan 01 River: Mary Wilson Drai Reach: Mary Wilson (Continued)

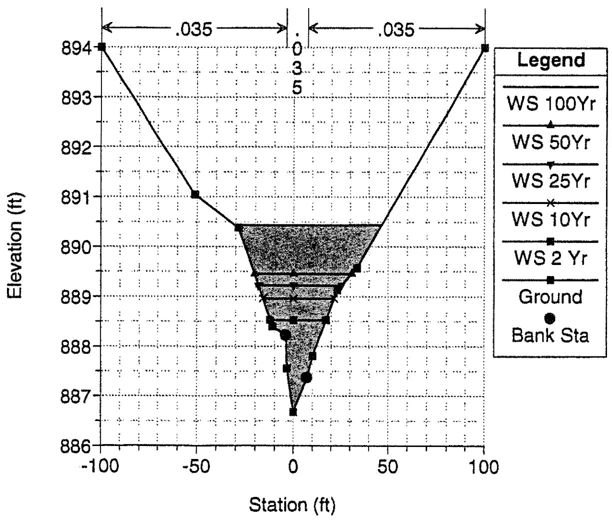
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Mary Wilson	009	208.00	814.51	822.80	816.73	822.80	0.000002	0.19	1584.74	400.00	0.01
Mary Wilson	009	174.00	814.51	822.30	816.64	822.30	0.000002	0.19	1384.74	400.00	0.01
Mary Wilson	009	134.00	814.51	822.00	816.52	822.00	0.000001	0.15	1264.74	320.00	0.01

H.G. KENYON DRAIN

HEC-RAS CROSS-SECTIONS AND PROFILE SUMMARY TABLE

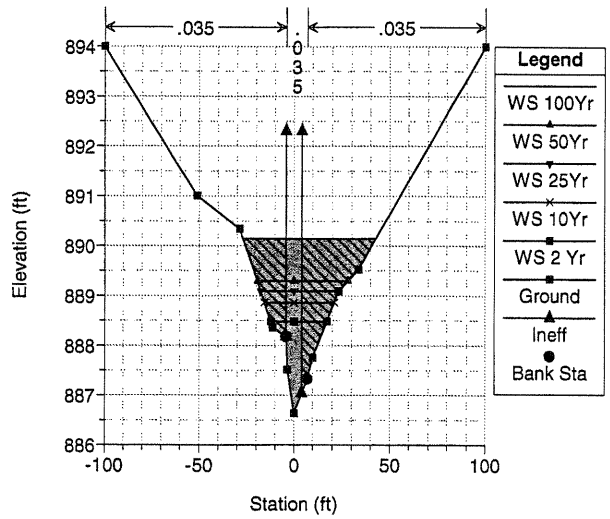
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 8172   Copied Cross Section #28 7' Upstream of 3'x6.5' Oak Ridge Road B



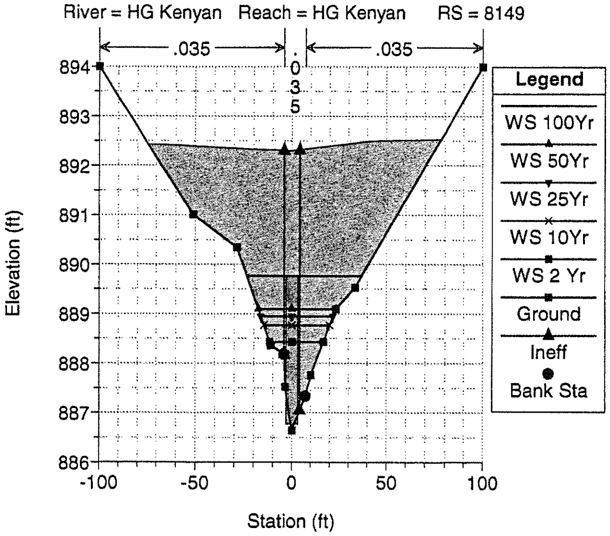
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 8165   Cross Section #28 Upstream of 3'x6.5' Oak Ridge Road Bridge Stru



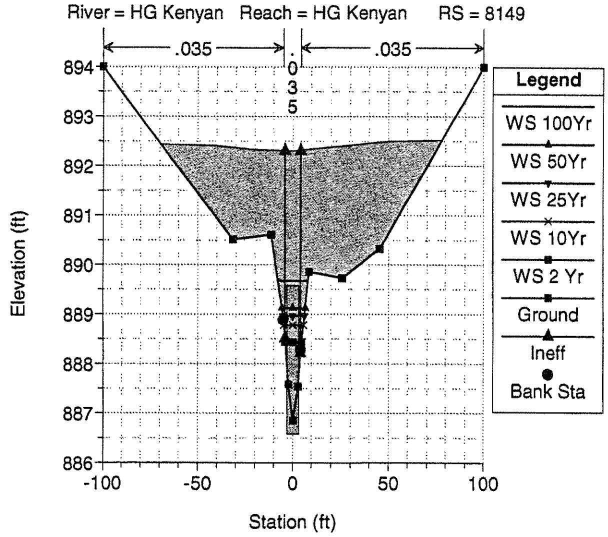
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 8149



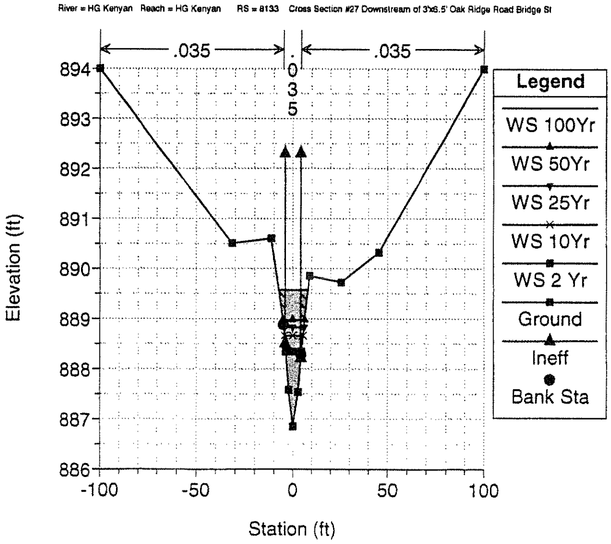
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 8149



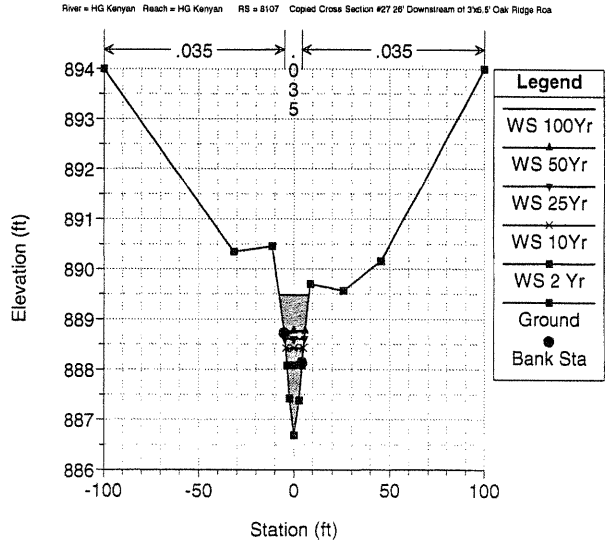
H.G. Kenyon Drain

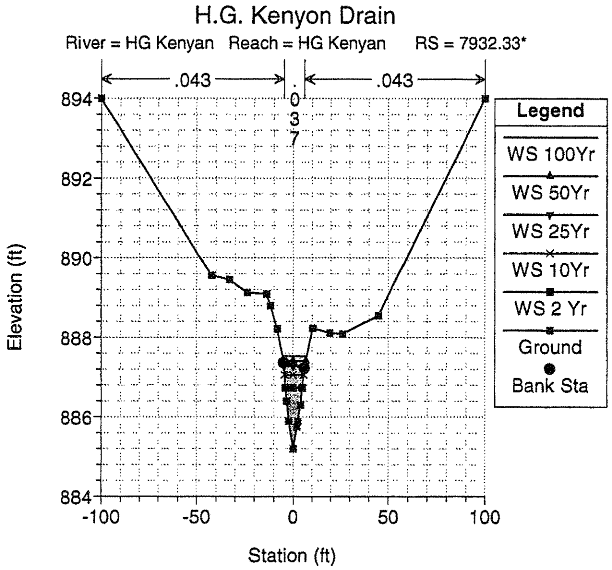
River = HG Kenyan   Reach = HG Kenyan   RS = 8133   Cross Section #27 Downstream of 3'x6.5' Oak Ridge Road Bridge St

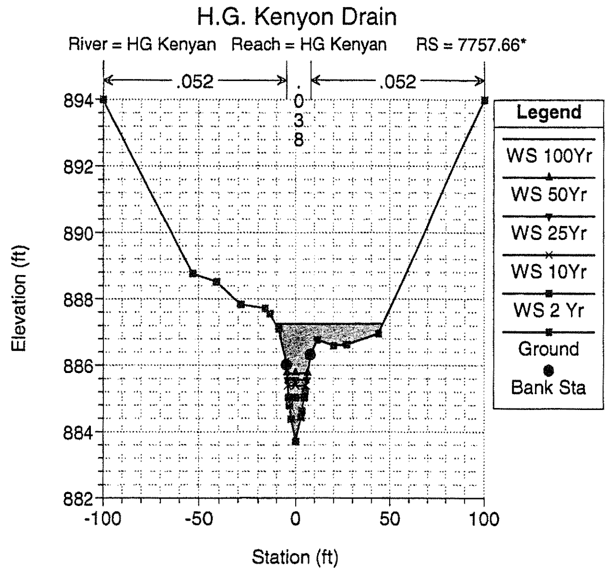


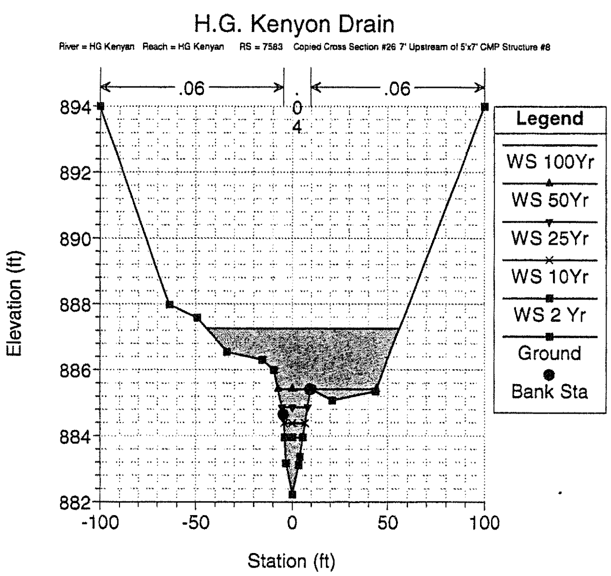
H.G. Kenyon Drain

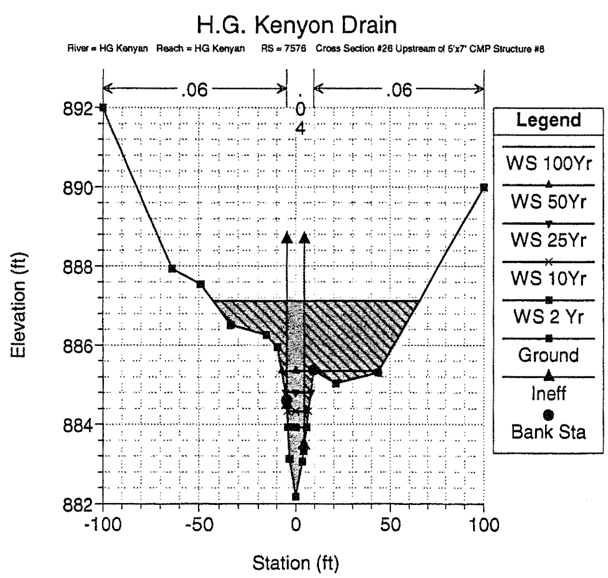
River = HG Kenyan   Reach = HG Kenyan   RS = 8107   Copied Cross Section #27 26' Downstream of 3'x6.5' Oak Ridge Roa

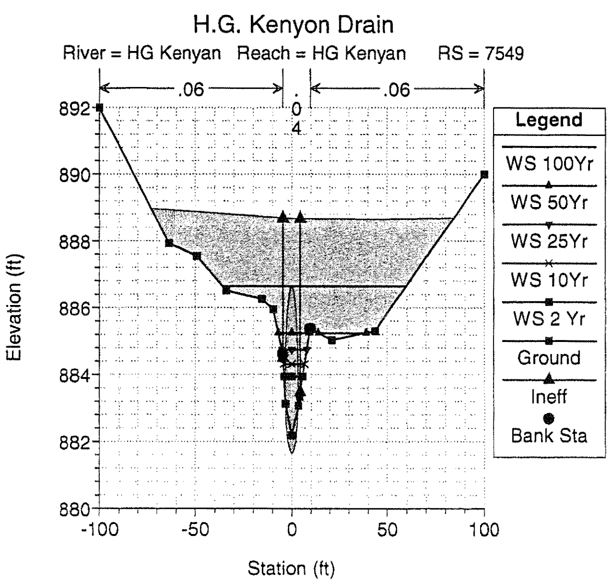


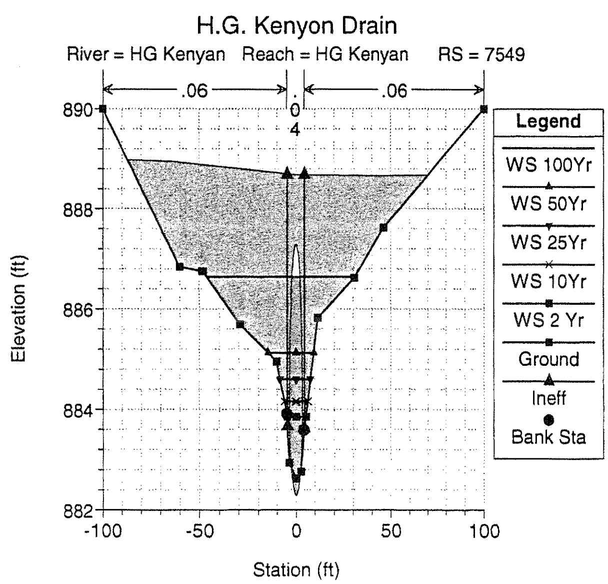

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7932.33*
.043
.037
.043
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

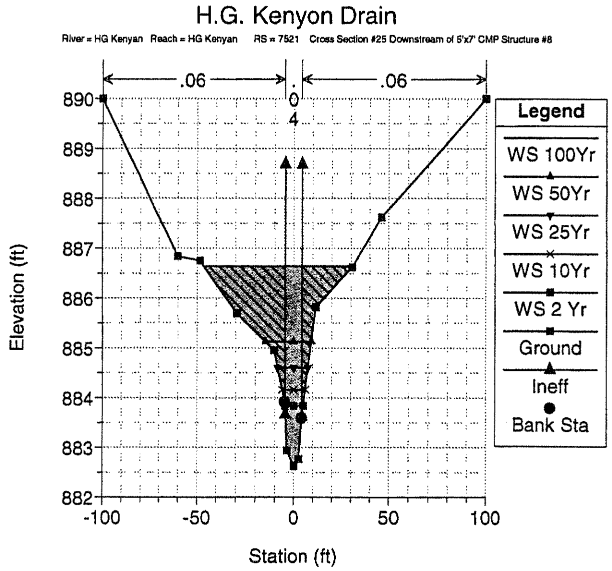

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7757.66*
.052
.038
.052
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

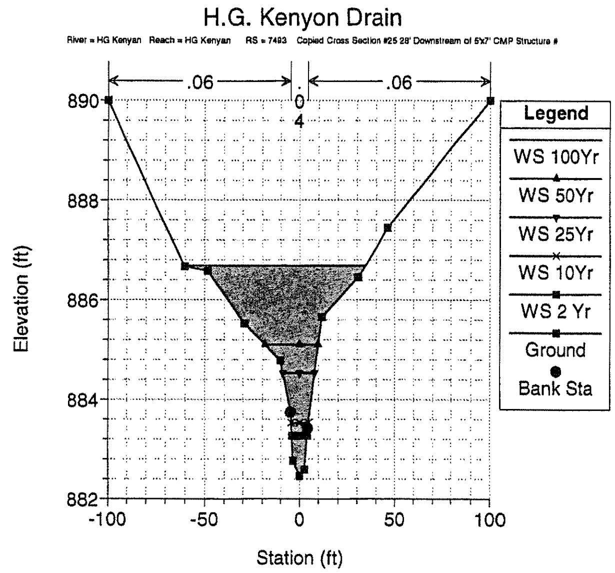

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7583 Copied Cross Section #26 7' Upstream of 5'x7' CMP Structure #8
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

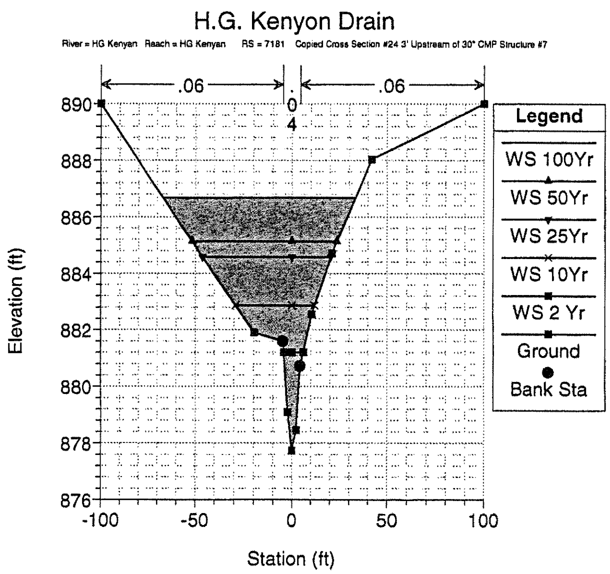

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7576 Cross Section #26 Upstream of 5'x7' CMP Structure #8
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

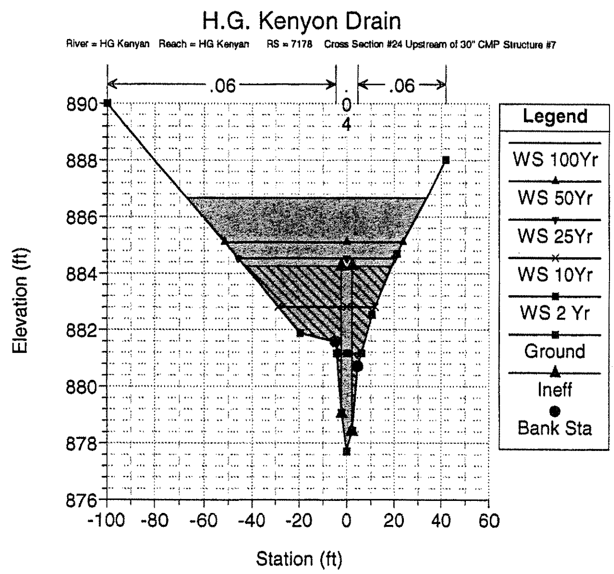

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7549
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

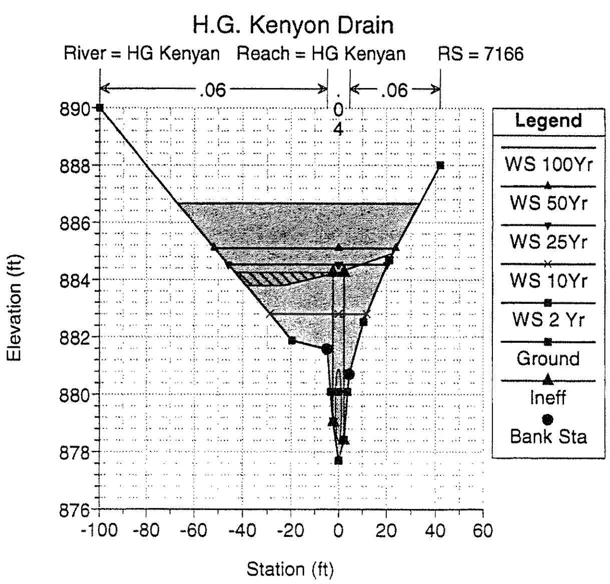

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7549
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

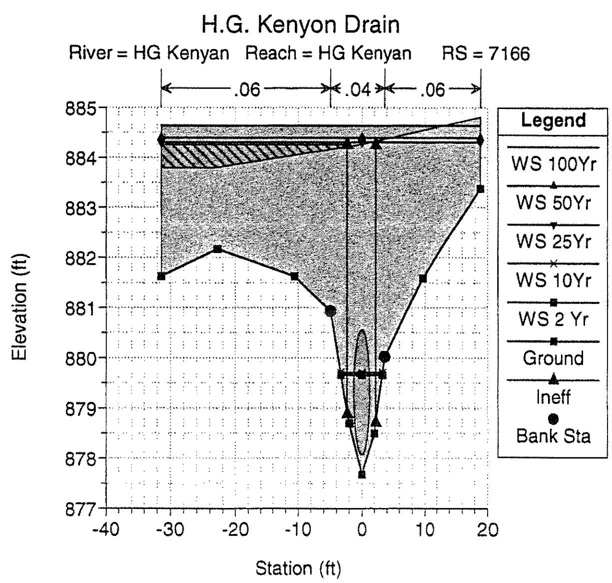

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7521 Cross Section #25 Downstream of 5'x7' CMP Structure #8
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

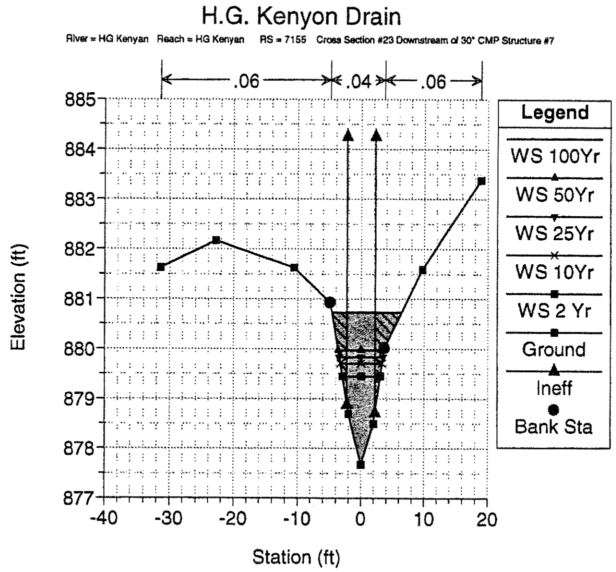

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7493 Copied Cross Section #25 28' Downstream of 5'x7' CMP Structure #
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

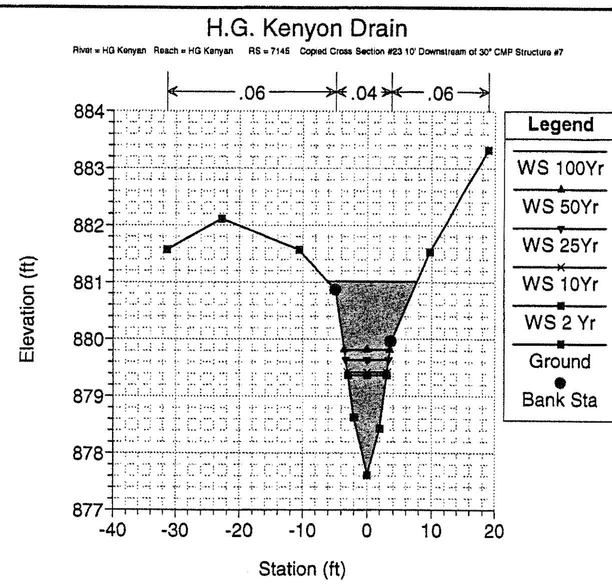

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7181 Copied Cross Section #24 3' Upstream of 30" CMP Structure #7
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

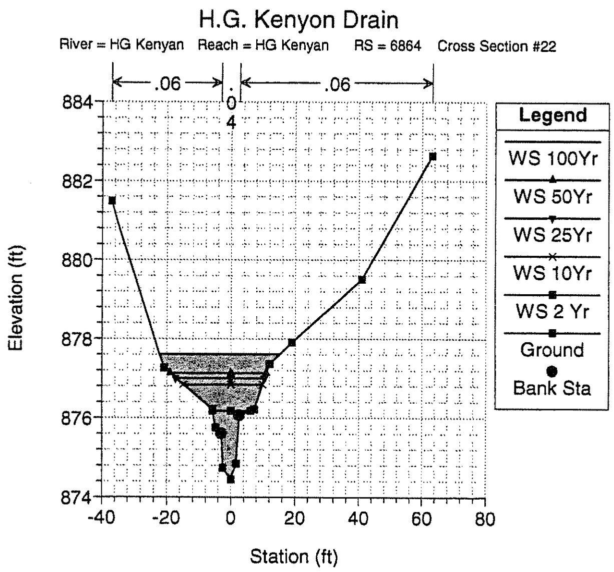

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7178 Cross Section #24 Upstream of 30" CMP Structure #7
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

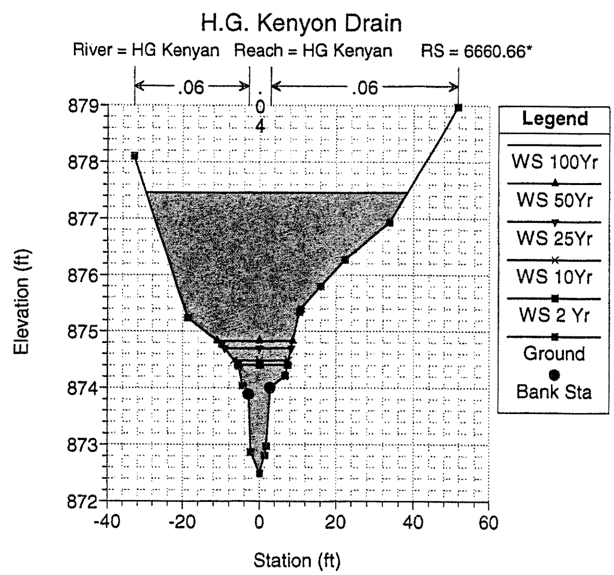

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7166
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

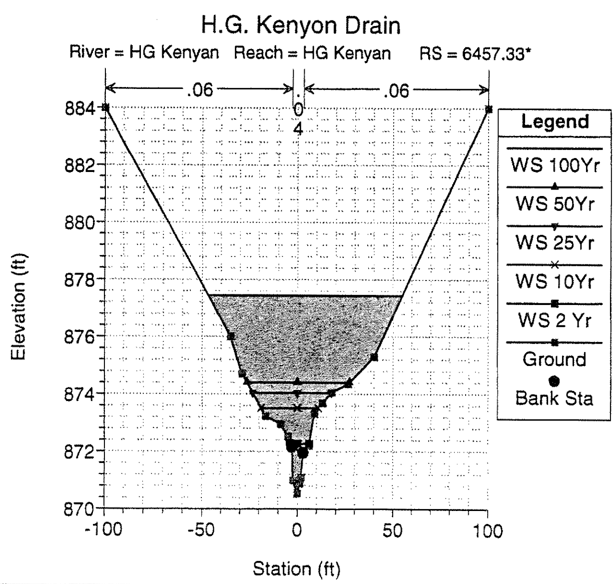

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7166
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

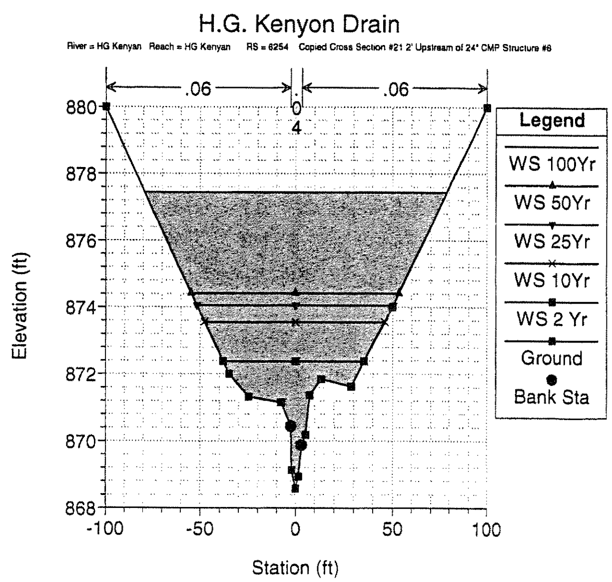

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7155 Cross Section #23 Downstream of 30" CMP Structure #7
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

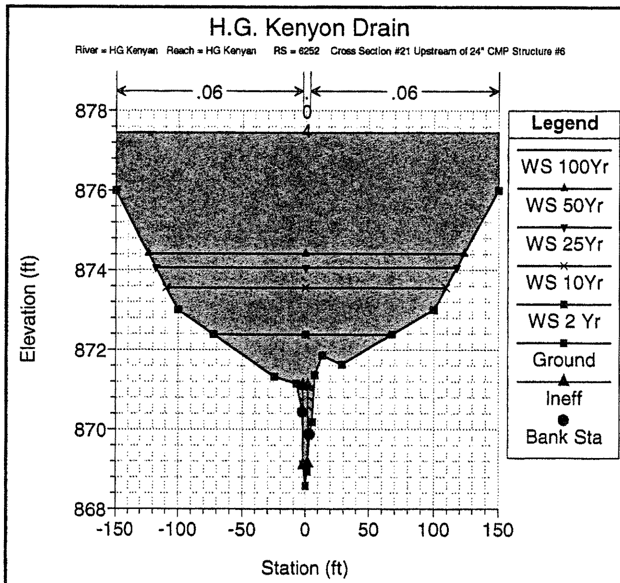

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 7145 Copied Cross Section #23 10' Downstream of 30" CMP Structure #7
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

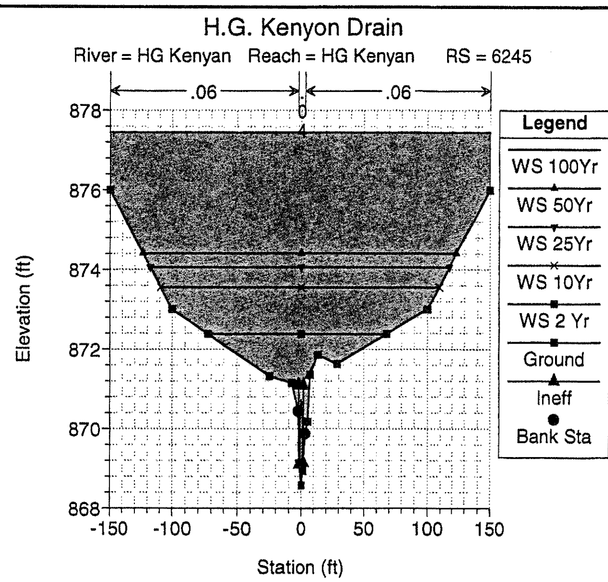

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 6864 Cross Section #22
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

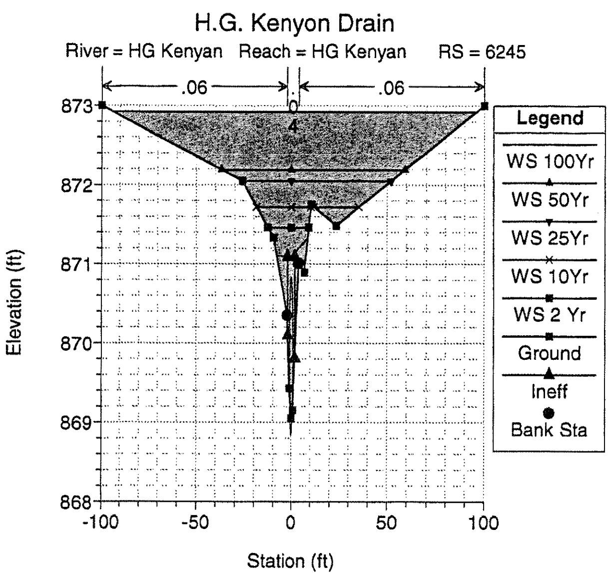

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 6660.66*
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

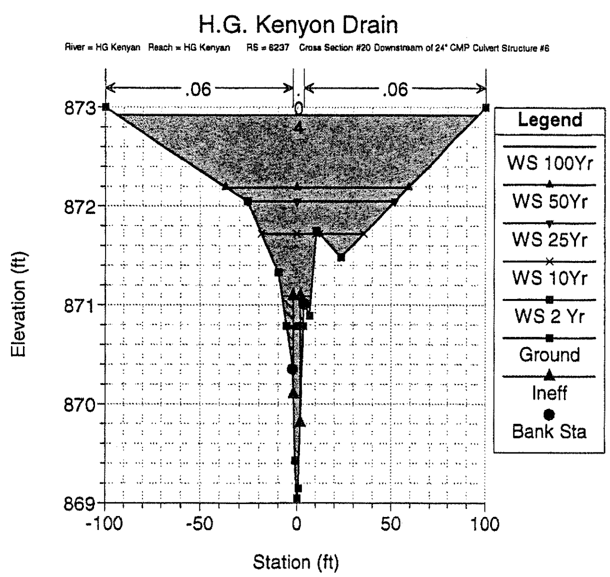

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 6457.33*
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

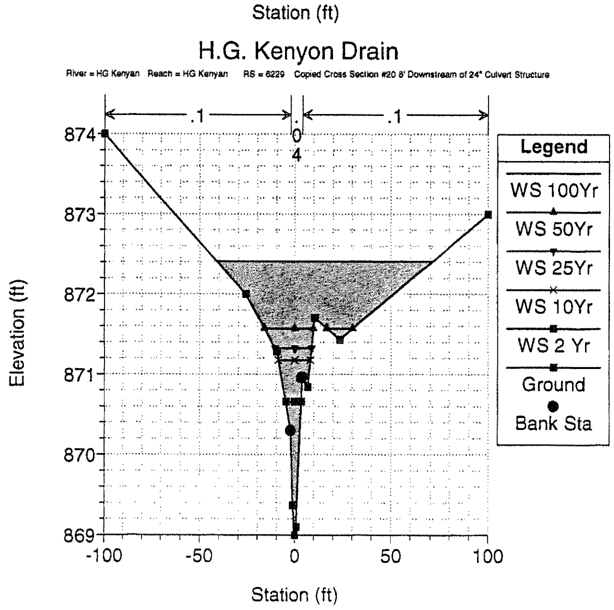

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 6254 Copied Cross Section #21 2' Upstream of 24" CMP Structure #6
.06
.04
.06
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

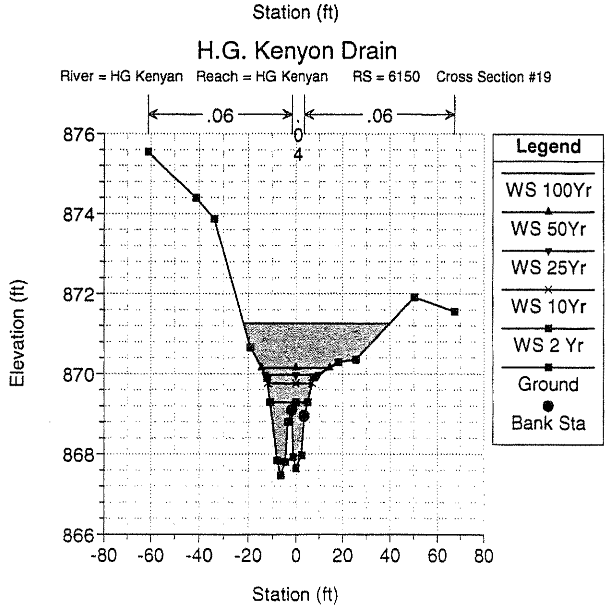

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 6252   Cross Section #21 Upstream of 24" CMP Structure #6
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

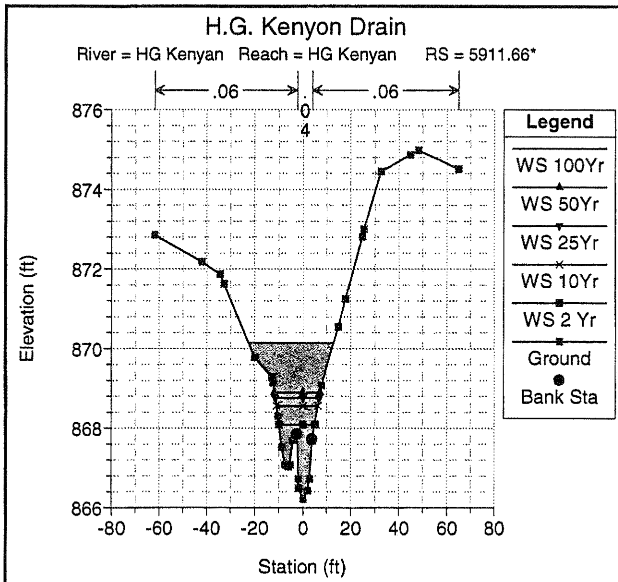

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 6245
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

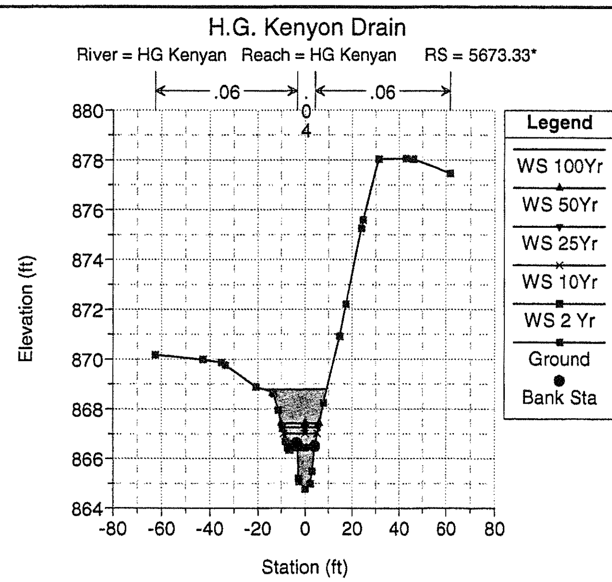

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 6245
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

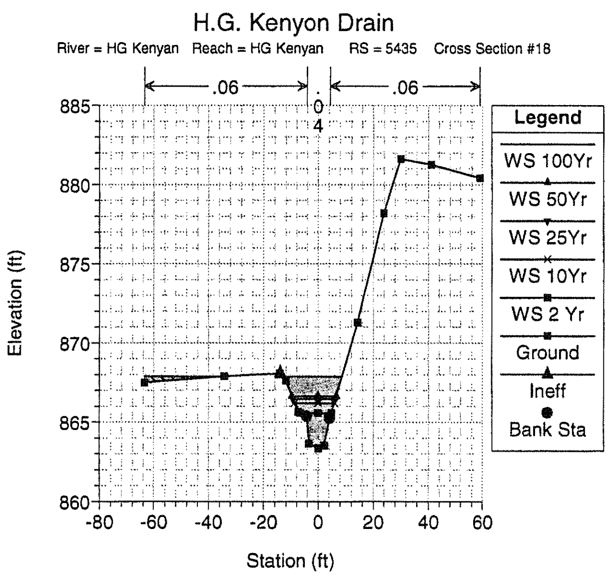

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 6237   Cross Section #20 Downstream of 24" CMP Culvert Structure #6
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

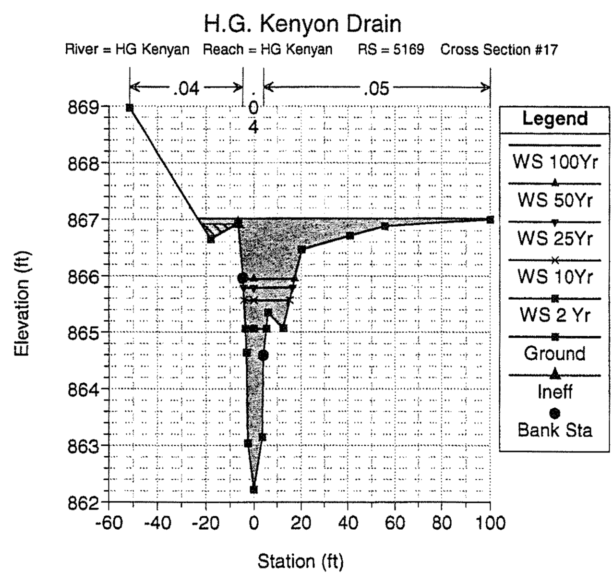

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 6229   Copied Cross Section #20 8' Downstream of 24" Culvert Structure
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

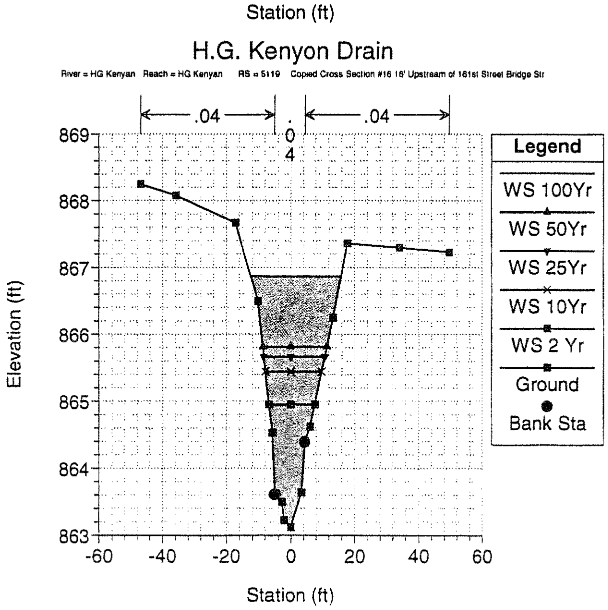

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 6150   Cross Section #19
.06
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

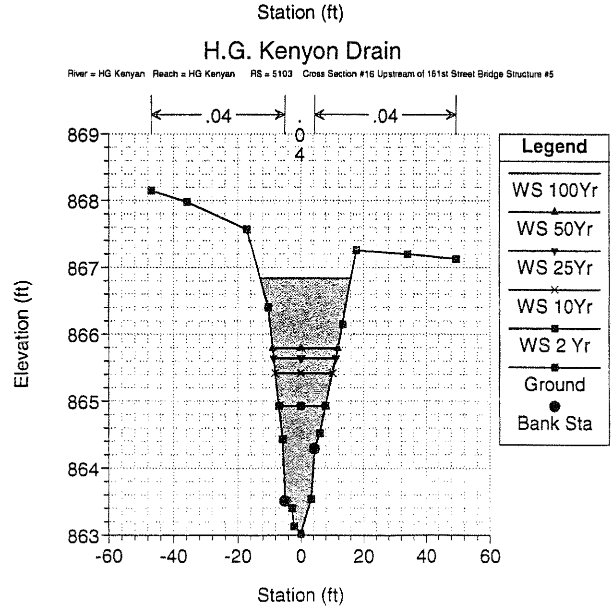

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 5911.66*
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 5673.33*
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 5435 Cross Section #18
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

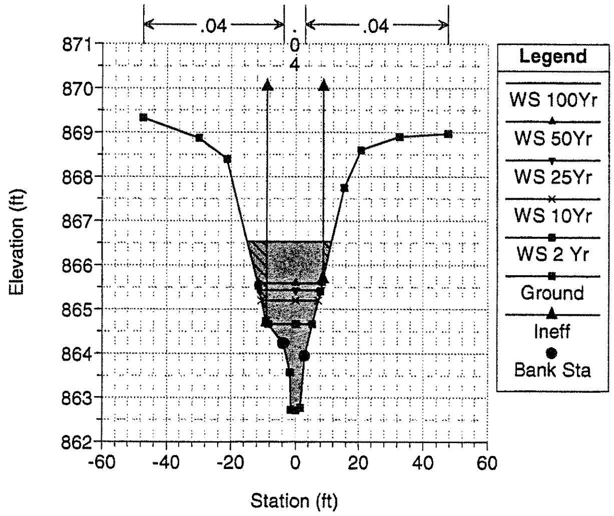

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 5169 Cross Section #17
.04
.04
.05
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 5119 Copied Cross Section #16 16' Upstream of 161st Street Bridge Str
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 5103 Cross Section #16 Upstream of 161st Street Bridge Structure #5
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

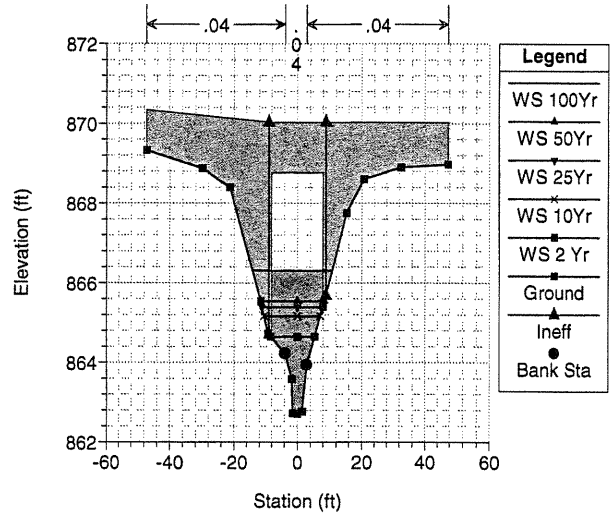
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 5062   Cross Section #15 Downstream of 161st Street Bridge structure #5



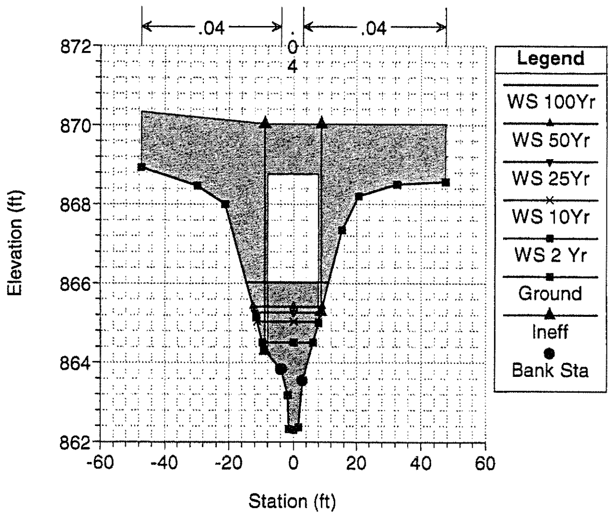
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 5042   161st Street Bridge



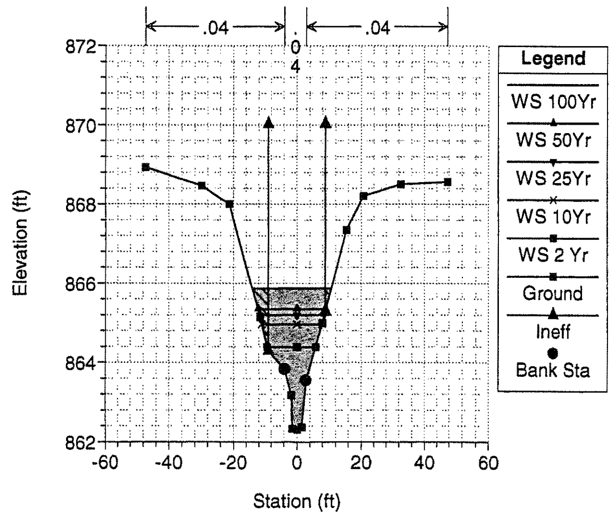
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 5042   161st Street Bridge



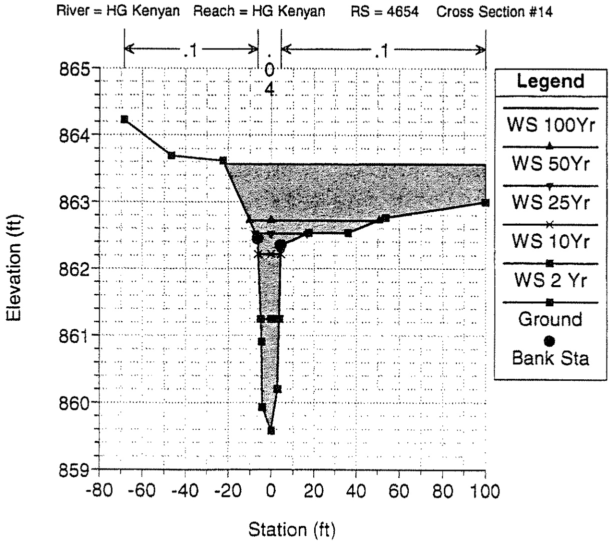
H.G. Kenyon Drain

River = HG Kenyan   Reach = HG Kenyan   RS = 4998   Copied Cross Section #15 64' Downstream of 161st Street Bridge s



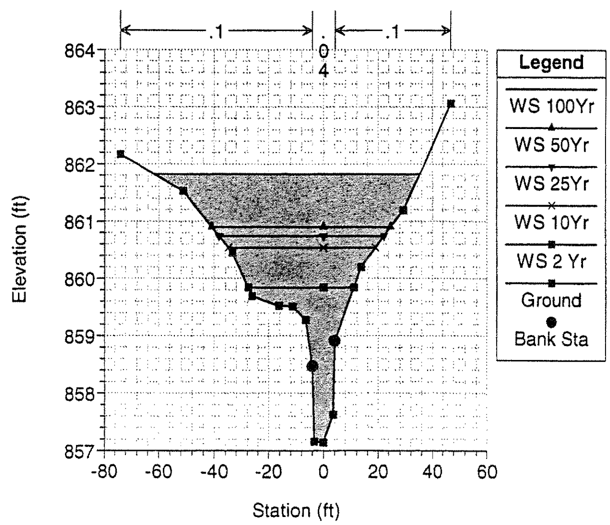
H.G. Kenyon Drain

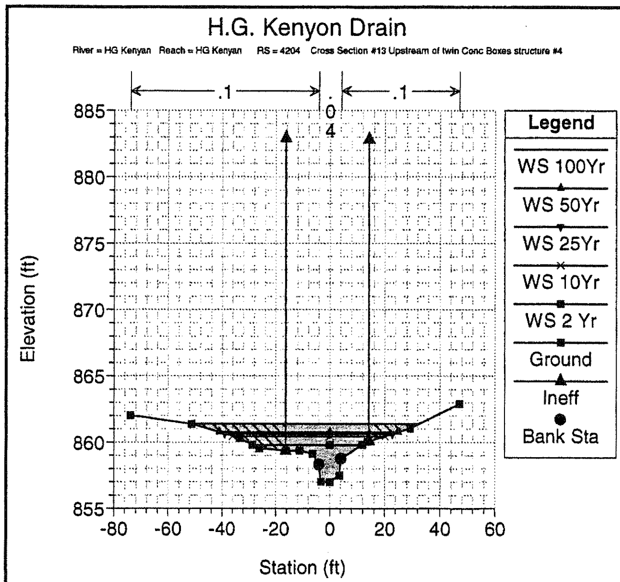
River = HG Kenyan   Reach = HG Kenyan   RS = 4654   Cross Section #14

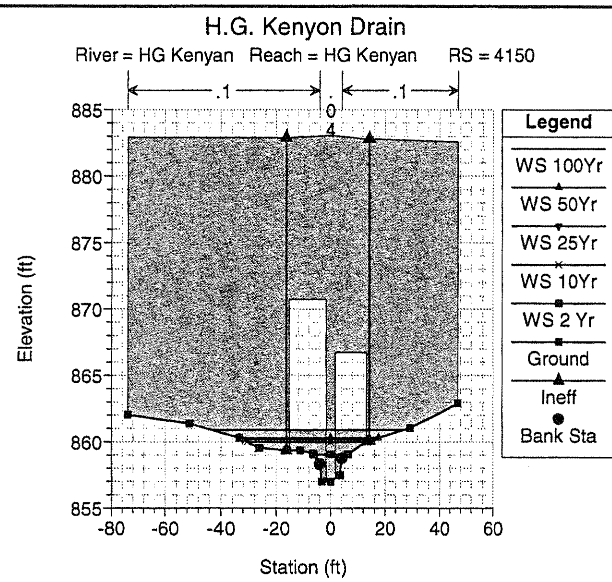


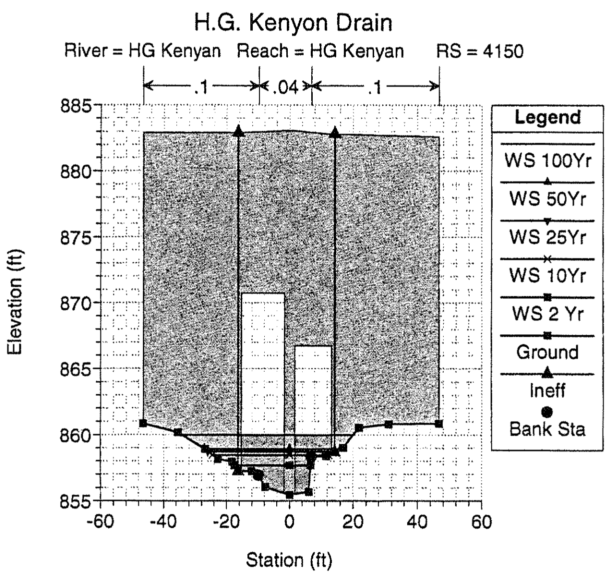
H.G. Kenyon Drain

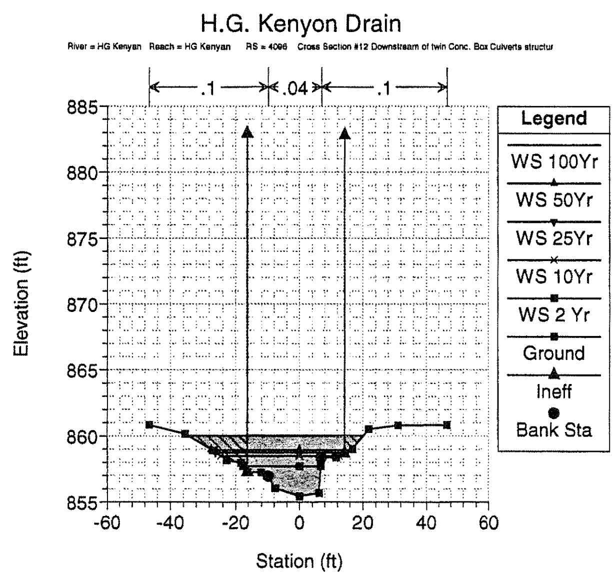
River = HG Kenyan   Reach = HG Kenyan   RS = 4229   Copied Cross Section #13 25' Upstream of twin Conc Boxes structu

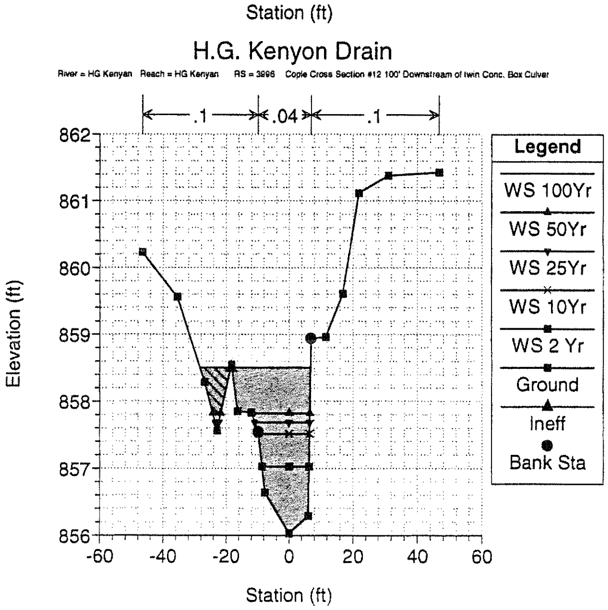


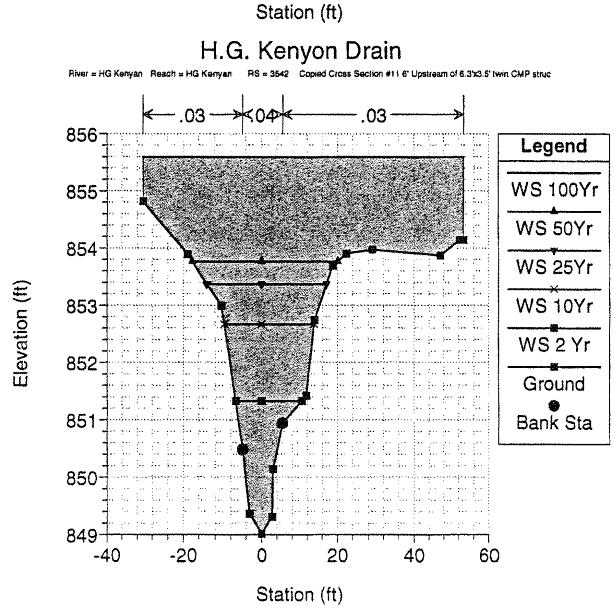

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 4204 Cross Section #13 Upstream of twin Conc Boxes structure #4
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

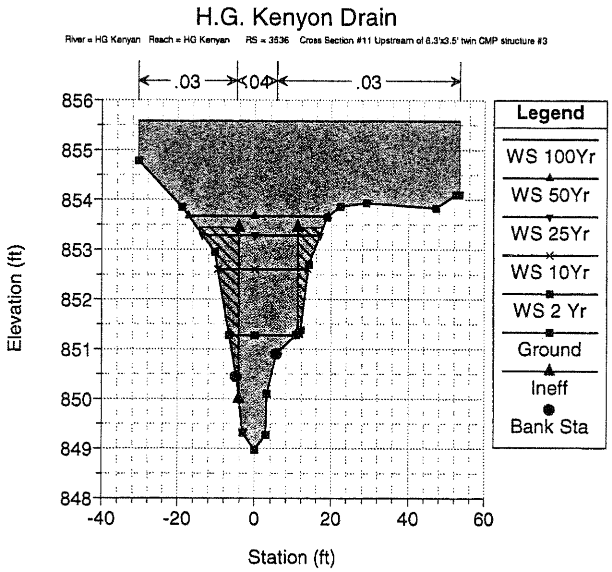

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 4150
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

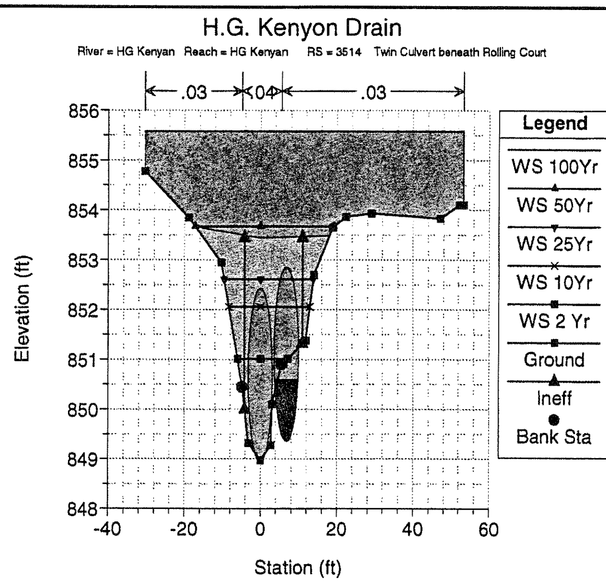

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 4150
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

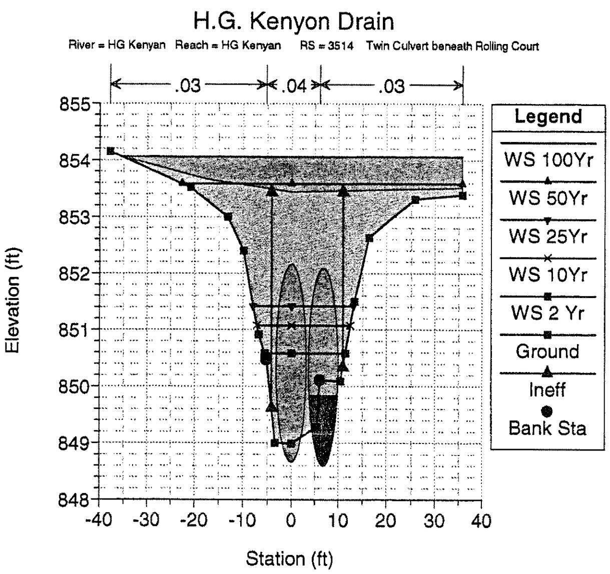

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 4096 Cross Section #12 Downstream of twin Conc. Box Culverts structur
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

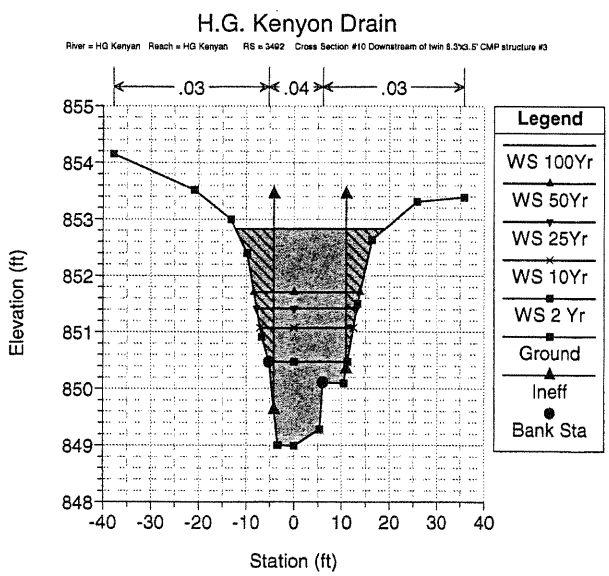

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 3996 Copie Cross Section #12 100' Downstream of twin Conc. Box Culver
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

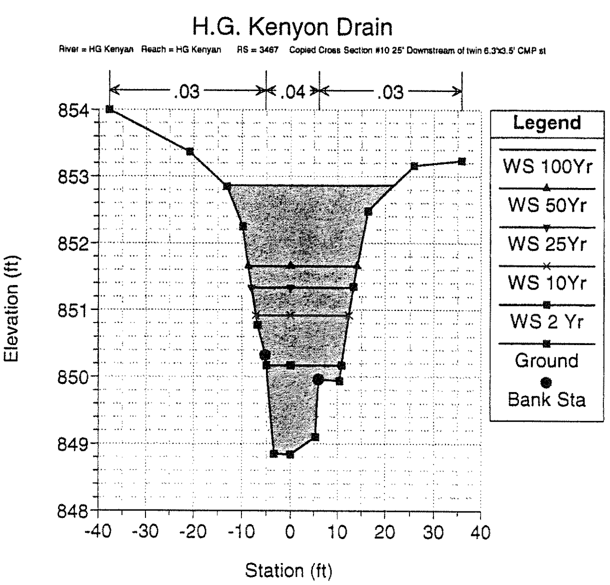

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 3542 Copied Cross Section #11 6' Upstream of 6.3'x3.5' twin CMP struc
.03
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

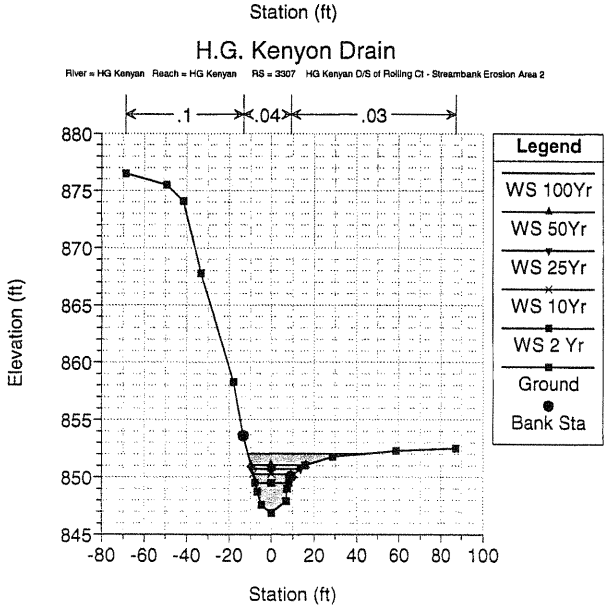

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 3536   Cross Section #11 Upstream of 6.3'x3.5' twin CMP structure #3
.03
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 3514   Twin Culvert beneath Rolling Court
.03
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 3514   Twin Culvert beneath Rolling Court
.03
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

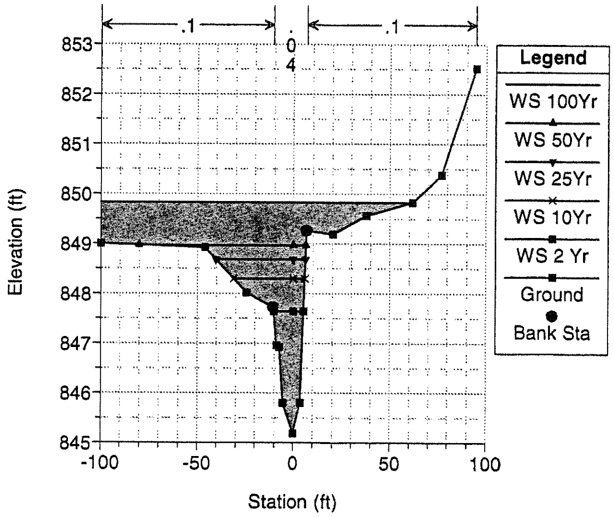

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 3492   Cross Section #10 Downstream of twin 6.3'x3.5' CMP structure #3
.03
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 3467   Copied Cross Section #10 25' Downstream of twin 6.3'x3.5' CMP st
.03
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 3307   HG Kenyan D/S of Rolling Ct - Streambank Erosion Area 2
.1
.04
.03
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

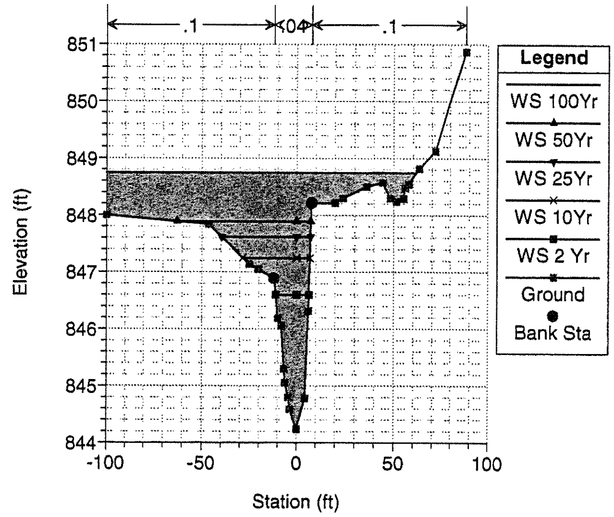
H.G. Kenyon Drain

River = HG Kenyan Reach = HG Kenyan RS = 2825 Cross Section #8



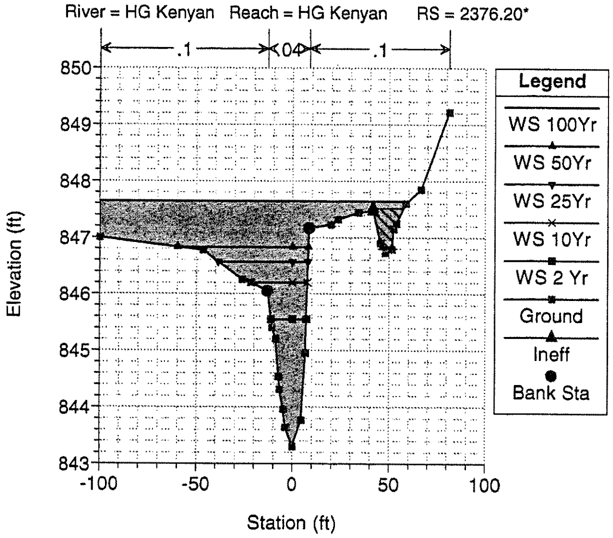
H.G. Kenyon Drain

River = HG Kenyan Reach = HG Kenyan RS = 2600.60*



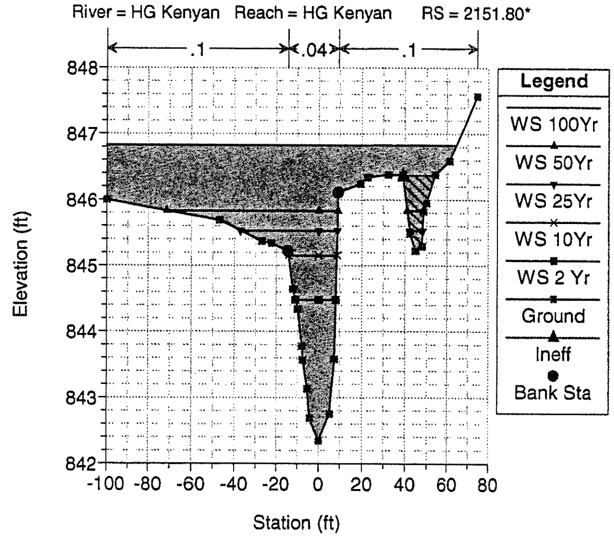
H.G. Kenyon Drain

River = HG Kenyan Reach = HG Kenyan RS = 2376.20*



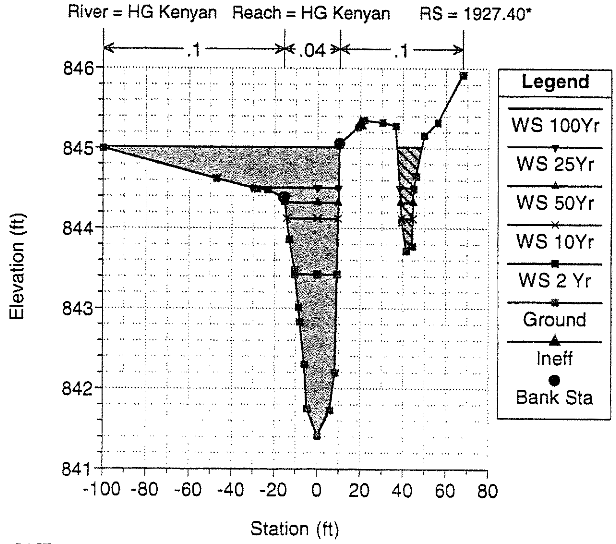
H.G. Kenyon Drain

River = HG Kenyan Reach = HG Kenyan RS = 2151.80*



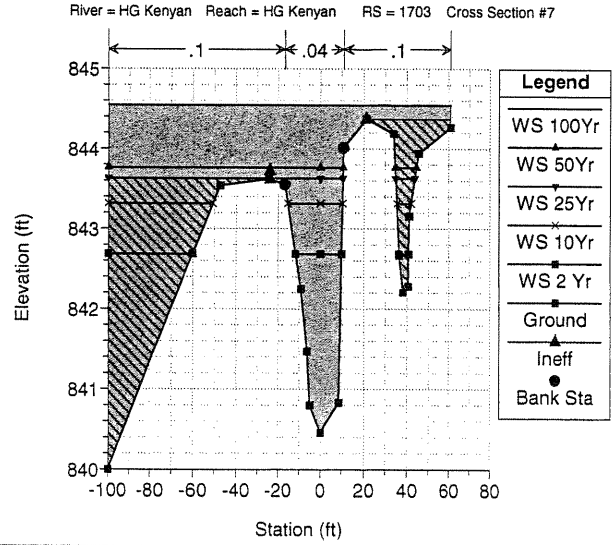
H.G. Kenyon Drain

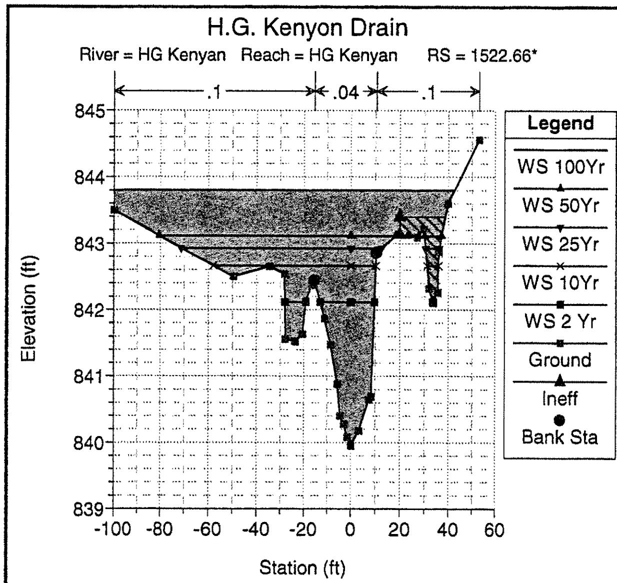
River = HG Kenyan Reach = HG Kenyan RS = 1927.40*

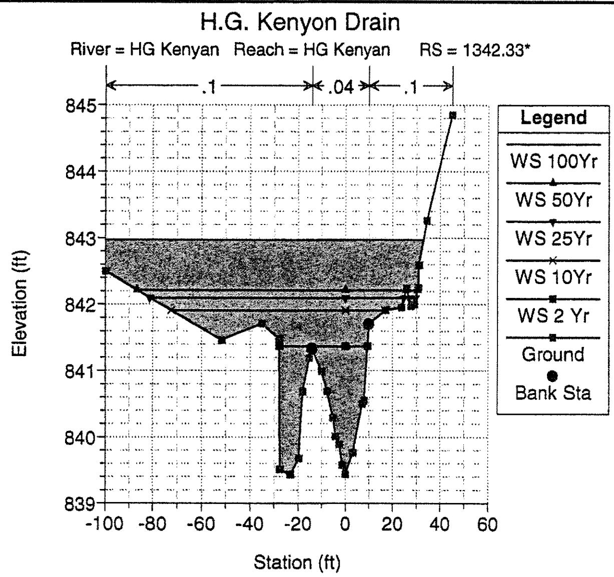


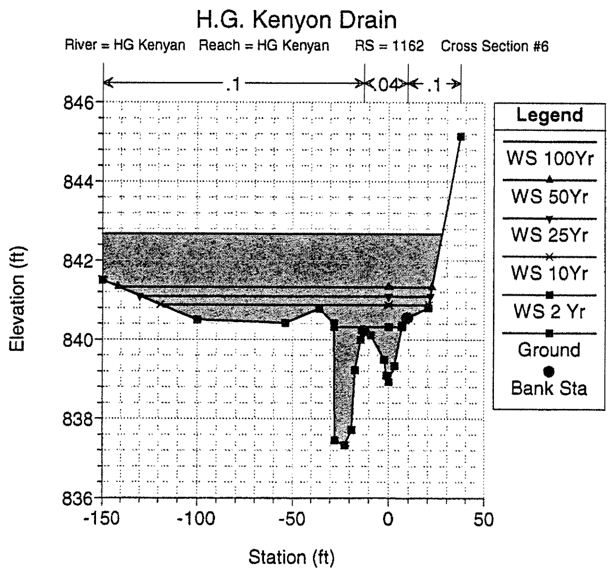
H.G. Kenyon Drain

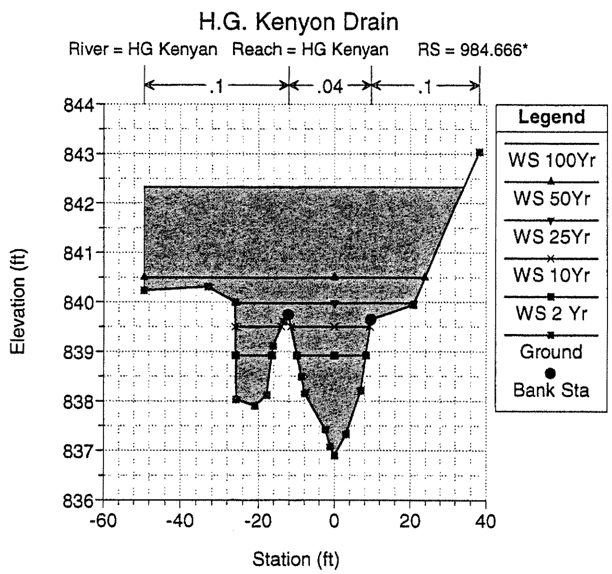
River = HG Kenyan Reach = HG Kenyan RS = 1703 Cross Section #7

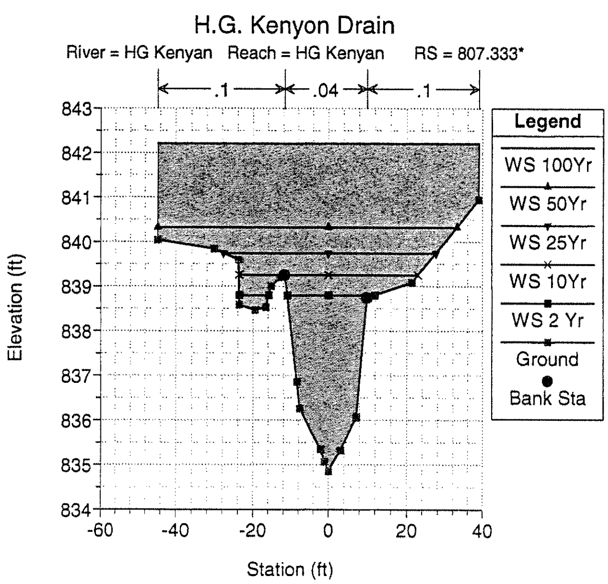


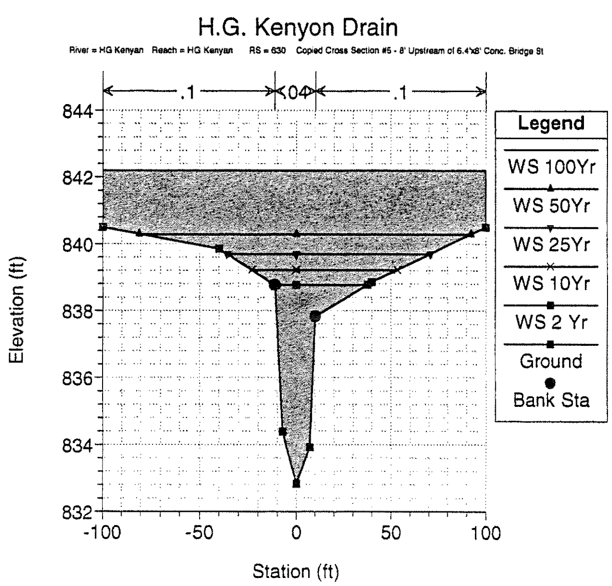

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 1522.66*
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta

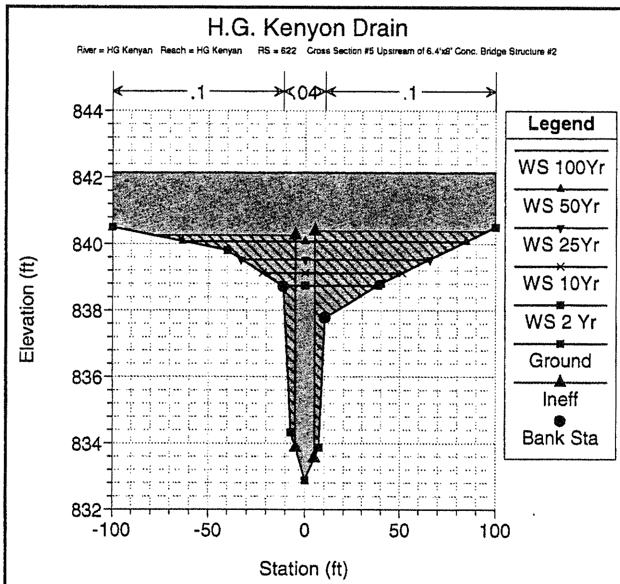

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 1342.33*
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

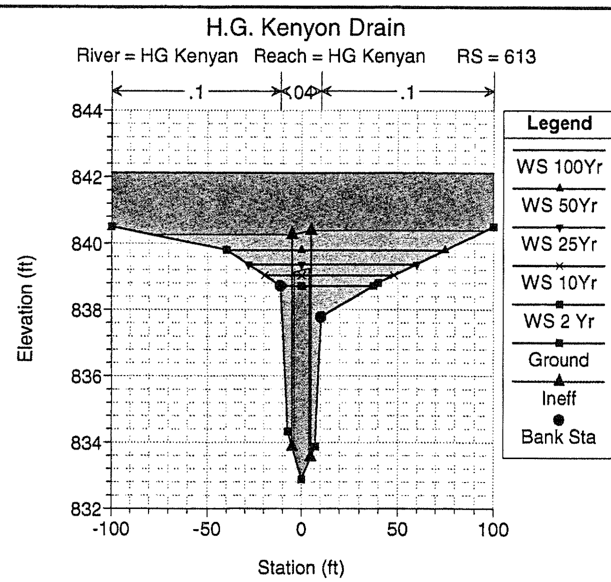

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 1162 Cross Section #6
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

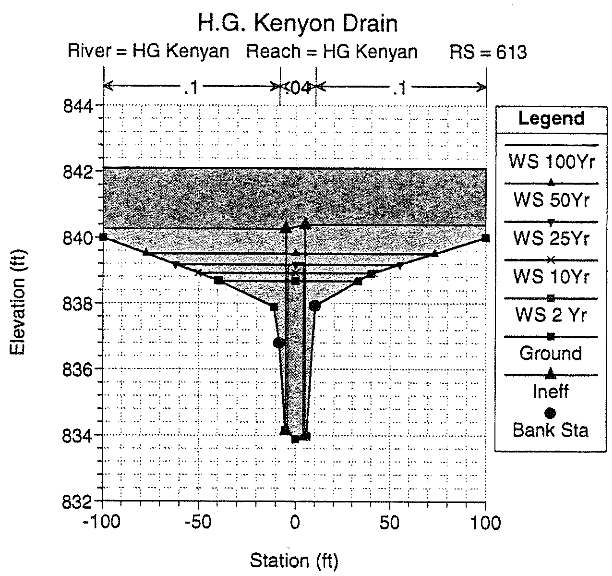

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 984.666*
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

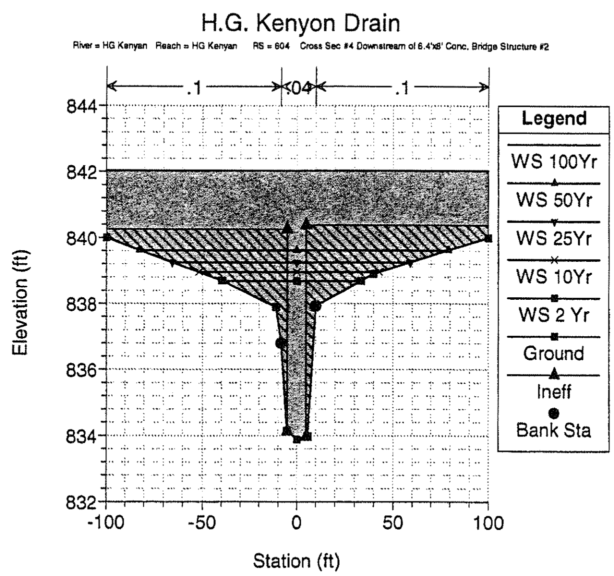

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 807.333*
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

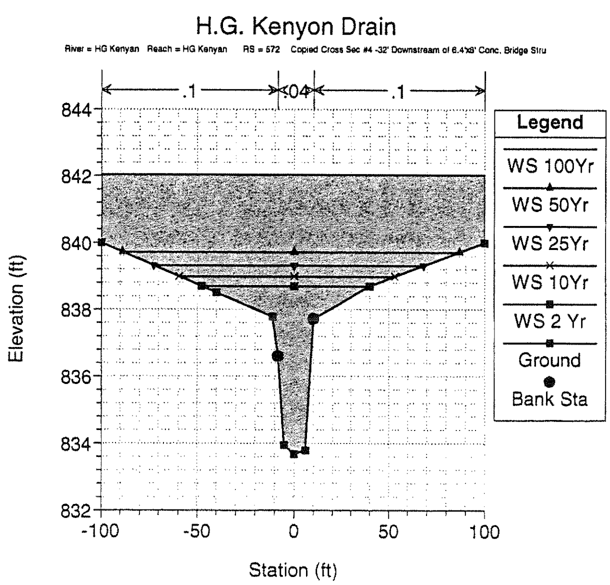

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 630 Copied Cross Section #5 - 8' Upstream of 6.4'x8' Conc. Bridge St
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

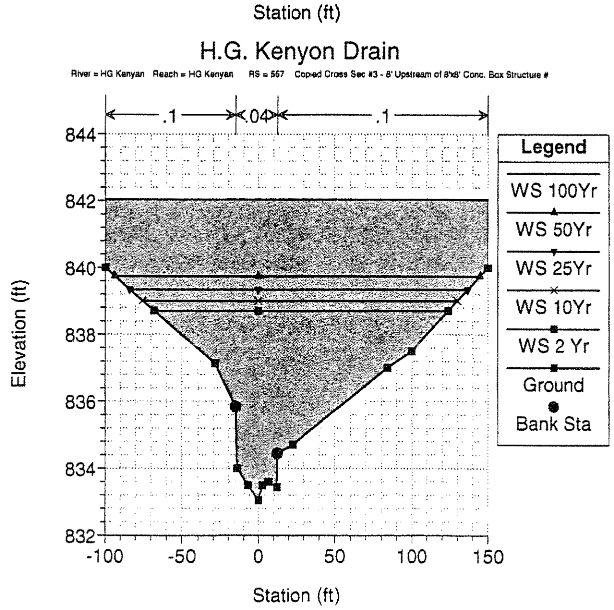

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 622   Cross Section #5 Upstream of 6.4'x8' Conc. Bridge Structure #2
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
844
842
840
838
836
834
832
-100
-50
0
50
100
Station (ft)

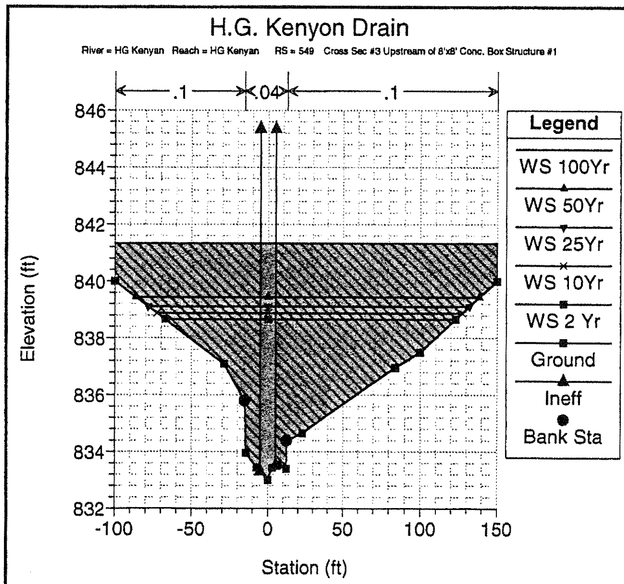

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 613
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
844
842
840
838
836
834
832
-100
-50
0
50
100
Station (ft)

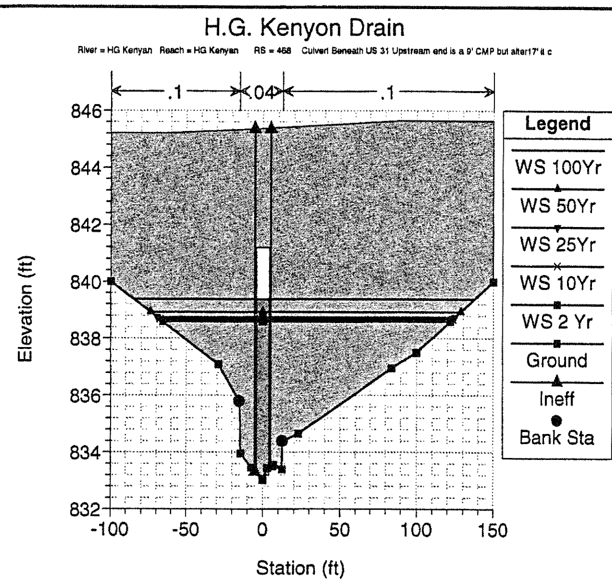

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 613
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
844
842
840
838
836
834
832
-100
-50
0
50
100
Station (ft)

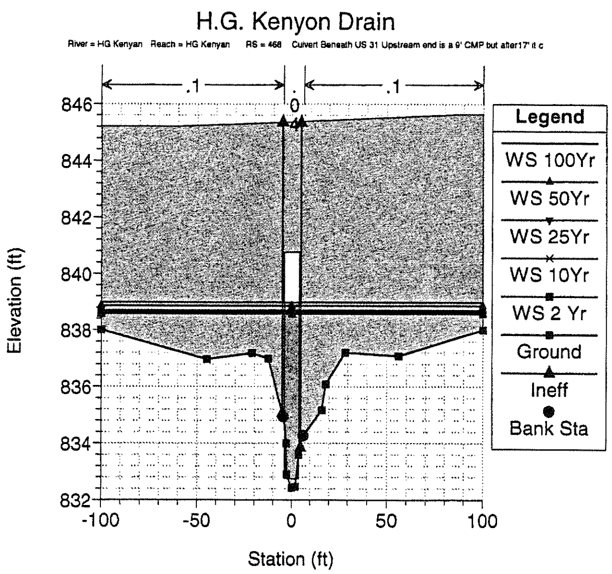

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 604   Cross Sec #4 Downstream of 6.4'x8' Conc. Bridge Structure #2
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta
Elevation (ft)
844
842
840
838
836
834
832
-100
-50
0
50
100
Station (ft)

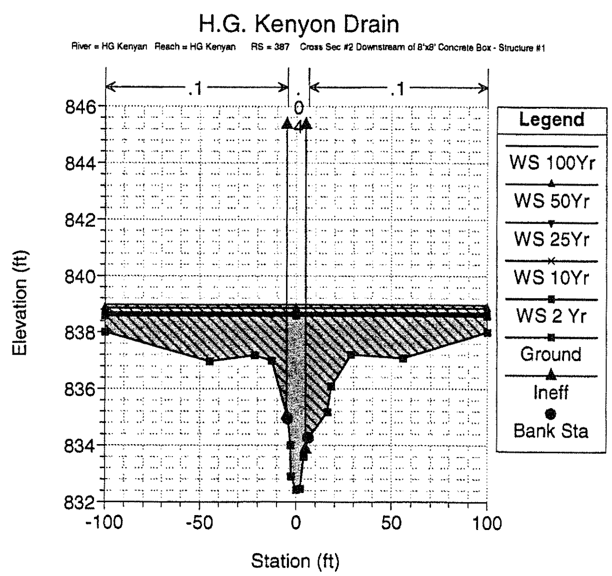

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 572   Copied Cross Sec #4 -32' Downstream of 6.4'x8' Conc. Bridge Stru
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
844
842
840
838
836
834
832
-100
-50
0
50
100
Station (ft)

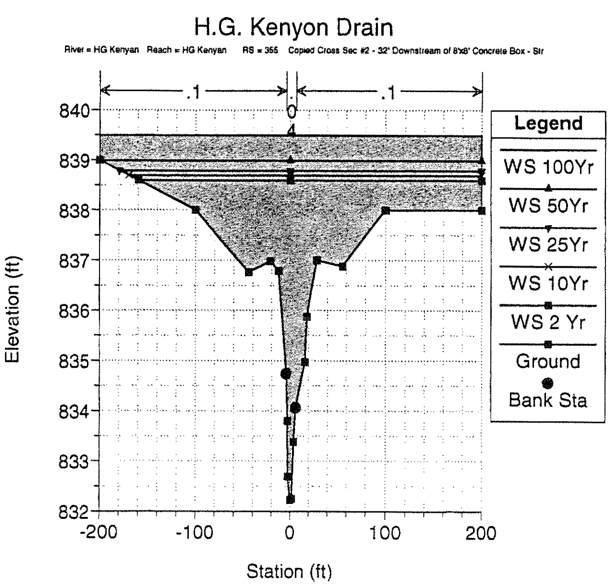

H.G. Kenyon Drain
River = HG Kenyan   Reach = HG Kenyan   RS = 557   Copied Cross Sec #3 - 8' Upstream of 8'x8' Conc. Box Structure #
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta
Elevation (ft)
844
842
840
838
836
834
832
-100
-50
0
50
100
150
Station (ft)

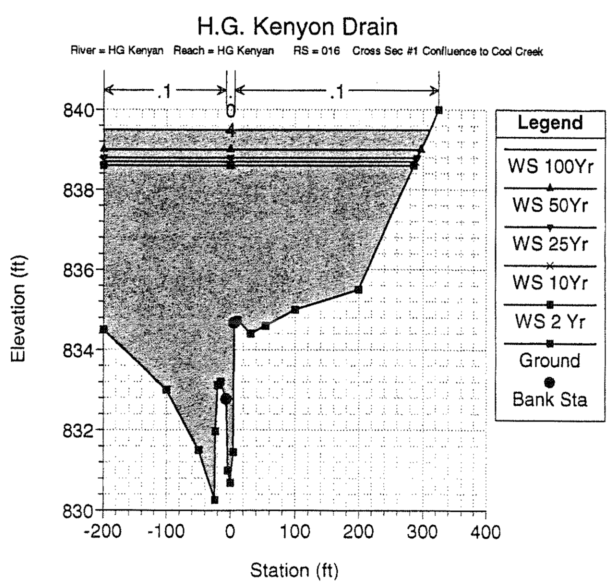

H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 549 Cross Sec #3 Upstream of 8'x8' Conc. Box Structure #1
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 468 Culvert Beneath US 31 Upstream end is a 9' CMP but after17' it c
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 468 Culvert Beneath US 31 Upstream end is a 9' CMP but after17' it c
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 387 Cross Sec #2 Downstream of 8'x8' Concrete Box - Structure #1
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Ineff
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 355 Copied Cross Sec #2 - 32' Downstream of 8'x8' Concrete Box - Str
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta


H.G. Kenyon Drain
River = HG Kenyan Reach = HG Kenyan RS = 016 Cross Sec #1 Confluence to Cool Creek
.1
.04
.1
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
WS 2 Yr
Ground
Bank Sta

HEC-RAS Plan: Exst. Cond. River: HG Kenyan Reach: HG Kenyan

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
HG Kenyan	8172	104.00	886.68	890.44		890.46	0.000179	1.24	122.86	77.35	0.12
HG Kenyan	8172	58.00	886.68	889.45		889.47	0.000332	1.34	59.60	51.42	0.15
HG Kenyan	8172	48.00	886.68	889.22		889.24	0.000364	1.31	48.65	43.97	0.16
HG Kenyan	8172	37.00	886.68	888.96		888.98	0.000397	1.25	37.85	37.69	0.16
HG Kenyan	8172	22.00	886.68	888.52		888.54	0.000457	1.12	23.29	29.63	0.17
HG Kenyan	8165	104.00	886.64	890.15	888.67	890.39	0.001972	3.91	26.65	69.79	0.39
HG Kenyan	8165	58.00	886.64	889.29	888.13	889.43	0.001769	2.99	19.39	47.54	0.35
HG Kenyan	8165	48.00	886.64	889.10	887.99	889.21	0.001638	2.71	17.71	41.14	0.33
HG Kenyan	8165	37.00	886.64	888.87	887.83	888.95	0.001441	2.35	15.74	36.73	0.30
HG Kenyan	8165	22.00	886.64	888.48	887.57	888.53	0.001111	1.77	12.45	29.52	0.26
HG Kenyan	8149	Culvert									
HG Kenyan	8133	104.00	886.85	889.58	889.16	890.12	0.007919	5.89	17.65	15.68	0.72
HG Kenyan	8133	58.00	886.85	888.98	888.63	889.31	0.007690	4.62	12.54	11.73	0.67
HG Kenyan	8133	48.00	886.85	888.83	888.49	889.11	0.007428	4.24	11.31	10.86	0.65
HG Kenyan	8133	37.00	886.85	888.66	888.32	888.88	0.006971	3.75	9.86	10.03	0.61
HG Kenyan	8133	22.00	886.85	888.34	888.02	888.49	0.006699	3.06	7.19	8.49	0.58
HG Kenyan	8107	104.00	886.69	889.49	889.03	889.85	0.005841	4.99	22.94	16.14	0.62
HG Kenyan	8107	58.00	886.69	888.77		889.09	0.008870	4.59	12.98	11.40	0.70
HG Kenyan	8107	48.00	886.69	888.61		888.90	0.009047	4.34	11.28	10.57	0.70
HG Kenyan	8107	37.00	886.69	888.42		888.67	0.009060	3.99	9.35	9.64	0.69
HG Kenyan	8107	22.00	886.69	888.08		888.27	0.009884	3.47	6.34	8.01	0.69
HG Kenyan	7932.33*	104.00	885.20	887.53	887.49	888.18	0.017499	6.48	16.27	13.01	0.95
HG Kenyan	7932.33*	58.00	885.20	887.41	886.98	887.65	0.007381	3.96	14.70	12.02	0.61
HG Kenyan	7932.33*	48.00	885.20	887.28	886.84	887.49	0.007016	3.64	13.21	11.18	0.58
HG Kenyan	7932.33*	37.00	885.20	887.06		887.24	0.007182	3.39	10.90	10.24	0.58
HG Kenyan	7932.33*	22.00	885.20	886.74		886.86	0.006489	2.83	7.78	8.97	0.53
HG Kenyan	7757.66*	104.00	883.71	887.27		887.36	0.001591	2.72	55.59	57.34	0.30
HG Kenyan	7757.66*	58.00	883.71	885.77	885.48	886.07	0.011257	4.43	13.08	10.96	0.72
HG Kenyan	7757.66*	48.00	883.71	885.56	885.34	885.86	0.012679	4.39	10.93	10.22	0.75
HG Kenyan	7757.66*	37.00	883.71	885.39	885.16	885.64	0.012044	4.00	9.24	9.59	0.72
HG Kenyan	7757.66*	22.00	883.71	885.03	884.88	885.24	0.014138	3.65	6.03	8.20	0.75
HG Kenyan	7583	104.00	882.22	887.26		887.27	0.000156	1.06	171.07	100.64	0.10
HG Kenyan	7583	58.00	882.22	885.42		885.48	0.001359	2.00	35.59	51.63	0.25
HG Kenyan	7583	48.00	882.22	884.87		884.96	0.002520	2.38	20.29	13.65	0.33
HG Kenyan	7583	37.00	882.22	884.38		884.49	0.003931	2.58	14.33	11.25	0.40
HG Kenyan	7583	22.00	882.22	883.96		884.04	0.003858	2.22	9.90	9.72	0.39
HG Kenyan	7576	104.00	882.18	887.13	884.46	887.24	0.000883	2.71	38.33	108.60	0.23
HG Kenyan	7576	58.00	882.18	885.35	883.91	885.45	0.001663	2.60	22.33	50.79	0.29
HG Kenyan	7576	48.00	882.18	884.81	883.77	884.93	0.002579	2.75	17.47	13.52	0.35
HG Kenyan	7576	37.00	882.18	884.33	883.61	884.45	0.003797	2.80	13.19	11.21	0.41
HG Kenyan	7576	22.00	882.18	883.93	883.33	884.01	0.003450	2.26	9.72	9.75	0.37
HG Kenyan	7549	Culvert									
HG Kenyan	7521	104.00	882.63	886.65	884.50	886.80	0.001264	3.09	33.80	77.71	0.28
HG Kenyan	7521	58.00	882.63	885.13	883.98	885.26	0.002217	2.90	20.10	24.28	0.34
HG Kenyan	7521	48.00	882.63	884.60	883.85	884.75	0.003698	3.13	15.38	16.17	0.42
HG Kenyan	7521	37.00	882.63	884.16	883.70	884.32	0.005986	3.26	11.38	12.36	0.51
HG Kenyan	7521	22.00	882.63	883.84	883.44	883.94	0.005607	2.60	8.48	9.91	0.47
HG Kenyan	7493	104.00	882.46	886.69		886.72	0.000388	1.76	120.20	94.69	0.16
HG Kenyan	7493	58.00	882.46	885.10		885.18	0.001383	2.36	32.36	28.59	0.27
HG Kenyan	7493	48.00	882.46	884.53		884.64	0.002704	2.74	20.17	17.05	0.36
HG Kenyan	7493	37.00	882.46	883.53	883.53	883.93	0.026756	5.10	7.27	9.30	1.00
HG Kenyan	7493	22.00	882.46	883.27	883.27	883.57	0.029716	4.43	4.97	8.30	1.01
HG Kenyan	7181	104.00	877.73	886.69		886.69	0.000023	0.59	332.36	100.69	0.04
HG Kenyan	7181	58.00	877.73	885.13		885.13	0.000025	0.53	195.41	75.52	0.04
HG Kenyan	7181	48.00	877.73	884.58		884.58	0.000029	0.53	156.16	66.75	0.04
HG Kenyan	7181	37.00	877.73	882.87		882.88	0.000124	0.85	63.65	41.26	0.08
HG Kenyan	7181	22.00	877.73	881.20		881.22	0.000448	1.13	19.77	10.50	0.14

HEC-RAS Plan: Exst. Cond. River: HG Kenyan Reach: HG Kenyan (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
HG Kenyan	7178	104.00	877.71	886.68	880.76	886.69	0.000117	1.05	193.27	100.75	0.08
HG Kenyan	7178	58.00	877.71	885.11	879.95	885.13	0.000299	1.33	73.46	75.35	0.12
HG Kenyan	7178	48.00	877.71	884.54	879.74	884.57	0.000504	1.55	40.52	66.34	0.15
HG Kenyan	7178	37.00	877.71	882.81	879.49	882.86	0.000347	1.79	20.68	40.74	0.15
HG Kenyan	7178	22.00	877.71	881.17	879.12	881.22	0.000534	1.65	13.30	10.46	0.17
HG Kenyan	7166	Culvert									
HG Kenyan	7155	104.00	877.67	880.73	880.73	882.02	0.020217	9.10	11.43	11.07	1.01
HG Kenyan	7155	58.00	877.67	879.98	879.91	880.79	0.020501	7.23	8.02	7.31	0.95
HG Kenyan	7155	48.00	877.67	879.84	879.71	880.49	0.018319	6.48	7.41	6.98	0.89
HG Kenyan	7155	37.00	877.67	879.71	879.47	880.16	0.014390	5.43	6.81	6.67	0.78
HG Kenyan	7155	22.00	877.67	879.45	879.09	879.69	0.009400	3.88	5.66	6.05	0.61
HG Kenyan	7145	104.00	877.61	881.02	880.49	881.46	0.009775	5.42	20.79	13.84	0.65
HG Kenyan	7145	58.00	877.61	879.82	879.82	880.47	0.027771	6.46	8.98	7.08	1.01
HG Kenyan	7145	48.00	877.61	879.64	879.64	880.24	0.028372	6.20	7.75	6.65	1.01
HG Kenyan	7145	37.00	877.61	879.42	879.42	879.95	0.029126	5.84	6.34	6.12	1.01
HG Kenyan	7145	22.00	877.61	879.37		879.58	0.011680	3.63	6.05	6.01	0.64
HG Kenyan	6864	200.00	874.45	877.62		878.18	0.012849	7.43	45.92	37.51	0.78
HG Kenyan	6864	86.00	874.45	877.13	876.76	877.38	0.006371	4.61	29.50	30.15	0.53
HG Kenyan	6864	75.00	874.45	877.01	876.64	877.25	0.006350	4.44	25.94	27.88	0.53
HG Kenyan	6864	61.00	874.45	876.85	876.43	877.06	0.006103	4.13	21.65	24.87	0.51
HG Kenyan	6864	35.00	874.45	876.18		876.44	0.010796	4.22	9.19	11.90	0.64
HG Kenyan	6660.66*	200.00	872.49	877.46		877.52	0.000992	2.85	135.57	68.28	0.24
HG Kenyan	6660.66*	86.00	872.49	874.83	874.83	875.40	0.016147	6.50	17.85	19.88	0.82
HG Kenyan	6660.66*	75.00	872.49	874.70	874.70	875.25	0.016472	6.27	15.47	17.53	0.82
HG Kenyan	6660.66*	61.00	872.49	874.49	874.49	875.03	0.018424	6.10	12.04	14.32	0.85
HG Kenyan	6660.66*	35.00	872.49	874.41	873.92	874.61	0.007487	3.75	10.91	13.08	0.54
HG Kenyan	6457.33*	200.00	870.54	877.45		877.46	0.000129	1.29	308.14	101.79	0.09
HG Kenyan	6457.33*	86.00	870.54	874.41		874.46	0.001063	2.43	66.61	53.79	0.23
HG Kenyan	6457.33*	75.00	870.54	874.05		874.12	0.001459	2.64	49.48	41.12	0.27
HG Kenyan	6457.33*	61.00	870.54	873.51		873.63	0.002572	3.09	30.61	29.83	0.34
HG Kenyan	6457.33*	35.00	870.54	872.27		872.59	0.013715	4.55	8.22	9.95	0.71
HG Kenyan	6254	200.00	868.58	877.45		877.45	0.000019	0.59	669.21	158.02	0.04
HG Kenyan	6254	86.00	868.58	874.42		874.42	0.000043	0.65	265.54	108.09	0.05
HG Kenyan	6254	75.00	868.58	874.06		874.06	0.000049	0.66	228.30	102.26	0.05
HG Kenyan	6254	61.00	868.58	873.56		873.56	0.000061	0.69	178.76	93.67	0.06
HG Kenyan	6254	35.00	868.58	872.38		872.39	0.000152	0.89	80.76	73.67	0.09
HG Kenyan	6252	200.00	868.58	877.45	872.20	877.45	0.000004	0.27	1392.50	300.00	0.02
HG Kenyan	6252	86.00	868.58	874.42	871.70	874.42	0.000015	0.36	524.18	247.21	0.03
HG Kenyan	6252	75.00	868.58	874.06	871.60	874.06	0.000019	0.38	438.75	235.41	0.03
HG Kenyan	6252	61.00	868.58	873.56	870.76	873.56	0.000029	0.44	324.00	218.56	0.04
HG Kenyan	6252	35.00	868.58	872.39	870.16	872.39	0.000169	0.85	102.85	140.59	0.09
HG Kenyan	6245	Culvert									
HG Kenyan	6237	200.00	869.05	872.92	872.39	872.98	0.002188	3.24	160.87	189.92	0.33
HG Kenyan	6237	86.00	869.05	872.19	871.89	872.28	0.002629	3.16	61.40	96.12	0.36
HG Kenyan	6237	75.00	869.05	872.05	871.85	872.15	0.002865	3.17	49.25	78.25	0.37
HG Kenyan	6237	61.00	869.05	871.72	871.62	871.89	0.004823	3.71	27.43	52.78	0.47
HG Kenyan	6237	35.00	869.05	870.79	870.71	871.39	0.020747	6.22	5.63	9.31	0.92
HG Kenyan	6229	200.00	869.00	872.41	872.41	872.84	0.010594	6.80	88.42	112.84	0.73
HG Kenyan	6229	86.00	869.00	871.57	871.57	872.11	0.014790	6.28	22.89	40.40	0.81
HG Kenyan	6229	75.00	869.00	871.33	871.33	871.94	0.019849	6.62	16.12	19.93	0.91
HG Kenyan	6229	61.00	869.00	871.18	871.18	871.71	0.018999	6.08	13.36	17.49	0.88
HG Kenyan	6229	35.00	869.00	870.66	870.66	871.15	0.025495	5.64	6.64	8.57	0.97
HG Kenyan	6150	200.00	867.65	871.27		871.40	0.003452	4.19	88.71	62.06	0.41
HG Kenyan	6150	86.00	867.65	870.15		870.30	0.004851	3.77	33.95	29.05	0.45
HG Kenyan	6150	75.00	867.65	869.98		870.11	0.004862	3.57	29.48	22.69	0.45
HG Kenyan	6150	61.00	867.65	869.76		869.88	0.004771	3.27	25.12	19.10	0.43
HG Kenyan	6150	35.00	867.65	869.29		869.37	0.004883	2.70	16.81	16.12	0.42

HEC-RAS Plan: Exst. Cond. River: HG Kenyan Reach: HG Kenyan (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
HG Kenyan	5911.66*	200.00	866.22	870.15		870.43	0.004731	5.24	61.90	35.55	0.49
HG Kenyan	5911.66*	86.00	866.22	868.90		869.10	0.005069	4.07	28.63	19.32	0.47
HG Kenyan	5911.66*	75.00	866.22	868.76		868.94	0.005012	3.87	25.91	18.54	0.46
HG Kenyan	5911.66*	61.00	866.22	868.56	867.96	868.72	0.004913	3.60	22.31	17.46	0.45
HG Kenyan	5911.66*	35.00	866.22	868.10	867.55	868.21	0.004812	2.97	14.78	15.04	0.43
HG Kenyan	5673.33*	200.00	864.78	868.80		869.20	0.005499	5.72	49.82	26.97	0.53
HG Kenyan	5673.33*	86.00	864.78	867.43		867.72	0.006577	4.55	22.89	16.27	0.54
HG Kenyan	5673.33*	75.00	864.78	867.25		867.53	0.006952	4.42	20.07	15.49	0.54
HG Kenyan	5673.33*	61.00	864.78	867.01		867.27	0.007582	4.24	16.38	14.33	0.56
HG Kenyan	5673.33*	35.00	864.78	866.44		866.66	0.009314	3.74	9.45	8.79	0.59
HG Kenyan	5435	200.00	863.35	867.91	866.43	868.20	0.003141	4.71	55.11	52.03	0.41
HG Kenyan	5435	86.00	863.35	866.64	865.25	866.79	0.002441	3.25	30.91	16.52	0.34
HG Kenyan	5435	75.00	863.35	866.46	865.11	866.60	0.002376	3.07	28.03	15.82	0.33
HG Kenyan	5435	61.00	863.35	866.21	864.91	866.32	0.002295	2.82	24.12	14.81	0.32
HG Kenyan	5435	35.00	863.35	865.58	864.49	865.66	0.002251	2.28	15.63	11.63	0.30
HG Kenyan	5169	200.00	862.22	867.02	865.92	867.28	0.003767	4.58	79.33	123.36	0.41
HG Kenyan	5169	86.00	862.22	865.95	864.43	866.09	0.002801	3.17	32.58	21.92	0.34
HG Kenyan	5169	75.00	862.22	865.79	864.28	865.92	0.002684	3.02	29.25	20.88	0.33
HG Kenyan	5169	61.00	862.22	865.57	864.08	865.68	0.002504	2.81	24.70	19.38	0.32
HG Kenyan	5169	35.00	862.22	865.06	863.64	865.13	0.001728	2.11	16.83	8.98	0.26
HG Kenyan	5119	200.00	863.12	866.87		867.12	0.002933	4.47	56.41	28.29	0.43
HG Kenyan	5119	86.00	863.12	865.82		865.96	0.002494	3.23	31.21	20.22	0.37
HG Kenyan	5119	75.00	863.12	865.66		865.80	0.002469	3.07	28.23	19.21	0.36
HG Kenyan	5119	61.00	863.12	865.44		865.56	0.002468	2.86	24.15	17.73	0.36
HG Kenyan	5119	35.00	863.12	864.95		865.03	0.002366	2.32	16.23	14.43	0.33
HG Kenyan	5103	200.00	863.02	866.84		867.07	0.002684	4.34	58.46	28.99	0.41
HG Kenyan	5103	86.00	863.02	865.79		865.92	0.002192	3.09	32.79	20.74	0.35
HG Kenyan	5103	75.00	863.02	865.64		865.76	0.002156	2.94	29.72	19.72	0.34
HG Kenyan	5103	61.00	863.02	865.42		865.52	0.002132	2.73	25.52	18.24	0.33
HG Kenyan	5103	35.00	863.02	864.93		865.00	0.001978	2.19	17.34	14.93	0.31
HG Kenyan	5062	200.00	862.71	866.53	865.79	866.89	0.005045	5.27	43.04	26.54	0.51
HG Kenyan	5062	86.00	862.71	865.59	864.98	865.78	0.004278	3.88	26.22	20.36	0.44
HG Kenyan	5062	75.00	862.71	865.44	864.89	865.62	0.004393	3.76	23.59	19.40	0.45
HG Kenyan	5062	61.00	862.71	865.20	864.72	865.38	0.004814	3.65	19.69	17.89	0.46
HG Kenyan	5062	35.00	862.71	864.67	864.18	864.84	0.006305	3.38	11.57	13.96	0.50
HG Kenyan	5042	Bridge									
HG Kenyan	4998	200.00	862.31	865.87	865.39	866.33	0.007237	5.98	38.42	24.84	0.60
HG Kenyan	4998	86.00	862.31	865.35	864.58	865.50	0.003164	3.48	29.09	21.41	0.39
HG Kenyan	4998	75.00	862.31	865.20	864.49	865.35	0.003169	3.35	26.47	20.45	0.38
HG Kenyan	4998	61.00	862.31	864.96	864.32	865.10	0.003384	3.22	22.35	18.94	0.39
HG Kenyan	4998	35.00	862.31	864.39	863.78	864.52	0.004479	3.01	13.32	15.22	0.42
HG Kenyan	4654	300.00	859.58	863.57	863.42	863.93	0.006700	5.79	125.71	121.91	0.57
HG Kenyan	4654	159.00	859.58	862.72	862.20	863.26	0.010707	5.97	34.84	61.14	0.68
HG Kenyan	4654	138.00	859.58	862.53	861.99	863.05	0.011314	5.80	24.87	24.17	0.69
HG Kenyan	4654	112.00	859.58	862.22	861.73	862.69	0.011774	5.49	20.40	10.53	0.70
HG Kenyan	4654	53.00	859.58	861.25	860.99	861.60	0.014602	4.77	11.11	8.68	0.74
HG Kenyan	4229	300.00	857.14	861.83		862.05	0.002975	4.86	159.47	97.26	0.41
HG Kenyan	4229	159.00	857.14	860.90		861.08	0.002783	4.02	84.99	65.59	0.38
HG Kenyan	4229	138.00	857.14	860.74		860.91	0.002623	3.78	75.17	60.55	0.36
HG Kenyan	4229	112.00	857.14	860.54		860.69	0.002335	3.42	63.51	53.97	0.34
HG Kenyan	4229	53.00	857.14	859.85		859.93	0.001675	2.45	31.97	38.76	0.28
HG Kenyan	4204	300.00	856.99	861.43	860.58	861.88	0.005351	6.27	81.79	86.18	0.54
HG Kenyan	4204	159.00	856.99	860.76	859.71	860.99	0.003193	4.31	61.30	65.93	0.41
HG Kenyan	4204	138.00	856.99	860.63	859.52	860.83	0.002823	3.95	57.44	61.84	0.38
HG Kenyan	4204	112.00	856.99	860.46	859.07	860.62	0.002341	3.48	52.16	56.25	0.34
HG Kenyan	4204	53.00	856.99	859.81	858.32	859.88	0.001406	2.31	32.58	40.65	0.26
HG Kenyan	4150	Bridge									

HEC-RAS Plan: Exst. Cond. River: HG Kenyan Reach: HG Kenyan (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
HG Kenyan	4096	300.00	855.43	860.04	857.98	860.24	0.001780	3.77	100.95	54.91	0.32
HG Kenyan	4096	159.00	855.43	858.96	857.21	859.07	0.001472	2.81	68.00	43.83	0.28
HG Kenyan	4096	138.00	855.43	858.76	857.08	858.86	0.001403	2.63	62.00	41.04	0.27
HG Kenyan	4096	112.00	855.43	858.48	856.90	858.57	0.001322	2.39	53.66	37.20	0.26
HG Kenyan	4096	53.00	855.43	857.71	856.42	857.75	0.000931	1.64	35.19	24.47	0.21
HG Kenyan	3996	300.00	856.03	858.51	858.51	859.55	0.021432	8.32	40.48	34.97	1.01
HG Kenyan	3996	159.00	856.03	857.82	857.82	858.52	0.022346	6.71	23.98	21.38	0.99
HG Kenyan	3996	138.00	856.03	857.69	857.69	858.33	0.023342	6.45	21.48	18.85	1.00
HG Kenyan	3996	112.00	856.03	857.52	857.52	858.08	0.023873	6.00	18.66	16.32	0.99
HG Kenyan	3996	53.00	856.03	857.03	857.03	857.39	0.027152	4.83	10.98	15.03	0.99
HG Kenyan	3542	300.00	849.01	855.60		855.63	0.000229	1.73	220.68	83.80	0.12
HG Kenyan	3542	159.00	849.01	853.77		853.84	0.000694	2.36	79.72	37.85	0.20
HG Kenyan	3542	138.00	849.01	853.37		853.45	0.000809	2.38	66.20	31.23	0.22
HG Kenyan	3542	112.00	849.01	852.67		852.76	0.001253	2.58	47.49	23.57	0.26
HG Kenyan	3542	53.00	849.01	851.33		851.46	0.003379	2.88	19.46	17.35	0.39
HG Kenyan	3536	300.00	848.97	855.59	852.44	855.63	0.000295	1.93	202.68	83.80	0.14
HG Kenyan	3536	159.00	848.97	853.67	851.66	853.81	0.001377	3.19	57.63	36.41	0.28
HG Kenyan	3536	138.00	848.97	853.29	851.51	853.41	0.001165	2.87	48.24	30.58	0.26
HG Kenyan	3536	112.00	848.97	852.60	851.25	852.74	0.001713	3.04	37.84	23.46	0.31
HG Kenyan	3536	53.00	848.97	851.28	850.43	851.42	0.003788	3.09	17.77	17.14	0.41
HG Kenyan	3514	Culvert									
HG Kenyan	3492	300.00	848.99	852.83	851.74	853.37	0.004411	5.67	51.27	31.52	0.52
HG Kenyan	3492	159.00	848.99	851.71	850.97	852.04	0.004811	4.65	34.19	22.32	0.51
HG Kenyan	3492	138.00	848.99	851.42	850.85	851.75	0.005724	4.68	29.80	20.98	0.55
HG Kenyan	3492	112.00	848.99	851.07	850.67	851.40	0.007137	4.68	24.55	19.57	0.59
HG Kenyan	3492	53.00	848.99	850.48	850.06	850.67	0.006881	3.60	15.50	16.49	0.55
HG Kenyan	3467	300.00	848.84	852.87		853.14	0.002882	4.61	75.04	35.25	0.42
HG Kenyan	3467	159.00	848.84	851.66		851.89	0.003589	3.98	42.44	22.81	0.44
HG Kenyan	3467	138.00	848.84	851.33		851.58	0.004630	4.14	35.27	21.25	0.48
HG Kenyan	3467	112.00	848.84	850.92		851.20	0.006902	4.42	26.77	19.55	0.57
HG Kenyan	3467	53.00	848.84	850.17		850.42	0.011405	4.08	13.55	15.98	0.68
HG Kenyan	3307	484.00	846.86	852.06		852.51	0.004645	5.67	97.78	56.43	0.51
HG Kenyan	3307	246.00	846.86	851.04		851.31	0.003508	4.24	60.06	26.23	0.43
HG Kenyan	3307	203.00	846.86	850.70		850.95	0.003529	4.00	51.78	23.15	0.43
HG Kenyan	3307	151.00	846.86	850.27		850.47	0.003369	3.57	42.48	19.59	0.41
HG Kenyan	3307	85.00	846.86	849.51		849.64	0.003106	2.91	29.23	16.04	0.38
HG Kenyan	2825	484.00	845.19	849.83		850.20	0.004878	5.63	186.08	161.75	0.52
HG Kenyan	2825	246.00	845.19	848.97		849.31	0.004993	4.80	74.89	86.88	0.51
HG Kenyan	2825	203.00	845.19	848.68		848.97	0.004813	4.44	59.53	46.85	0.49
HG Kenyan	2825	151.00	845.19	848.30		848.55	0.004764	4.04	43.38	37.25	0.48
HG Kenyan	2825	85.00	845.19	847.64		847.81	0.004707	3.30	25.74	16.08	0.46
HG Kenyan	2600.60*	484.00	844.24	848.75		849.12	0.004756	5.49	182.65	161.79	0.52
HG Kenyan	2600.60*	246.00	844.24	847.89		848.20	0.004809	4.61	71.27	70.08	0.50
HG Kenyan	2600.60*	203.00	844.24	847.62		847.90	0.004741	4.31	57.08	46.98	0.49
HG Kenyan	2600.60*	151.00	844.24	847.25		847.48	0.004699	3.89	41.75	35.46	0.48
HG Kenyan	2600.60*	85.00	844.24	846.60		846.76	0.004639	3.20	26.58	17.61	0.46
HG Kenyan	2376.20*	484.00	843.30	847.65	847.23	848.02	0.004956	5.47	174.24	160.11	0.53
HG Kenyan	2376.20*	246.00	843.30	846.83	845.88	847.13	0.004733	4.47	68.88	73.25	0.50
HG Kenyan	2376.20*	203.00	843.30	846.57	845.65	846.83	0.004694	4.17	55.14	46.80	0.49
HG Kenyan	2376.20*	151.00	843.30	846.20	845.34	846.42	0.004685	3.76	40.78	29.57	0.48
HG Kenyan	2376.20*	85.00	843.30	845.55	844.81	845.70	0.004734	3.15	27.02	18.86	0.46
HG Kenyan	2151.80*	484.00	842.35	846.83	846.12	847.09	0.003307	4.60	213.43	164.61	0.44
HG Kenyan	2151.80*	246.00	842.35	845.83	844.82	846.10	0.004321	4.21	71.47	88.13	0.48
HG Kenyan	2151.80*	203.00	842.35	845.53	844.60	845.78	0.004648	4.04	53.61	51.94	0.49
HG Kenyan	2151.80*	151.00	842.35	845.16	844.26	845.36	0.004717	3.65	41.32	22.80	0.48
HG Kenyan	2151.80*	85.00	842.35	844.48	843.78	844.64	0.004750	3.14	27.09	19.08	0.46
HG Kenyan	1927.40*	484.00	841.41	845.02	844.95	845.77	0.011680	7.12	92.09	121.95	0.79
HG Kenyan	1927.40*	246.00	841.41	844.32	843.76	844.74	0.008971	5.19	47.41	30.94	0.66

HEC-RAS Plan: Exst. Cond. River: HG Kenyan Reach: HG Kenyan (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
HG Kenyan	1927.40*	203.00	841.41	844.51	843.53	844.74	0.004570	3.89	52.83	46.86	0.48
HG Kenyan	1927.40*	151.00	841.41	844.12	843.21	844.32	0.004564	3.55	42.51	29.19	0.47
HG Kenyan	1927.40*	85.00	841.41	843.42	842.74	843.57	0.004735	3.11	27.33	19.42	0.46
HG Kenyan	1703	484.00	840.46	844.55	843.72	844.66	0.002072	3.35	290.86	161.10	0.34
HG Kenyan	1703	246.00	840.46	843.76	842.69	843.84	0.001892	2.64	172.08	120.84	0.31
HG Kenyan	1703	203.00	840.46	843.63	842.46	843.82	0.003597	3.50	58.30	119.79	0.43
HG Kenyan	1703	151.00	840.46	843.32	842.15	843.46	0.003117	3.06	49.42	81.97	0.39
HG Kenyan	1703	85.00	840.46	842.69	841.69	842.78	0.002620	2.47	34.39	66.40	0.35
HG Kenyan	1522.66*	484.00	839.95	843.80	843.24	844.09	0.004662	4.94	190.90	142.66	0.52
HG Kenyan	1522.66*	246.00	839.95	843.11	842.31	843.33	0.004295	3.95	94.34	110.49	0.47
HG Kenyan	1522.66*	203.00	839.95	842.93	842.11	843.12	0.004205	3.68	77.31	89.56	0.46
HG Kenyan	1522.66*	151.00	839.95	842.66	841.84	842.82	0.004007	3.28	57.43	72.88	0.44
HG Kenyan	1522.66*	85.00	839.95	842.12	841.34	842.23	0.003662	2.68	35.29	32.06	0.41
HG Kenyan	1342.33*	484.00	839.44	842.98		843.21	0.004897	4.85	206.77	132.91	0.53
HG Kenyan	1342.33*	246.00	839.44	842.21		842.42	0.005860	4.21	108.23	116.71	0.55
HG Kenyan	1342.33*	203.00	839.44	842.10		842.27	0.005213	3.81	95.17	108.89	0.51
HG Kenyan	1342.33*	151.00	839.44	841.91		842.05	0.004572	3.30	76.13	89.63	0.47
HG Kenyan	1342.33*	85.00	839.44	841.37		841.46	0.004900	2.62	42.81	37.46	0.45
HG Kenyan	1162	484.00	838.93	842.68		842.74	0.001369	2.77	401.33	177.64	0.29
HG Kenyan	1162	246.00	838.93	841.33		841.43	0.004856	3.44	165.67	164.04	0.49
HG Kenyan	1162	203.00	838.93	841.10		841.21	0.006458	3.55	128.71	151.41	0.55
HG Kenyan	1162	151.00	838.93	840.88		840.98	0.007526	3.40	96.91	139.64	0.57
HG Kenyan	1162	85.00	838.93	840.32		840.38	0.007283	2.32	43.68	34.64	0.51
HG Kenyan	984.666*	484.00	836.90	842.33		842.48	0.001403	3.61	241.30	83.51	0.31
HG Kenyan	984.666*	246.00	836.90	840.50		840.70	0.003377	3.89	97.56	73.28	0.43
HG Kenyan	984.666*	203.00	836.90	839.98		840.20	0.004974	4.04	66.24	46.99	0.50
HG Kenyan	984.666*	151.00	836.90	839.50		839.72	0.006621	4.01	47.36	32.92	0.56
HG Kenyan	984.666*	85.00	836.90	838.92		839.09	0.007267	3.49	29.89	27.70	0.56
HG Kenyan	807.333*	484.00	834.86	842.21		842.31	0.000606	2.83	298.17	83.74	0.20
HG Kenyan	807.333*	246.00	834.86	840.33		840.42	0.000781	2.51	142.18	77.80	0.22
HG Kenyan	807.333*	203.00	834.86	839.74		839.83	0.000962	2.52	101.22	55.23	0.23
HG Kenyan	807.333*	151.00	834.86	839.26		839.33	0.000912	2.22	77.20	46.73	0.22
HG Kenyan	807.333*	85.00	834.86	838.80		838.83	0.000484	1.49	59.15	30.85	0.16
HG Kenyan	630	484.00	832.83	842.20		842.23	0.000190	1.79	639.38	200.00	0.11
HG Kenyan	630	246.00	832.83	840.29		840.33	0.000248	1.70	259.78	172.99	0.12
HG Kenyan	630	203.00	832.83	839.70		839.74	0.000272	1.66	179.00	106.68	0.13
HG Kenyan	630	151.00	832.83	839.22		839.25	0.000221	1.40	135.26	76.54	0.11
HG Kenyan	630	85.00	832.83	838.78		838.79	0.000100	0.89	107.54	49.12	0.07
HG Kenyan	622	484.00	832.88	842.15	837.48	842.18	0.000767	2.71	424.90	200.00	0.21
HG Kenyan	622	246.00	832.88	840.07	835.95	840.28	0.000759	3.63	67.77	148.22	0.25
HG Kenyan	622	203.00	832.88	839.53	835.62	839.70	0.000682	3.26	62.36	98.63	0.23
HG Kenyan	622	151.00	832.88	839.12	835.21	839.23	0.000473	2.59	58.27	73.27	0.19
HG Kenyan	622	85.00	832.88	838.75	834.60	838.78	0.000187	1.56	54.50	50.21	0.12
HG Kenyan	613	Bridge									
HG Kenyan	604	484.00	833.88	842.04	838.14	842.07	0.000200	1.82	683.26	200.00	0.12
HG Kenyan	604	246.00	833.88	839.62	836.61	839.91	0.001361	4.35	56.57	161.75	0.32
HG Kenyan	604	203.00	833.88	839.25	836.29	839.48	0.001163	3.84	52.84	124.23	0.29
HG Kenyan	604	151.00	833.88	838.96	835.88	839.10	0.000777	3.02	49.93	94.92	0.24
HG Kenyan	604	85.00	833.88	838.69	835.27	838.74	0.000296	1.80	47.24	73.03	0.15
HG Kenyan	572	484.00	833.68	842.04		842.07	0.000179	1.75	709.69	200.00	0.11
HG Kenyan	572	246.00	833.68	839.72		839.77	0.000409	2.08	248.04	175.65	0.16
HG Kenyan	572	203.00	833.68	839.31		839.37	0.000419	2.00	184.19	140.89	0.16
HG Kenyan	572	151.00	833.68	838.99		839.03	0.000321	1.67	142.91	112.86	0.14
HG Kenyan	572	85.00	833.68	838.70		838.71	0.000135	1.04	113.63	87.76	0.09
HG Kenyan	557	484.00	833.06	842.05		842.06	0.000039	0.93	1259.35	250.00	0.06
HG Kenyan	557	246.00	833.06	839.75		839.76	0.000049	0.84	684.52	238.75	0.06
HG Kenyan	557	203.00	833.06	839.35		839.35	0.000046	0.78	591.91	220.67	0.06
HG Kenyan	557	151.00	833.06	839.01		839.02	0.000033	0.64	520.76	205.70	0.05

HEC-RAS Plan: Exst. Cond. River: HG Kenyan Reach: HG Kenyan (Continued)

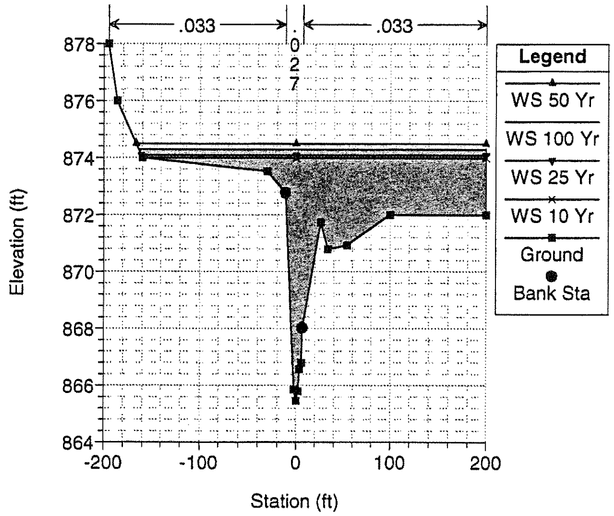
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
HG Kenyan	557	85.00	833.06	838.71		838.71	0.000014	0.39	459.86	191.96	0.03
HG Kenyan	549	484.00	833.01	841.34	837.41	841.89	0.001601	5.98	80.97	250.00	0.37
HG Kenyan	549	246.00	833.01	839.44	835.89	839.68	0.001009	3.97	61.96	225.07	0.28
HG Kenyan	549	203.00	833.01	839.11	835.57	839.30	0.000824	3.46	58.69	210.52	0.25
HG Kenyan	549	151.00	833.01	838.87	835.15	838.98	0.000524	2.68	56.29	199.88	0.20
HG Kenyan	549	85.00	833.01	838.66	834.55	838.70	0.000189	1.57	54.15	190.39	0.12
HG Kenyan	468	Culvert									
HG Kenyan	387	484.00	832.43	838.99	837.39	840.11	0.006117	8.55	57.92	200.00	0.62
HG Kenyan	387	246.00	832.43	838.87	835.86	839.17	0.001695	4.44	56.70	200.00	0.33
HG Kenyan	387	203.00	832.43	838.70	835.52	838.92	0.001270	3.77	55.08	200.00	0.28
HG Kenyan	387	151.00	832.43	838.65	835.08	838.77	0.000727	2.83	54.50	200.00	0.21
HG Kenyan	387	85.00	832.43	838.59	834.38	838.63	0.000239	1.61	53.91	200.00	0.12
HG Kenyan	355	484.00	832.23	839.50		839.53	0.000377	2.28	802.48	400.00	0.16
HG Kenyan	355	246.00	832.23	838.99		839.01	0.000204	1.59	600.23	399.44	0.11
HG Kenyan	355	203.00	832.23	838.79		838.81	0.000188	1.49	521.93	379.33	0.11
HG Kenyan	355	151.00	832.23	838.70		838.71	0.000121	1.18	485.25	369.53	0.09
HG Kenyan	355	85.00	832.23	838.60		838.60	0.000045	0.71	449.79	359.81	0.05
HG Kenyan	016	484.00	830.69	839.50	832.92	839.50	0.000017	0.55	2481.43	511.11	0.03
HG Kenyan	016	246.00	830.69	839.00	832.32	839.00	0.000006	0.31	2229.35	497.22	0.02
HG Kenyan	016	203.00	830.69	838.80	832.15	838.80	0.000005	0.27	2130.45	491.67	0.02
HG Kenyan	016	151.00	830.69	838.70	831.92	838.70	0.000003	0.20	2081.44	488.89	0.01
HG Kenyan	016	85.00	830.69	838.60	831.50	838.60	0.000001	0.12	2032.67	486.11	0.01

J.M. THOMPSON DRAIN

HEC-RAS CROSS-SECTIONS AND PROFILE SUMMARY TABLE

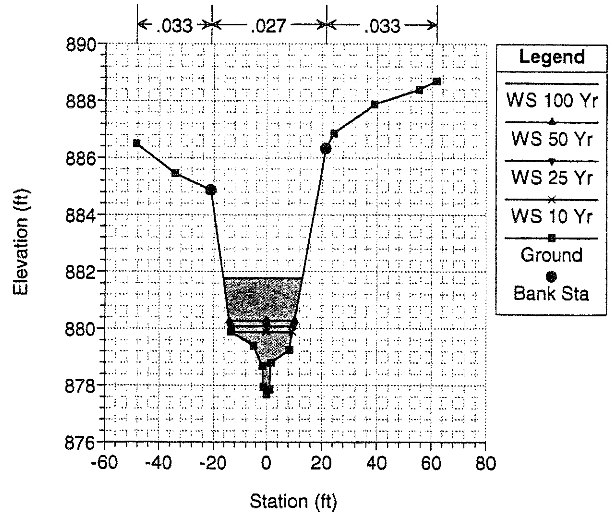
J.M. Thompson Drain

River = JM Thompson Drai   Reach = JM Thompson   RS = 22   Cross Section #1 at mouth to Cool Creek



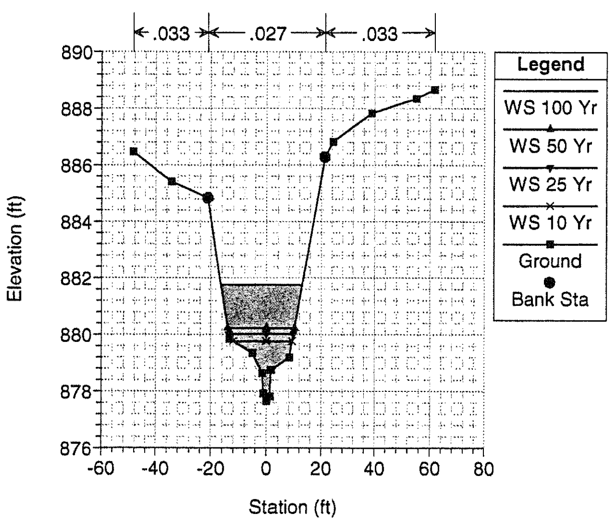
J.M. Thompson Drain

River = JM Thompson Drai   Reach = JM Thompson   RS = 3221   Cross Section #12 - Downstream of 181st Street Culverts - 36" an



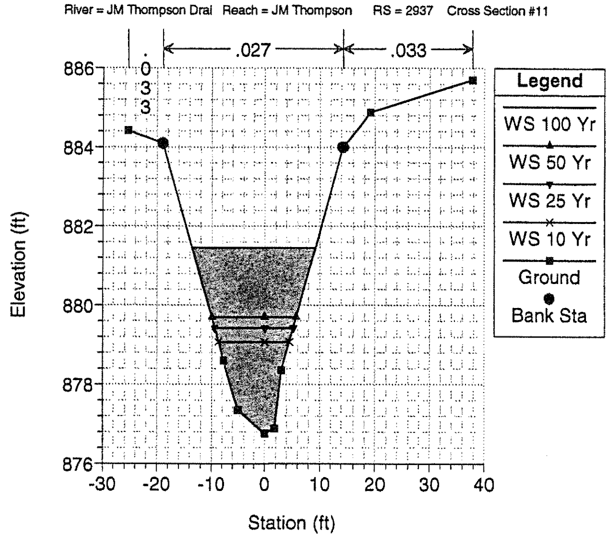
J.M. Thompson Drain

River = JM Thompson Drai   Reach = JM Thompson   RS = 3209   12' Downstream of 161st Street Culverts (copied cross section 32



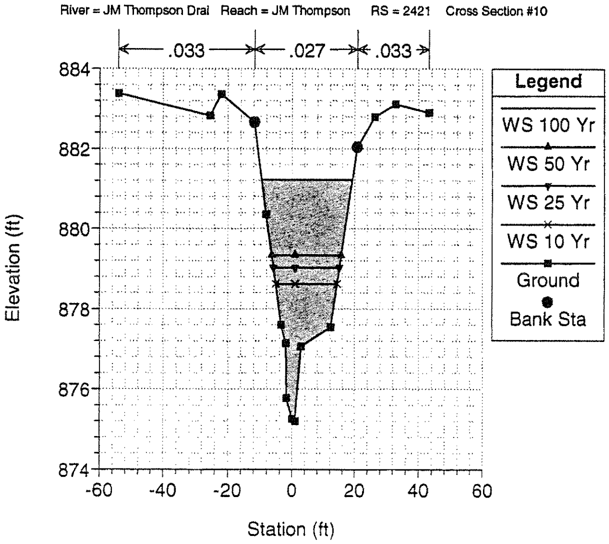
J.M. Thompson Drain

River = JM Thompson Drai   Reach = JM Thompson   RS = 2937   Cross Section #11



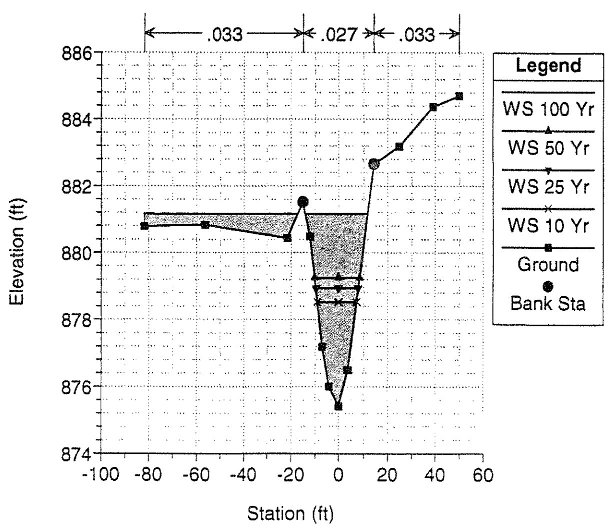
J.M. Thompson Drain

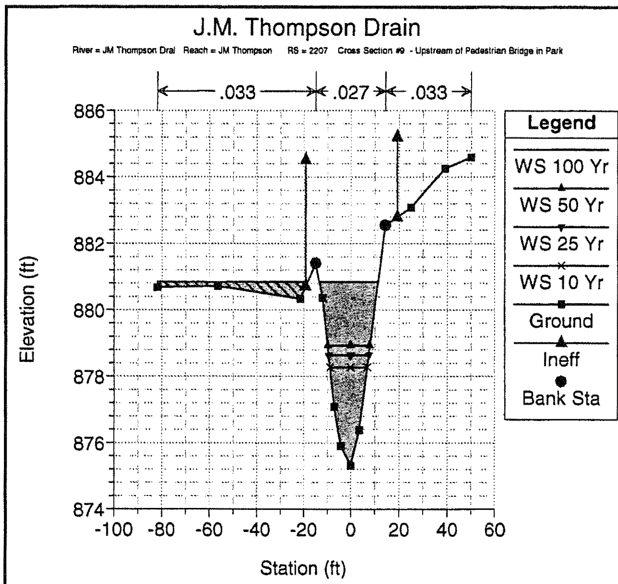
River = JM Thompson Drai   Reach = JM Thompson   RS = 2421   Cross Section #10

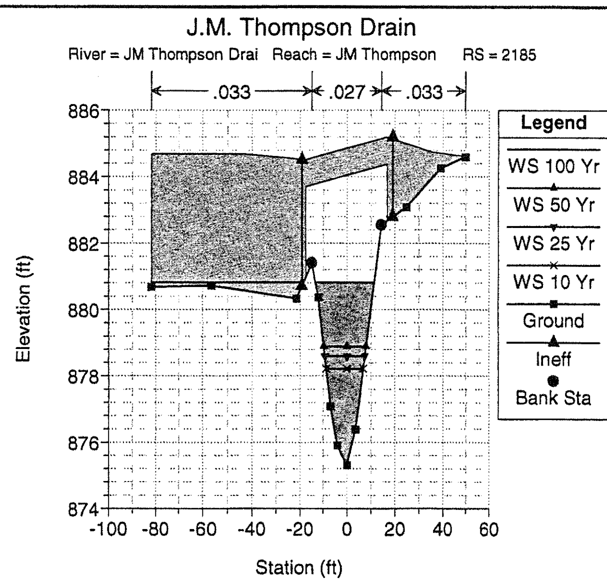


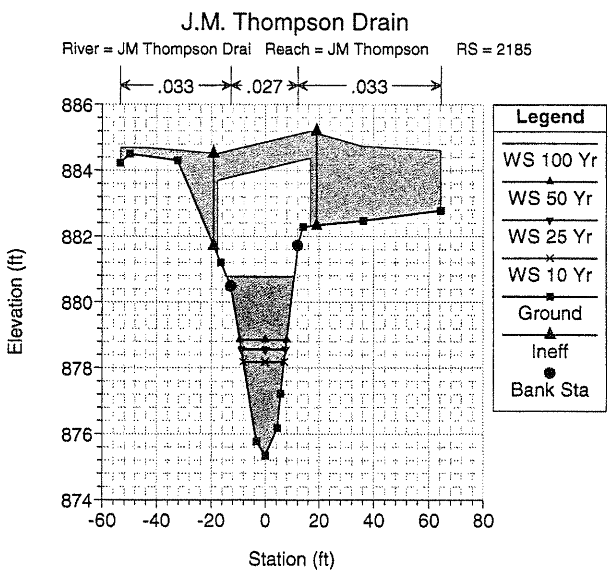
J.M. Thompson Drain

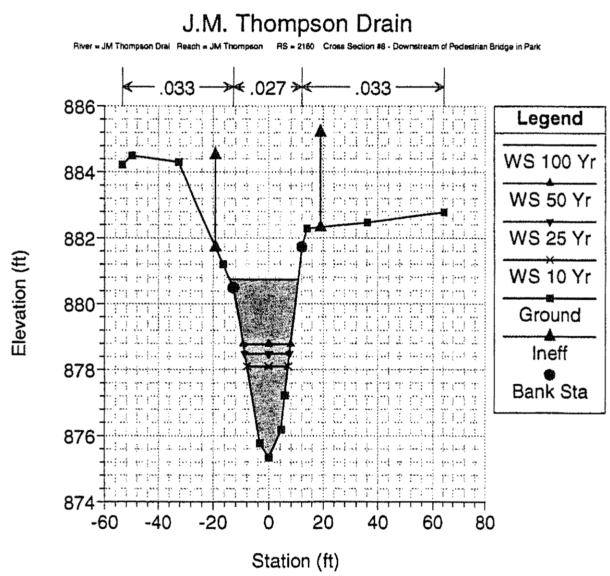
River = JM Thompson Drai   Reach = JM Thompson   RS = 2244   37' Upstream of Pedestrian Bridge in Park (copied cross section

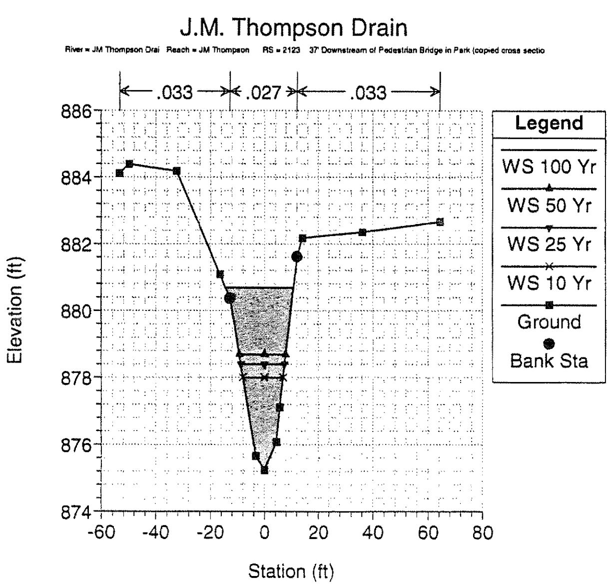


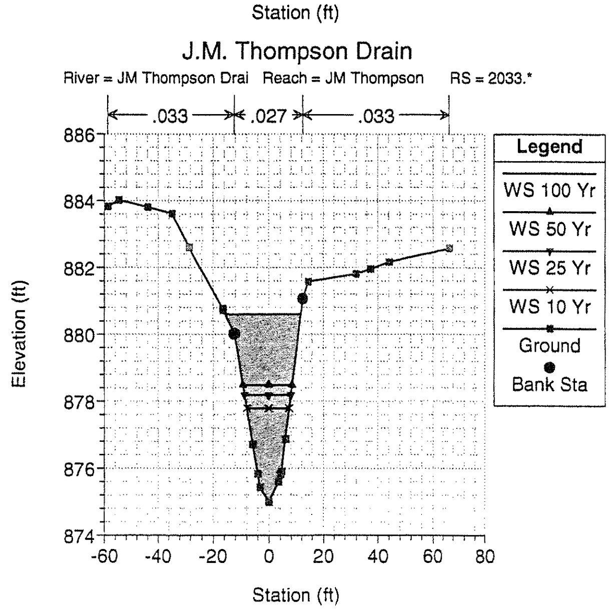

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 2207 Cross Section #9 - Upstream of Pedestrian Bridge in Park
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

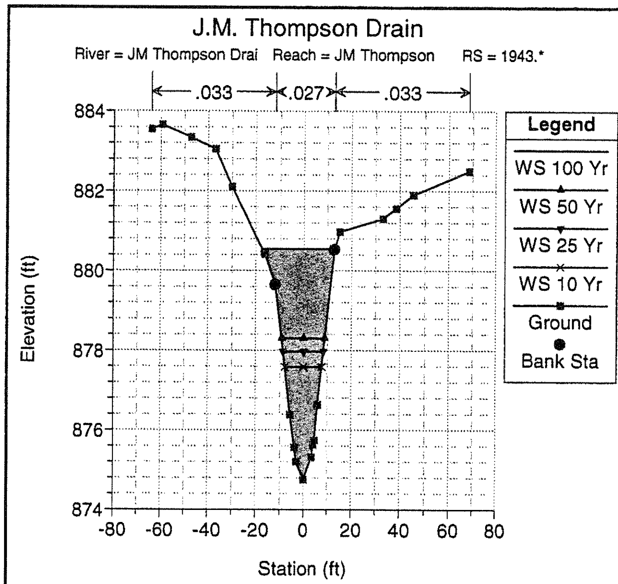

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 2185
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

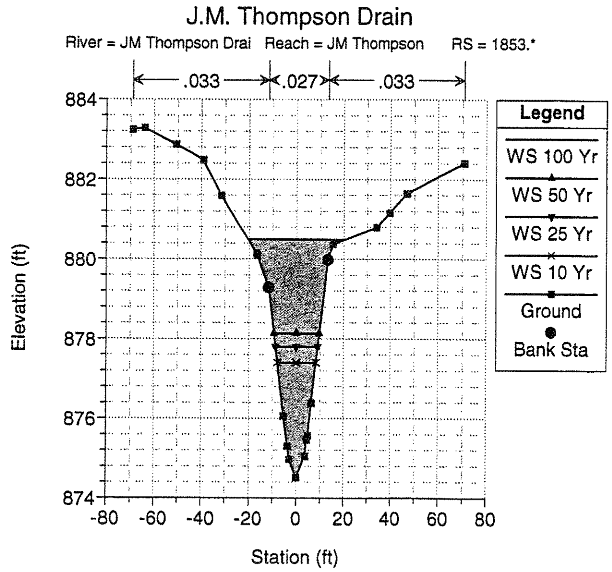

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 2185
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

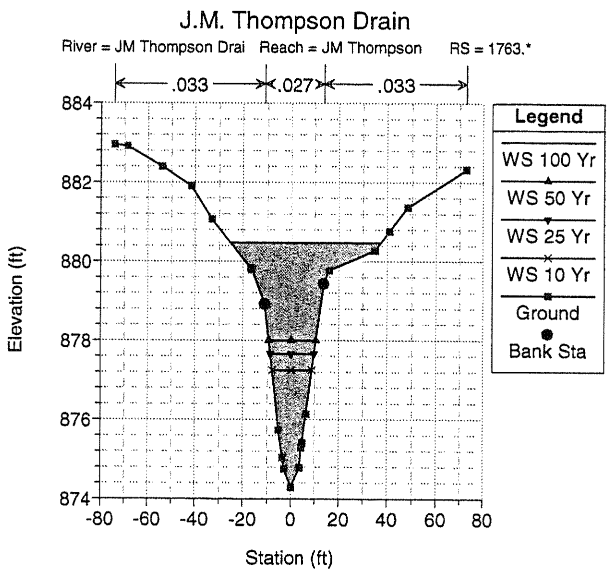

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 2160 Cross Section #8 - Downstream of Pedestrian Bridge in Park
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

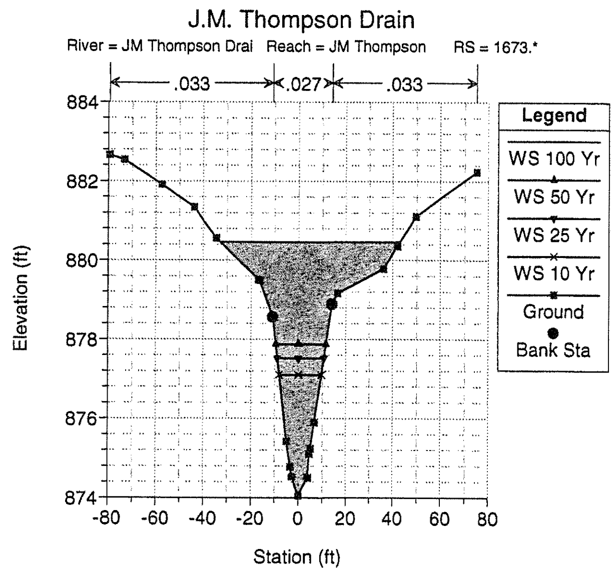

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 2123 37' Downstream of Pedestrian Bridge in Park (copied cross sectio
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

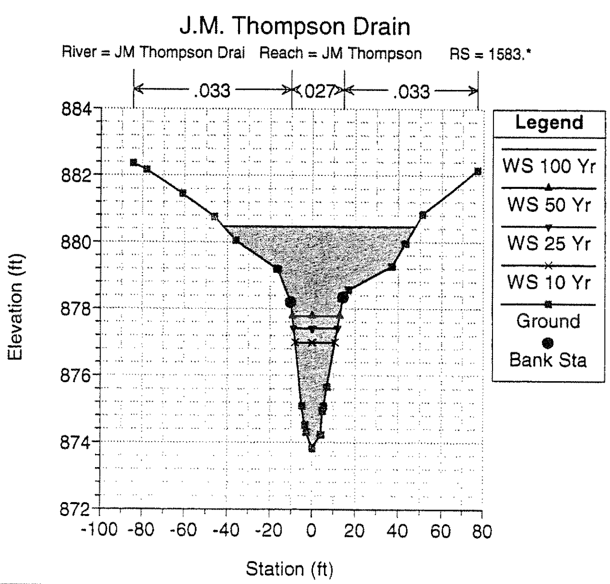

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 2033.*
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

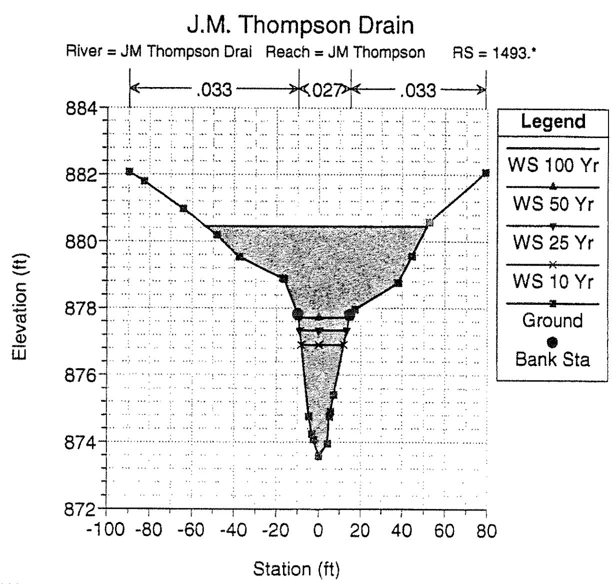

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1943.*
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

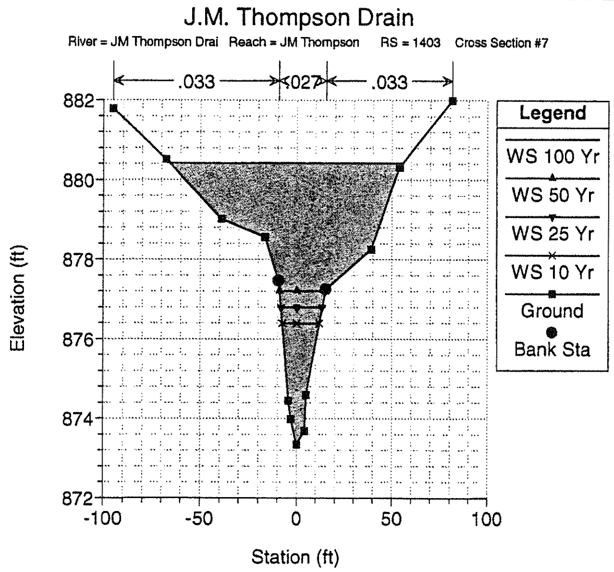

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1853.*
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

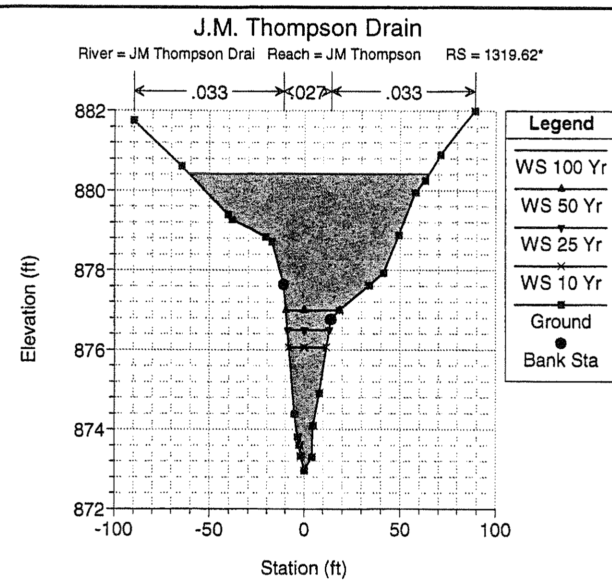

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1763.*
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

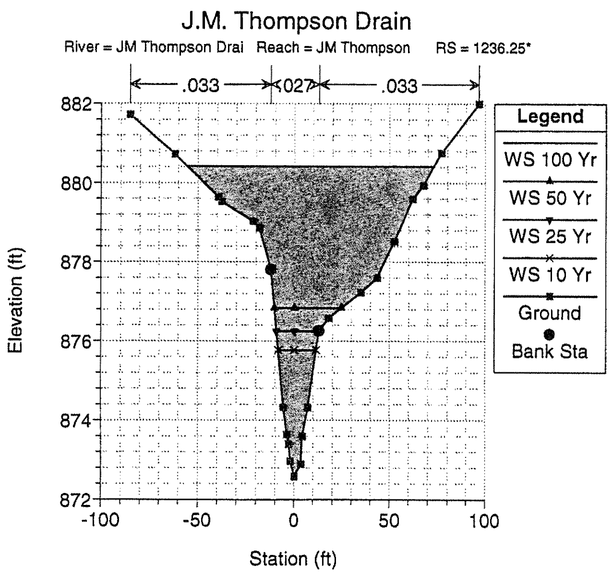

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1673.*
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

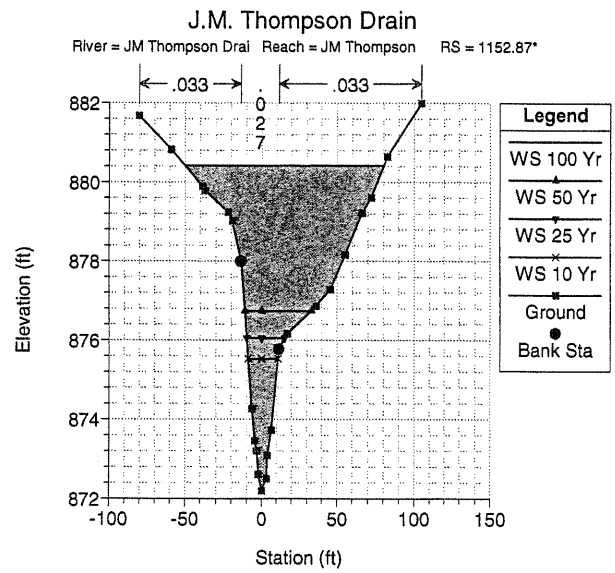

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1583.*
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

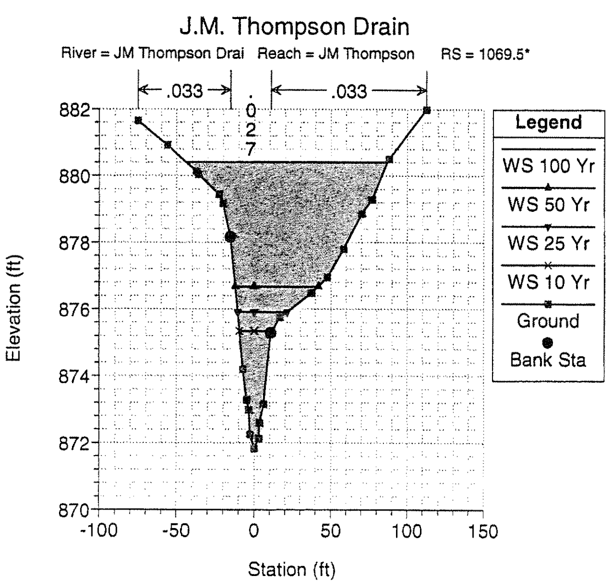

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1493.*
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

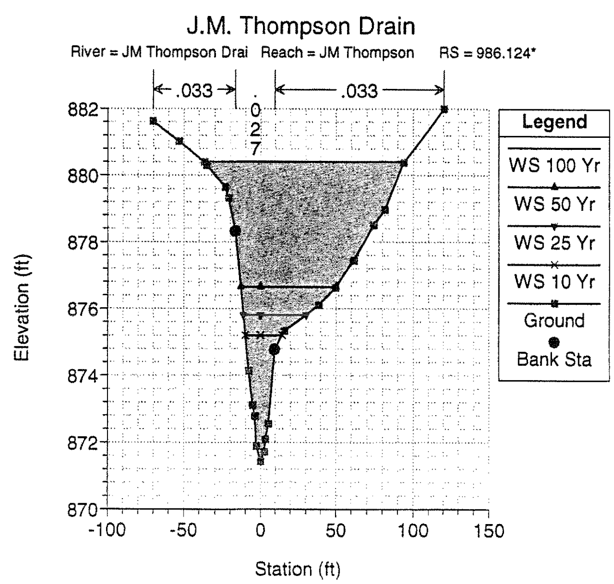

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1403 Cross Section #7
.033
.027
.033
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

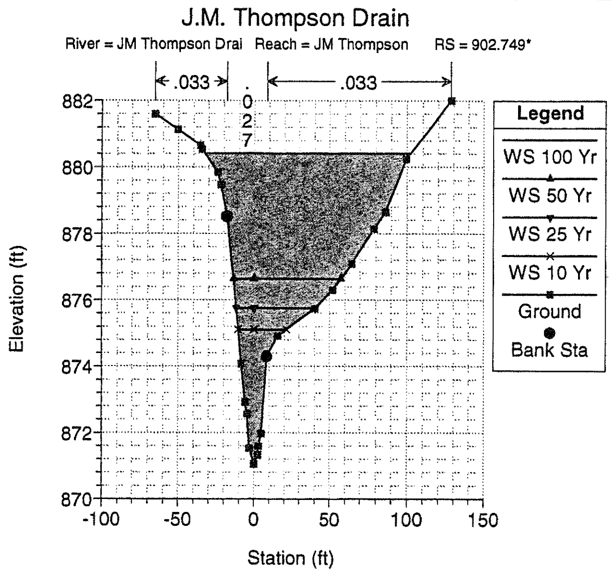

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1319.62*
.033
.027
.033
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1236.25*
.033
.027
.033
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

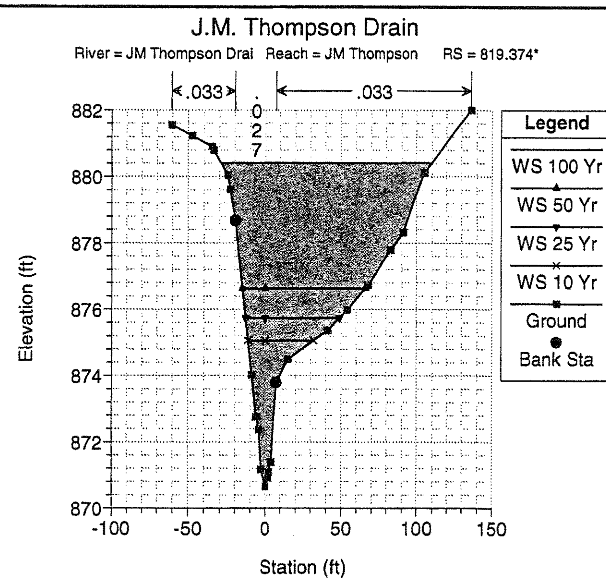

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1152.87*
.033
.027
.033
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 1069.5*
.033
.027
.033
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

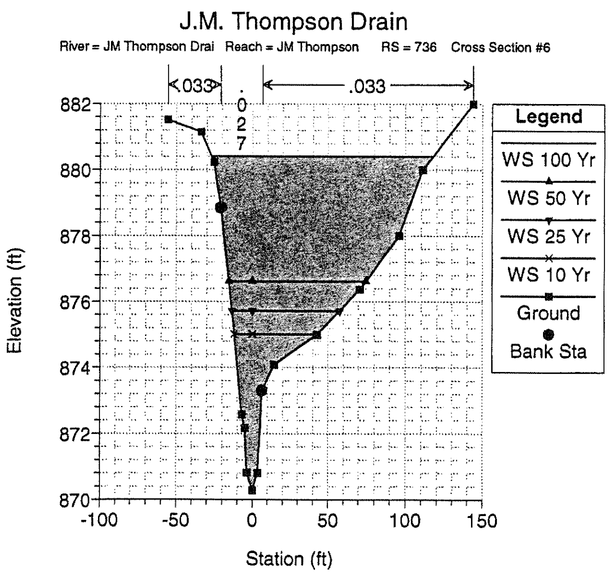

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 986.124*
.033
.027
.033
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



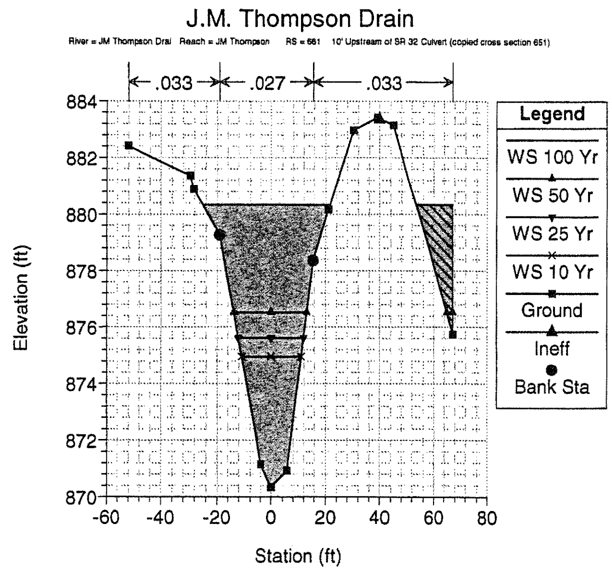
J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 902.749*
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta



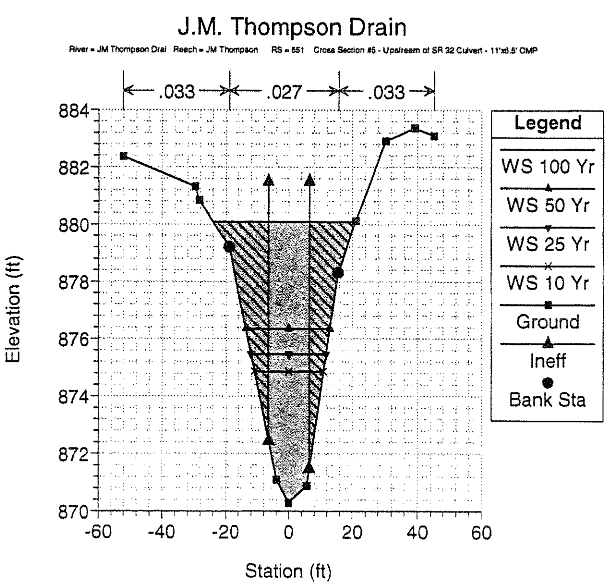
J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 819.374*
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta



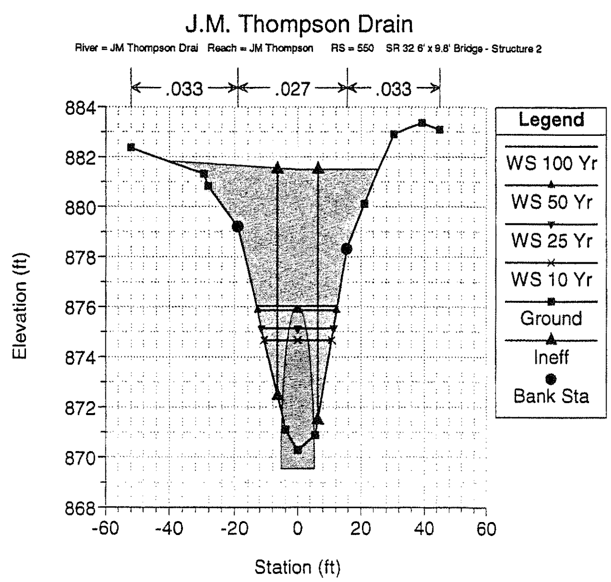
J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 736 Cross Section #6
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta



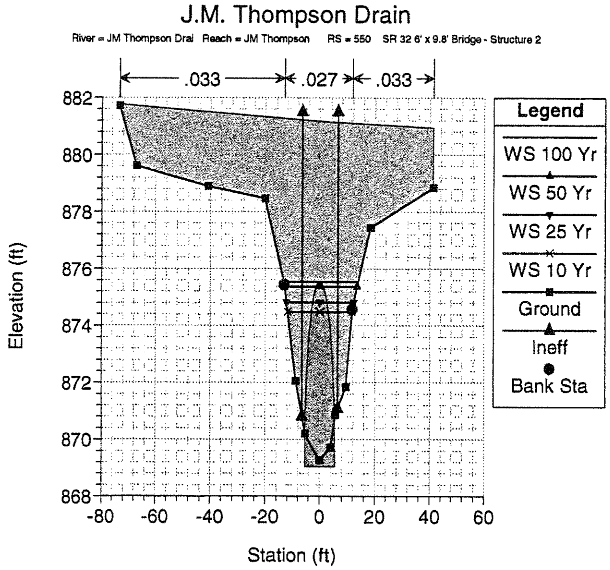
J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 661 10' Upstream of SR 32 Culvert (copied cross section 651)
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

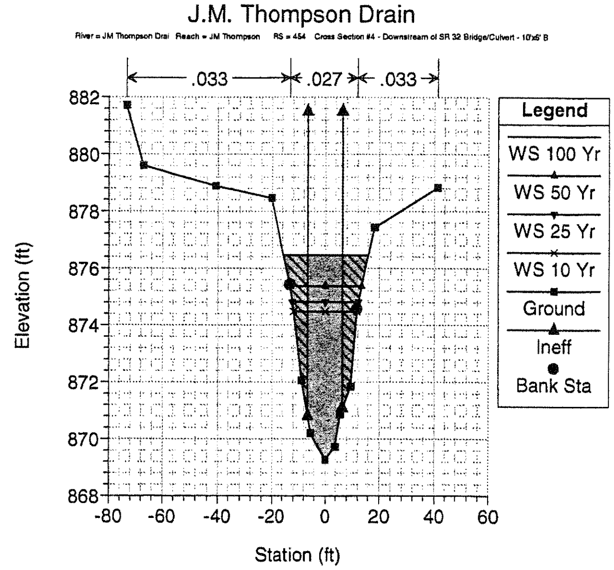


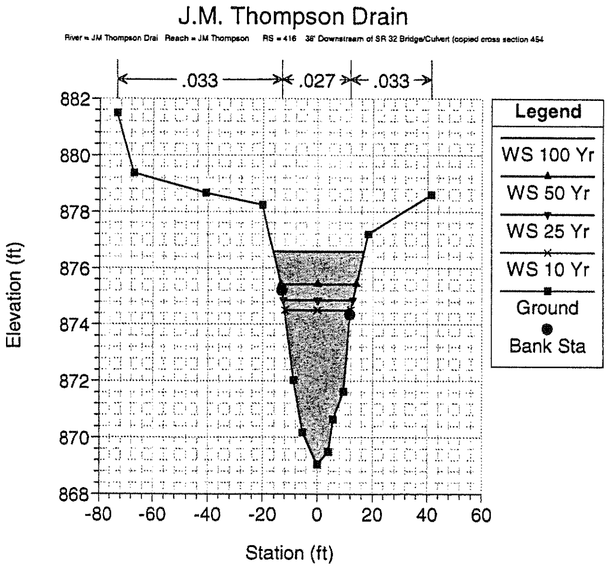
J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 651 Cross Section #5 - Upstream of SR 32 Culvert - 11'x6.5' CMP
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

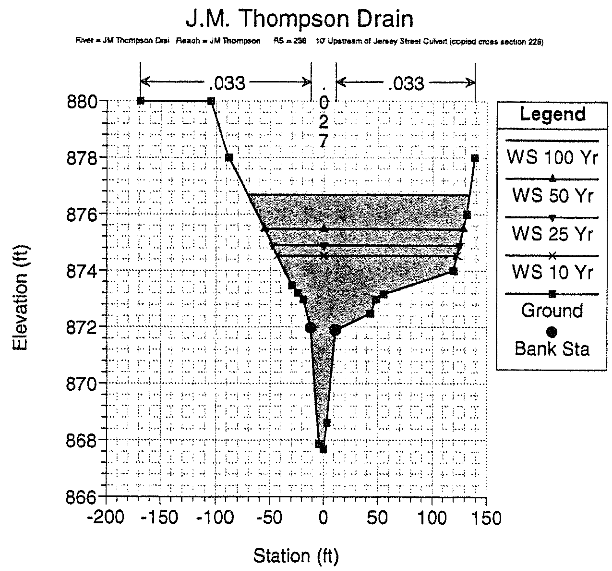


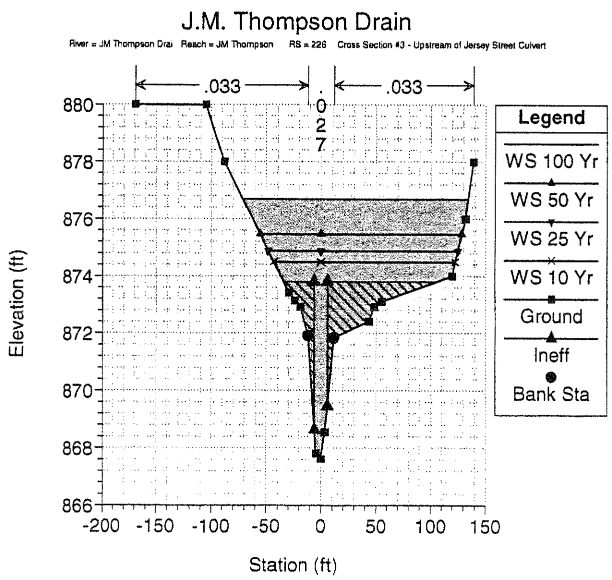
J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 550 SR 32 6' x 9.8' Bridge - Structure 2
.033
.027
.033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

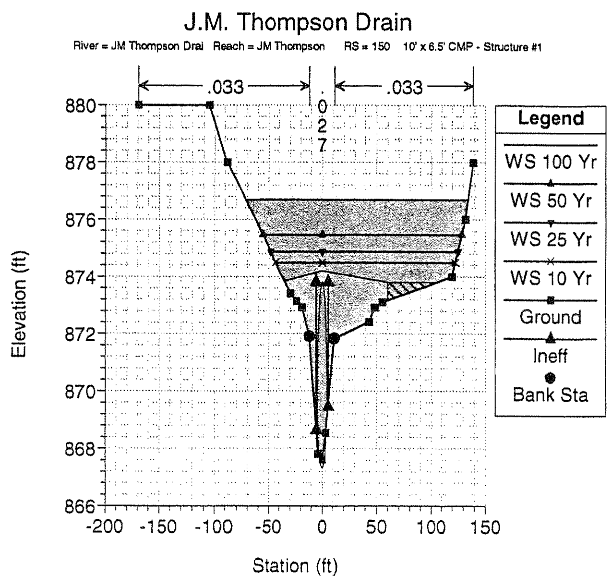

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 550 SR 32 6' x 9.8' Bridge - Structure 2
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

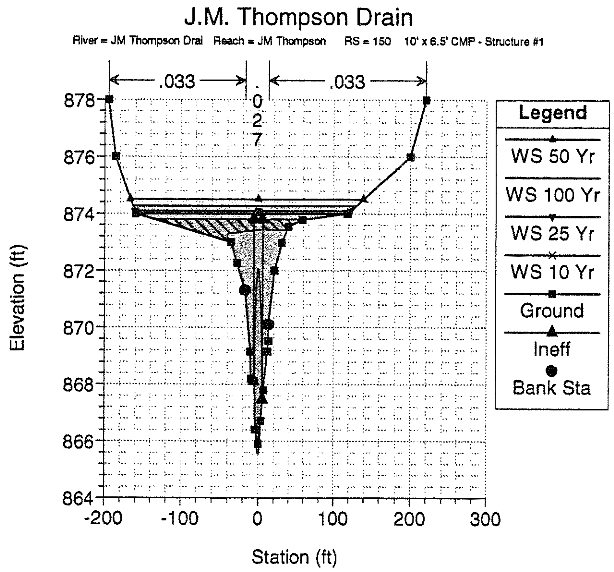

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 454 Cross Section #4 - Downstream of SR 32 Bridge/Culvert - 10'x6' B
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta


J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 416 38' Downstream of SR 32 Bridge/Culvert (copied cross section 454
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

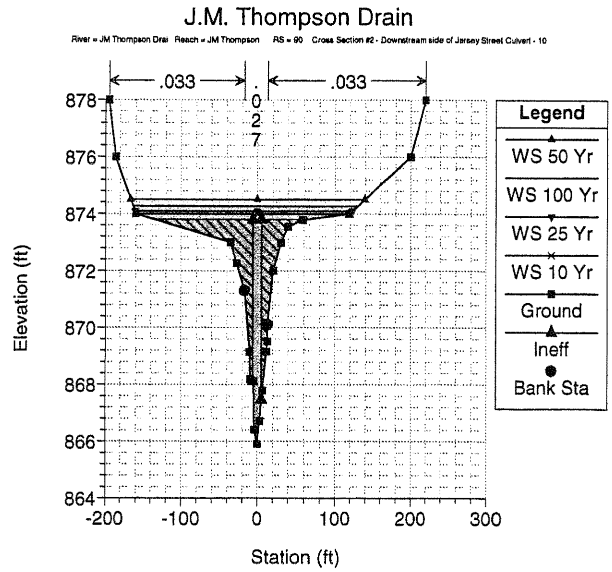

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 236 10' Upstream of Jersey Street Culvert (copied cross section 226)
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta


J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 226 Cross Section #3 - Upstream of Jersey Street Culvert
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta

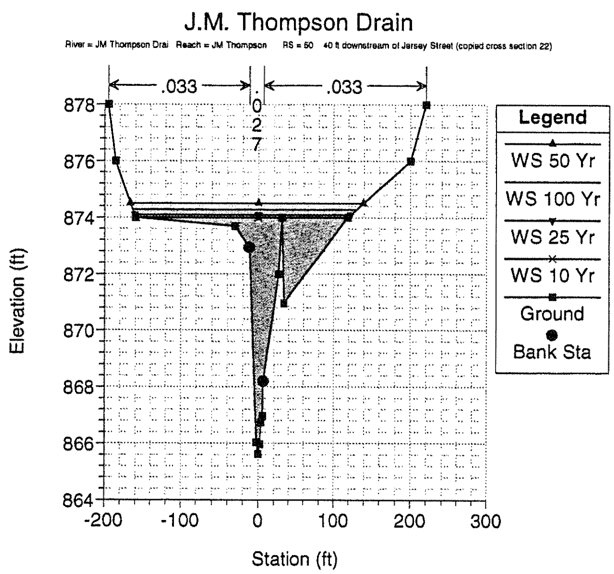

J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 150 10' x 6.5' CMP - Structure #1
.033 .027 .033
Elevation (ft)
Station (ft)
Legend
WS 100 Yr
WS 50 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta



J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 150 10' x 6.5' CMP - Structure #1
.033
.027
.033
Elevation (ft)
878
876
874
872
870
868
866
864
-200
-100
0
100
200
300
Station (ft)
Legend
WS 50 Yr
WS 100 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta



J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 90 Cross Section #2 - Downstream side of Jersey Street Culvert - 10
.033
.027
.033
Elevation (ft)
878
876
874
872
870
868
866
864
-200
-100
0
100
200
300
Station (ft)
Legend
WS 50 Yr
WS 100 Yr
WS 25 Yr
WS 10 Yr
Ground
Ineff
Bank Sta



J.M. Thompson Drain
River = JM Thompson Drai Reach = JM Thompson RS = 50 40 ft downstream of Jersey Street (copied cross section 22)
.033
.027
.033
Elevation (ft)
878
876
874
872
870
868
866
864
-200
-100
0
100
200
300
Station (ft)
Legend
WS 50 Yr
WS 100 Yr
WS 25 Yr
WS 10 Yr
Ground
Bank Sta

HEC-RAS Plan: Proposed River: JM Thompson Drai Reach: JM Thompson

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JM Thompson	3221	200.00	877.69	881.77		881.91	0.001094	2.99	66.95	29.34	0.35
JM Thompson	3221	84.00	877.69	880.27		880.42	0.003177	3.15	26.63	24.29	0.53
JM Thompson	3221	70.00	877.69	880.09		880.24	0.003880	3.15	22.23	23.67	0.57
JM Thompson	3221	53.00	877.69	879.87		880.02	0.004852	3.06	17.29	22.72	0.62
JM Thompson	3209	200.00	877.65	881.76		881.90	0.001054	2.95	67.81	29.44	0.34
JM Thompson	3209	84.00	877.65	880.23		880.38	0.003173	3.15	26.64	24.29	0.53
JM Thompson	3209	70.00	877.65	880.03		880.19	0.004142	3.22	21.77	23.60	0.59
JM Thompson	3209	53.00	877.65	879.77	879.53	879.94	0.006046	3.34	15.85	21.50	0.69
JM Thompson	2937	200.00	876.76	881.46		881.62	0.000977	3.17	63.10	22.85	0.34
JM Thompson	2937	84.00	876.76	879.70		879.83	0.001396	2.90	28.99	15.78	0.38
JM Thompson	2937	70.00	876.76	879.42		879.55	0.001476	2.82	24.81	14.68	0.38
JM Thompson	2937	53.00	876.76	879.07		879.18	0.001535	2.66	19.92	13.27	0.38
JM Thompson	2421	200.00	875.20	881.23		881.30	0.000370	2.13	93.92	28.88	0.21
JM Thompson	2421	84.00	875.20	879.34		879.40	0.000509	1.84	45.60	22.24	0.23
JM Thompson	2421	70.00	875.20	879.03		879.08	0.000566	1.80	38.78	21.11	0.23
JM Thompson	2421	53.00	875.20	878.62		878.67	0.000658	1.74	30.47	19.65	0.25
JM Thompson	2244	200.00	875.42	881.17		881.24	0.000350	2.15	115.66	90.51	0.21
JM Thompson	2244	84.00	875.42	879.26		879.31	0.000428	1.90	44.12	18.63	0.22
JM Thompson	2244	70.00	875.42	878.94		878.99	0.000435	1.82	38.39	17.58	0.22
JM Thompson	2244	53.00	875.42	878.53		878.57	0.000432	1.68	31.47	16.23	0.21
JM Thompson	2207	350.00	875.31	880.85	878.96	881.14	0.001473	4.33	80.81	88.27	0.42
JM Thompson	2207	168.00	875.31	878.94	877.88	879.21	0.002193	4.17	40.31	17.94	0.49
JM Thompson	2207	140.00	875.31	878.65	877.66	878.89	0.002206	3.97	35.22	16.98	0.49
JM Thompson	2207	107.00	875.31	878.27	877.39	878.48	0.002178	3.67	29.14	15.75	0.48
JM Thompson	2185	Bridge									
JM Thompson	2160	350.00	875.34	880.75	878.94	881.06	0.001525	4.46	78.63	24.90	0.43
JM Thompson	2160	168.00	875.34	878.78	877.84	879.09	0.002615	4.45	37.79	17.35	0.53
JM Thompson	2160	140.00	875.34	878.49	877.62	878.77	0.002659	4.26	32.86	16.36	0.53
JM Thompson	2160	107.00	875.34	878.10	877.34	878.35	0.002721	3.99	26.80	15.04	0.53
JM Thompson	2123	350.00	875.23	880.70		881.00	0.001443	4.38	80.15	25.30	0.42
JM Thompson	2123	168.00	875.23	878.69		878.99	0.002547	4.40	38.16	17.43	0.52
JM Thompson	2123	140.00	875.23	878.40		878.67	0.002595	4.22	33.16	16.42	0.52
JM Thompson	2123	107.00	875.23	878.01		878.25	0.002664	3.96	27.01	15.08	0.52
JM Thompson	2033.*	350.00	874.99	880.61		880.88	0.001203	4.12	85.86	27.45	0.39
JM Thompson	2033.*	168.00	874.99	878.49		878.78	0.002373	4.27	39.30	17.89	0.51
JM Thompson	2033.*	140.00	874.99	878.18		878.45	0.002459	4.12	33.95	16.80	0.51
JM Thompson	2033.*	107.00	874.99	877.79		878.02	0.002543	3.88	27.56	15.41	0.51
JM Thompson	1943.*	350.00	874.76	880.55		880.78	0.000991	3.84	92.88	30.41	0.36
JM Thompson	1943.*	168.00	874.76	878.31		878.57	0.002174	4.12	40.79	18.46	0.49
JM Thompson	1943.*	140.00	874.76	877.98		878.23	0.002312	4.01	34.88	17.26	0.50
JM Thompson	1943.*	107.00	874.76	877.58		877.80	0.002380	3.77	28.37	15.82	0.50
JM Thompson	1853.*	350.00	874.52	880.50		880.70	0.000768	3.56	102.87	41.90	0.32
JM Thompson	1853.*	168.00	874.52	878.14		878.38	0.001950	3.93	42.71	19.17	0.46
JM Thompson	1853.*	140.00	874.52	877.81		878.03	0.002071	3.83	36.55	17.90	0.47
JM Thompson	1853.*	107.00	874.52	877.40		877.61	0.002146	3.61	29.63	16.36	0.47
JM Thompson	1763.*	350.00	874.29	880.48		880.64	0.000572	3.23	123.81	62.91	0.28
JM Thompson	1763.*	168.00	874.29	878.00		878.22	0.001698	3.71	45.29	20.06	0.44
JM Thompson	1763.*	140.00	874.29	877.66		877.86	0.001820	3.63	38.60	18.67	0.44
JM Thompson	1763.*	107.00	874.29	877.24		877.43	0.001893	3.43	31.23	17.02	0.45
JM Thompson	1673.*	350.00	874.05	880.47		880.58	0.000404	2.85	153.04	76.29	0.24
JM Thompson	1673.*	168.00	874.05	877.88		878.07	0.001447	3.47	48.48	21.14	0.40
JM Thompson	1673.*	140.00	874.05	877.52		877.70	0.001562	3.40	41.18	19.61	0.41
JM Thompson	1673.*	107.00	874.05	877.10		877.26	0.001623	3.21	33.31	17.83	0.41
JM Thompson	1583.*	350.00	873.82	880.47		880.55	0.000274	2.46	190.30	89.80	0.20
JM Thompson	1583.*	168.00	873.82	877.79		877.95	0.001192	3.19	52.71	22.57	0.37
JM Thompson	1583.*	140.00	873.82	877.42		877.57	0.001289	3.13	44.72	20.89	0.38
JM Thompson	1583.*	107.00	873.82	877.00		877.13	0.001329	2.95	36.23	18.94	0.38

HEC-RAS Plan: Proposed River: JM Thompson Drai Reach: JM Thompson (Continued)

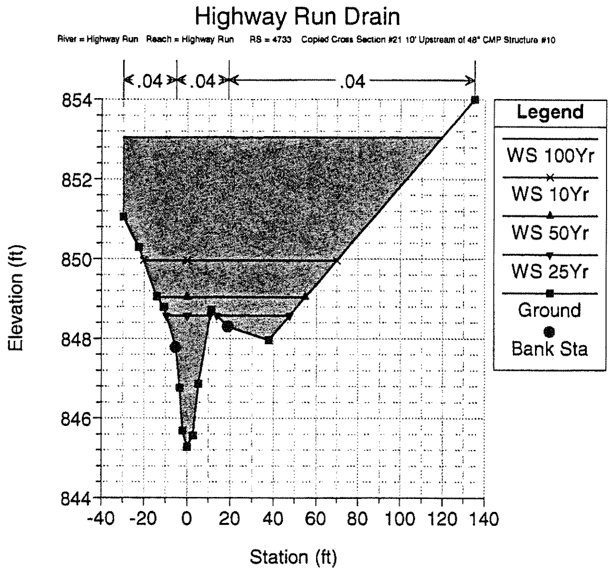
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JM Thompson	1493.*	350.00	873.58	880.47		880.52	0.000184	2.11	235.79	105.50	0.16
JM Thompson	1493.*	168.00	873.58	877.71		877.85	0.000960	2.90	57.92	24.34	0.33
JM Thompson	1493.*	140.00	873.58	877.34		877.47	0.001036	2.85	49.13	22.48	0.34
JM Thompson	1493.*	107.00	873.58	876.91		877.02	0.001058	2.68	39.91	20.35	0.34
JM Thompson	1403	488.00	873.35	880.42		880.50	0.000248	2.53	286.35	121.74	0.19
JM Thompson	1403	278.00	873.35	877.21		877.64	0.003487	5.24	53.04	24.24	0.62
JM Thompson	1403	231.00	873.35	876.80		877.24	0.004095	5.31	43.47	21.96	0.67
JM Thompson	1403	177.00	873.35	876.39		876.79	0.004304	5.06	34.96	19.72	0.67
JM Thompson	1319.62*	488.00	872.97	880.42		880.49	0.000196	2.34	309.73	126.16	0.17
JM Thompson	1319.62*	278.00	872.97	877.00		877.37	0.002741	4.90	57.24	28.45	0.56
JM Thompson	1319.62*	231.00	872.97	876.50		876.91	0.003646	5.11	45.19	22.23	0.63
JM Thompson	1319.62*	177.00	872.97	876.06		876.44	0.003984	4.93	35.90	19.96	0.65
JM Thompson	1236.25*	488.00	872.58	880.42		880.47	0.000150	2.12	339.66	128.77	0.15
JM Thompson	1236.25*	278.00	872.58	876.84		877.15	0.002043	4.50	64.27	35.44	0.49
JM Thompson	1236.25*	231.00	872.58	876.25		876.61	0.003099	4.85	47.66	22.47	0.59
JM Thompson	1236.25*	177.00	872.58	875.77		876.12	0.003503	4.73	37.46	20.16	0.61
JM Thompson	1152.87*	488.00	872.20	880.42		880.46	0.000115	1.89	375.70	130.57	0.13
JM Thompson	1152.87*	278.00	872.20	876.74		876.99	0.001478	4.06	75.20	44.59	0.42
JM Thompson	1152.87*	231.00	872.20	876.05		876.37	0.002427	4.54	51.38	25.87	0.53
JM Thompson	1152.87*	177.00	872.20	875.53		875.84	0.002928	4.46	39.70	20.32	0.56
JM Thompson	1069.5*	488.00	871.82	880.42		880.45	0.000087	1.68	418.22	131.65	0.12
JM Thompson	1069.5*	278.00	871.82	876.68		876.87	0.001036	3.59	90.99	54.26	0.36
JM Thompson	1069.5*	231.00	871.82	875.91		876.18	0.001842	4.19	57.33	32.08	0.46
JM Thompson	1069.5*	177.00	871.82	875.34		875.61	0.002317	4.14	42.73	21.16	0.50
JM Thompson	986.124*	488.00	871.43	880.42		880.44	0.000066	1.49	467.07	131.80	0.10
JM Thompson	986.124*	278.00	871.43	876.65		876.79	0.000704	3.12	111.92	63.38	0.30
JM Thompson	986.124*	231.00	871.43	875.82		876.04	0.001350	3.80	67.18	41.85	0.40
JM Thompson	986.124*	177.00	871.43	875.21		875.43	0.001714	3.81	47.34	24.84	0.44
JM Thompson	902.749*	488.00	871.05	880.42		880.44	0.000051	1.32	522.23	135.05	0.09
JM Thompson	902.749*	278.00	871.05	876.64		876.73	0.000479	2.68	136.81	71.55	0.25
JM Thompson	902.749*	231.00	871.05	875.76		875.93	0.000965	3.38	81.74	52.87	0.34
JM Thompson	902.749*	177.00	871.05	875.11		875.30	0.001274	3.49	54.04	32.36	0.38
JM Thompson	819.374*	488.00	870.66	880.42		880.43	0.000040	1.17	583.22	139.18	0.08
JM Thompson	819.374*	278.00	870.66	876.63		876.69	0.000329	2.30	165.97	81.05	0.21
JM Thompson	819.374*	231.00	870.66	875.73		875.85	0.000660	2.92	101.62	62.15	0.28
JM Thompson	819.374*	177.00	870.66	875.06		875.20	0.000918	3.12	65.22	43.70	0.33
JM Thompson	736	488.00	870.28	880.42		880.43	0.000031	1.03	649.84	144.79	0.07
JM Thompson	736	278.00	870.28	876.62		876.66	0.000228	1.96	199.52	90.75	0.17
JM Thompson	736	231.00	870.28	875.72		875.79	0.000450	2.50	125.55	71.46	0.24
JM Thompson	736	177.00	870.28	875.01		875.12	0.000652	2.75	81.00	55.56	0.28
JM Thompson	661	488.00	870.34	880.35	874.34	880.42	0.000143	2.13	236.80	60.76	0.15
JM Thompson	661	278.00	870.34	876.52	873.35	876.63	0.000455	2.67	104.22	29.42	0.24
JM Thompson	661	231.00	870.34	875.62	873.08	875.75	0.000619	2.85	81.08	24.22	0.27
JM Thompson	661	177.00	870.34	874.96	872.73	875.07	0.000645	2.70	65.66	22.10	0.28
JM Thompson	651	488.00	870.29	880.10	874.41	880.36	0.000302	4.07	119.83	45.14	0.24
JM Thompson	651	278.00	870.29	876.35	873.30	876.59	0.000560	3.91	71.09	26.71	0.29
JM Thompson	651	231.00	870.29	875.48	873.02	875.71	0.000692	3.87	59.69	23.92	0.32
JM Thompson	651	177.00	870.29	874.86	872.67	875.04	0.000657	3.43	51.66	21.95	0.30
JM Thompson	550	Culvert									
JM Thompson	454	488.00	869.27	876.47	873.39	876.98	0.000927	5.70	85.60	31.66	0.39
JM Thompson	454	278.00	869.27	875.38	872.30	875.61	0.000551	3.89	71.39	26.67	0.29
JM Thompson	454	231.00	869.27	874.82	872.01	875.03	0.000542	3.60	64.20	24.71	0.29
JM Thompson	454	177.00	869.27	874.47	871.67	874.61	0.000406	2.97	59.65	23.60	0.24
JM Thompson	416	488.00	869.04	876.60		876.78	0.000477	3.47	146.68	33.30	0.26
JM Thompson	416	278.00	869.04	875.43		875.53	0.000348	2.53	110.91	27.91	0.21
JM Thompson	416	231.00	869.04	874.86		874.96	0.000370	2.42	95.87	25.64	0.22
JM Thompson	416	177.00	869.04	874.50		874.56	0.000292	2.04	86.73	24.31	0.19

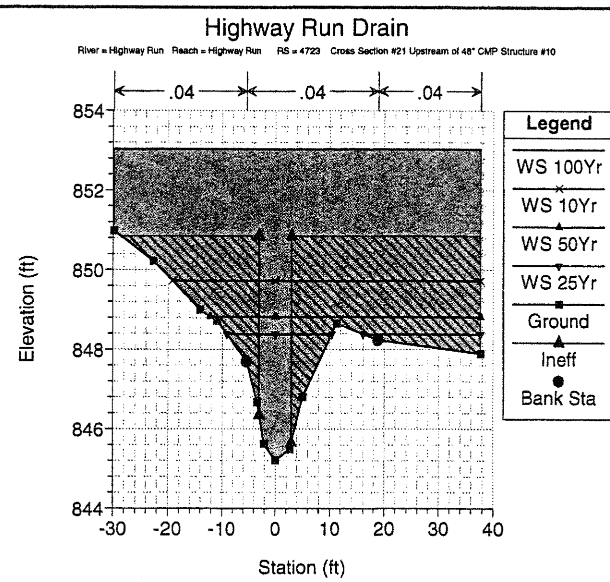
HEC-RAS Plan: Proposed River: JM Thompson Drai Reach: JM Thompson (Continued)

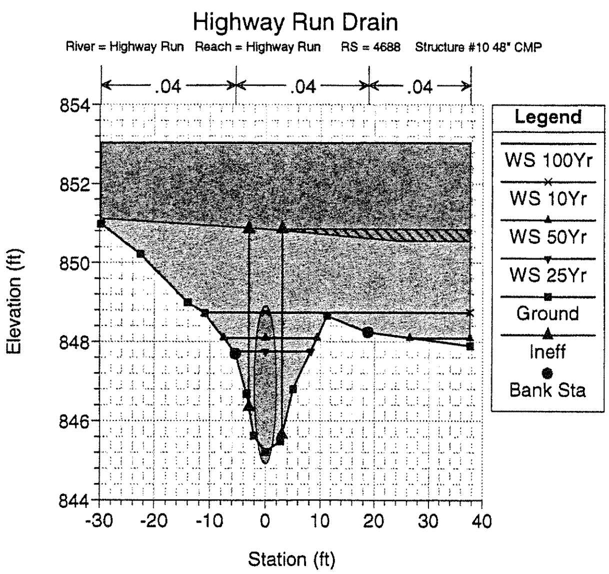
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JM Thompson	236	488.00	867.68	876.70		876.71	0.000032	1.12	719.03	205.77	0.07
JM Thompson	236	278.00	867.68	875.48		875.49	0.000031	0.97	479.53	184.41	0.07
JM Thompson	236	231.00	867.68	874.90		874.92	0.000039	1.03	376.87	173.59	0.08
JM Thompson	236	177.00	867.68	874.52		874.53	0.000036	0.94	312.02	166.39	0.07
JM Thompson	226	488.00	867.62	876.70	871.93	876.71	0.000070	1.39	574.41	205.88	0.10
JM Thompson	226	278.00	867.62	875.47	870.75	875.48	0.000097	1.40	336.76	184.62	0.12
JM Thompson	226	231.00	867.62	874.88	870.44	874.91	0.000166	1.66	232.94	173.62	0.15
JM Thompson	226	177.00	867.62	874.49	870.07	874.52	0.000197	1.69	167.62	166.33	0.16
JM Thompson	150	Culvert									
JM Thompson	90	488.00	865.91	874.28	870.44	874.33	0.000135	2.03	413.25	294.17	0.14
JM Thompson	90	278.00	865.91	874.50	869.24	874.51	0.000034	1.04	478.26	305.76	0.07
JM Thompson	90	231.00	865.91	874.09	868.93	874.11	0.000038	1.06	358.20	283.98	0.08
JM Thompson	90	177.00	865.91	874.00	868.56	874.00	0.000025	0.85	330.68	277.10	0.06
JM Thompson	50	488.00	865.63	874.29		874.33	0.000148	2.08	442.98	294.38	0.15
JM Thompson	50	278.00	865.63	874.50		874.51	0.000037	1.07	506.81	305.76	0.07
JM Thompson	50	231.00	865.63	874.09		874.11	0.000041	1.08	387.27	284.07	0.08
JM Thompson	50	177.00	865.63	874.00		874.00	0.000025	0.84	359.63	277.46	0.06
JM Thompson	22	488.00	865.46	874.30	870.04	874.31	0.000046	1.18	753.66	363.90	0.08
JM Thompson	22	278.00	865.46	874.50	868.97	874.50	0.000012	0.61	826.71	366.50	0.04
JM Thompson	22	231.00	865.46	874.10	868.64	874.10	0.000013	0.62	681.14	361.30	0.04
JM Thompson	22	177.00	865.46	874.00	868.22	874.00	0.000009	0.50	645.08	360.00	0.03

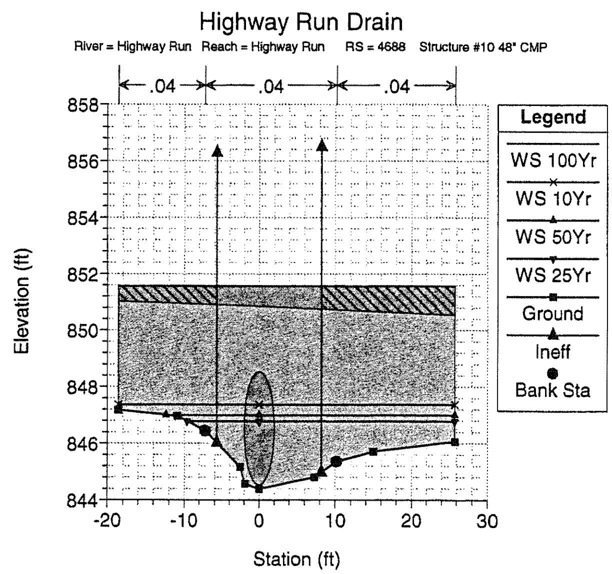
HIGHWAY RUN DRAIN

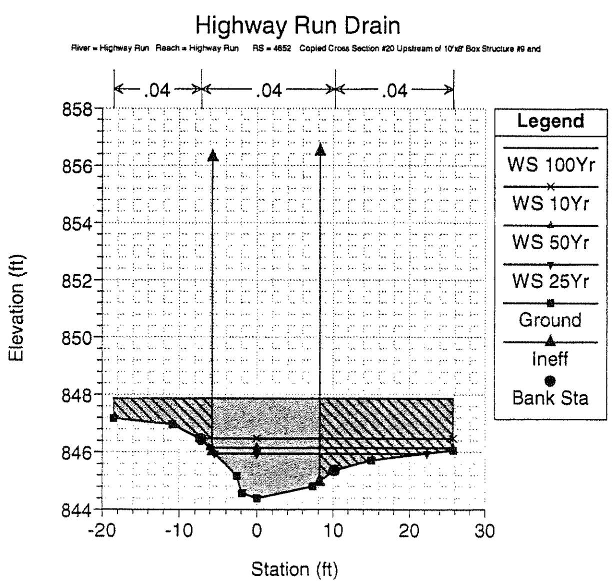
HEC-RAS CROSS-SECTIONS AND PROFILE SUMMARY TABLE

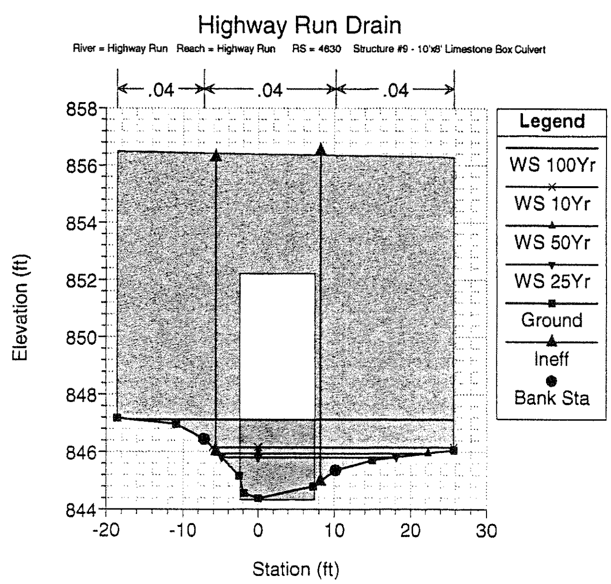

Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 4733   Copied Cross Section #21 10' Upstream of 48" CMP Structure #10
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta
Elevation (ft)
854
852
850
848
846
844
-40
-20
0
20
40
60
80
100
120
140
Station (ft)

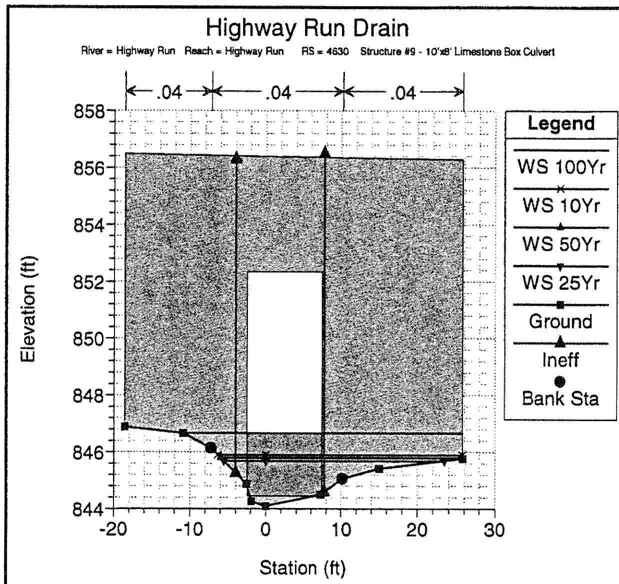

Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 4723   Cross Section #21 Upstream of 48" CMP Structure #10
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
854
852
850
848
846
844
-30
-20
-10
0
10
20
30
40
Station (ft)

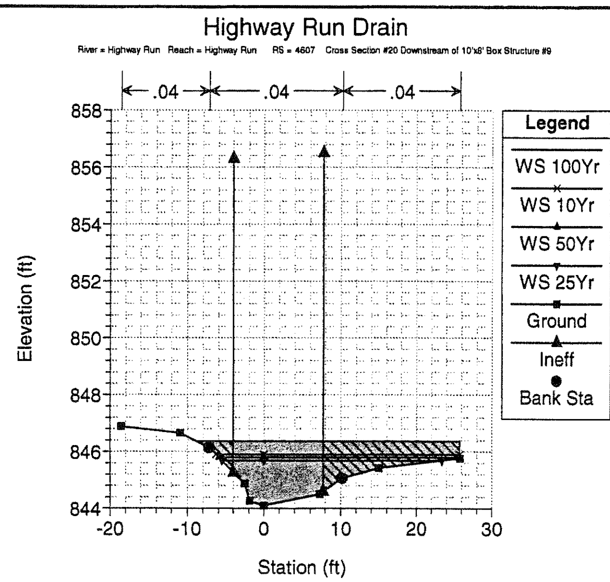

Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 4688   Structure #10 48" CMP
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
854
852
850
848
846
844
-30
-20
-10
0
10
20
30
40
Station (ft)

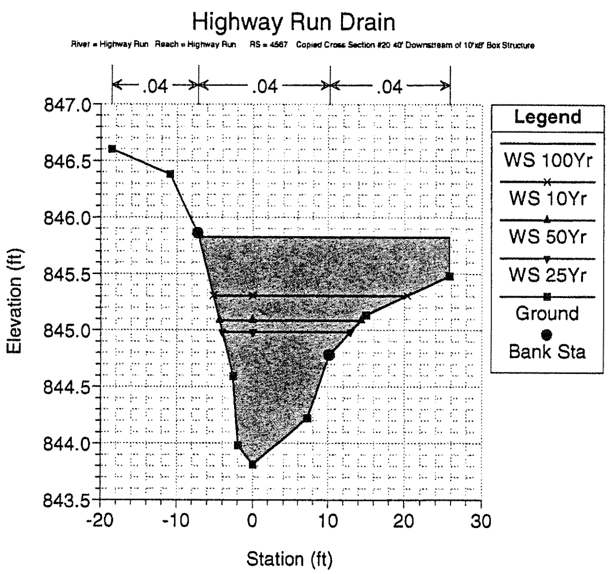

Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 4688   Structure #10 48" CMP
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
858
856
854
852
850
848
846
844
-20
-10
0
10
20
30
Station (ft)

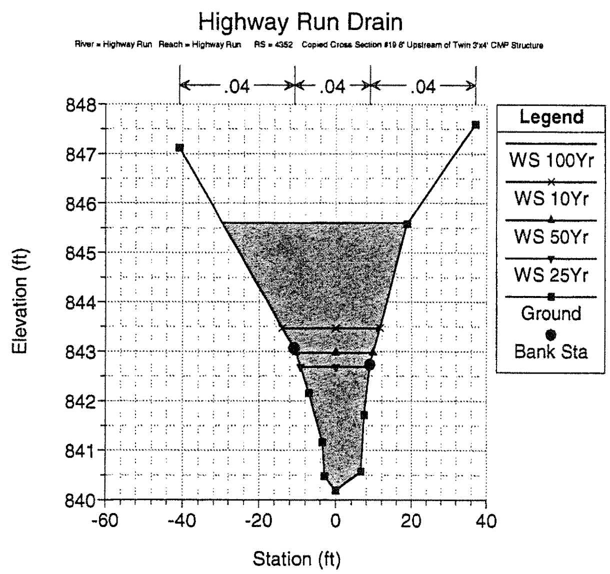

Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 4652   Copied Cross Section #20 Upstream of 10'x8' Box Structure #9 and
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
858
856
854
852
850
848
846
844
-20
-10
0
10
20
30
Station (ft)

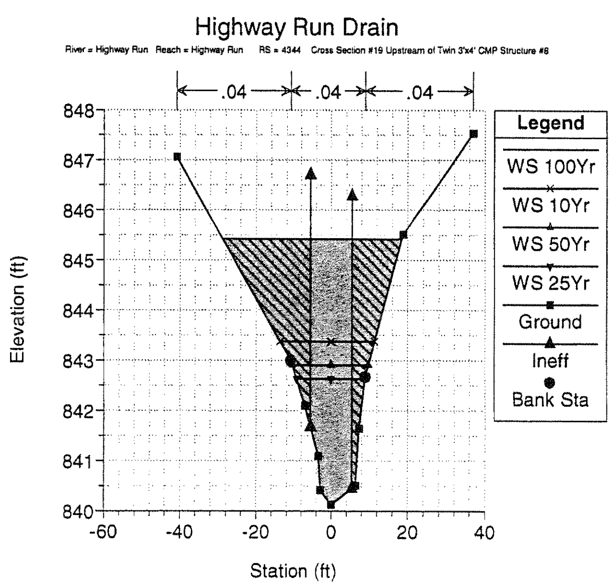

Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 4630   Structure #9 - 10'x8' Limestone Box Culvert
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
858
856
854
852
850
848
846
844
-20
-10
0
10
20
30
Station (ft)

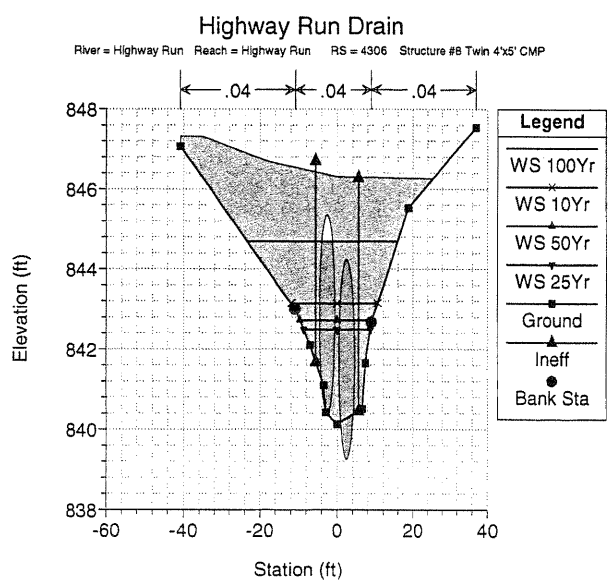

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4630 Structure #9 - 10'x8' Limestone Box Culvert
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

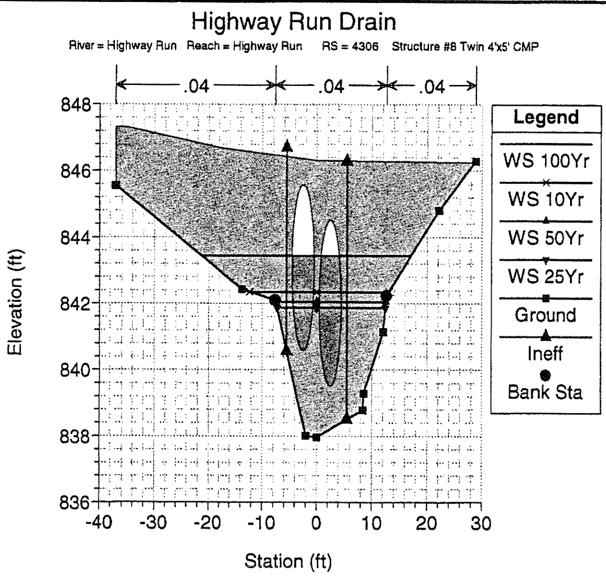

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4607 Cross Section #20 Downstream of 10'x8' Box Structure #9
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

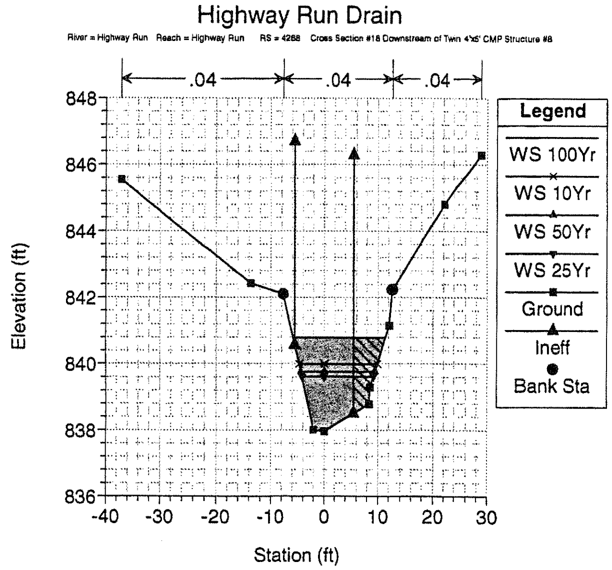

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4567 Copied Cross Section #20 40' Downstream of 10'x8' Box Structure
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

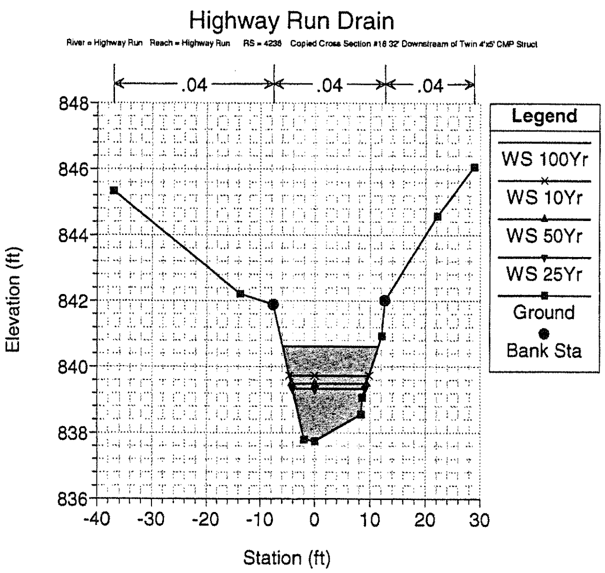

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4352 Copied Cross Section #19 8' Upstream of Twin 3'x4' CMP Structure
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

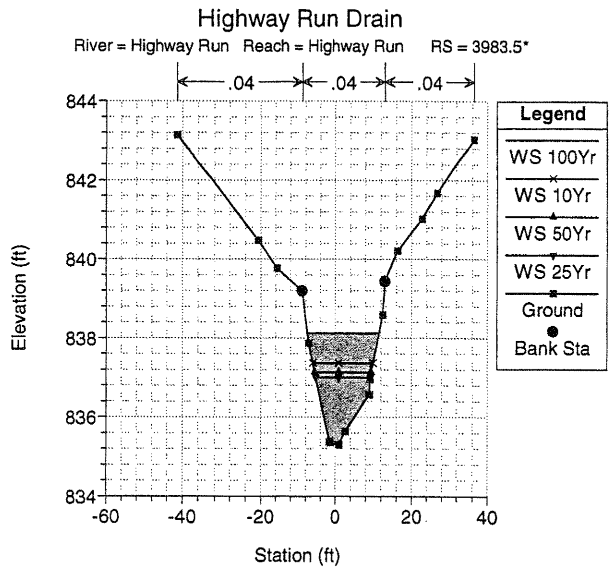

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4344 Cross Section #19 Upstream of Twin 3'x4' CMP Structure #8
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

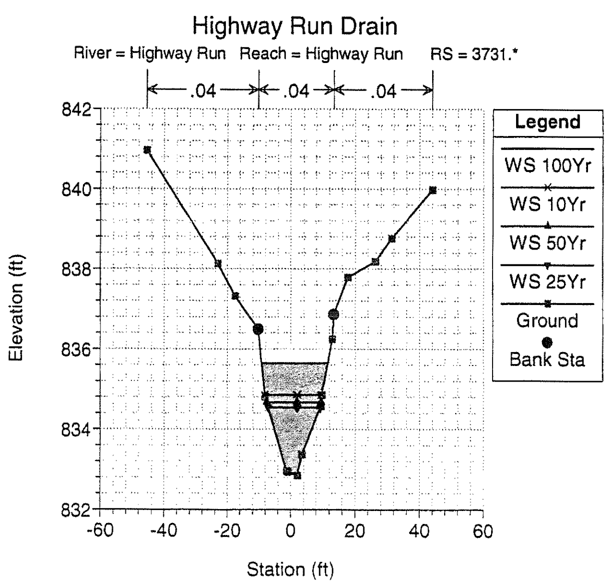

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4306 Structure #8 Twin 4'x5' CMP
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

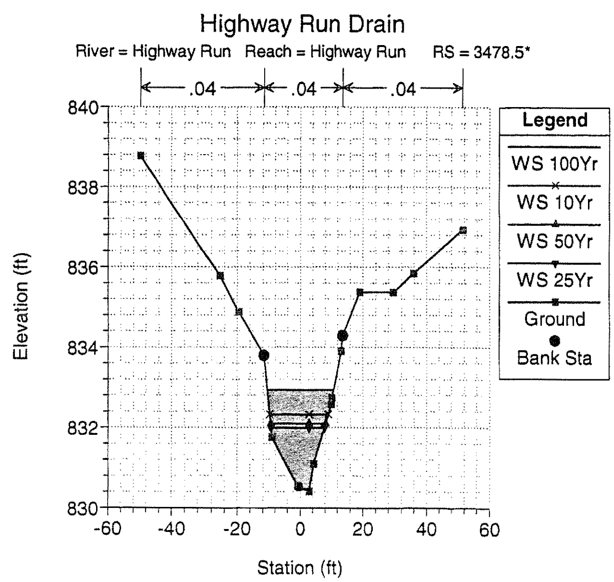

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4306 Structure #8 Twin 4'x5' CMP
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4268 Cross Section #18 Downstream of Twin 4'x5' CMP Structure #8
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 4236 Copied Cross Section #18 32' Downstream of Twin 4'x5' CMP Struct
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

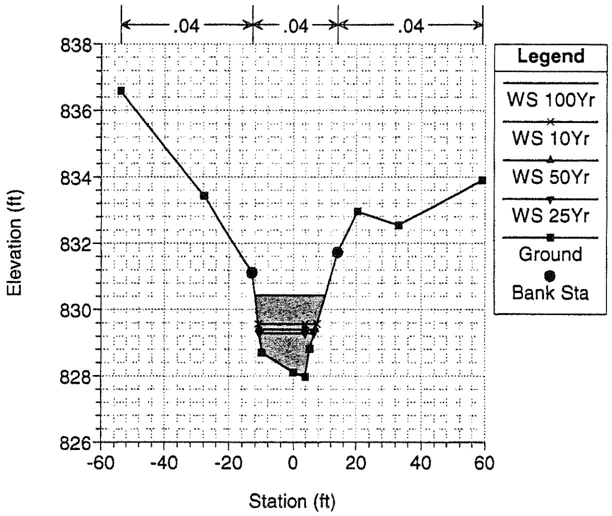

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 3983.5*
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 3731.*
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 3478.5*
.04
.04
.04
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

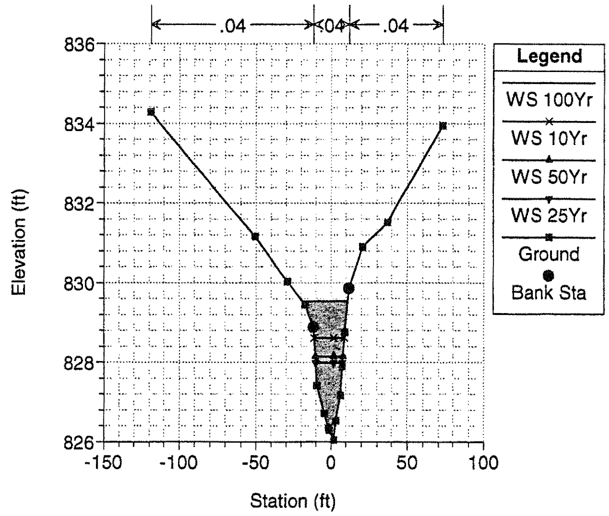
Highway Run Drain

River = Highway Run   Reach = Highway Run   RS = 3226   Cross Section #17



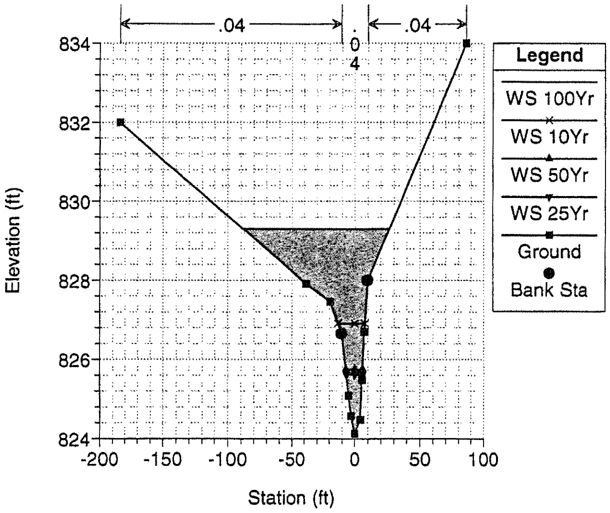
Highway Run Drain

River = Highway Run   Reach = Highway Run   RS = 3005.*



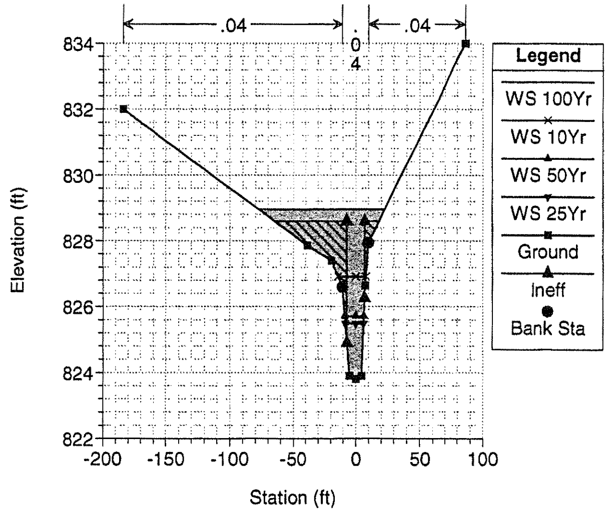
Highway Run Drain

River = Highway Run   Reach = Highway Run   RS = 2784   Copied Cross Section #16 8' Upstream of Twin 3'x4' CMP Structure



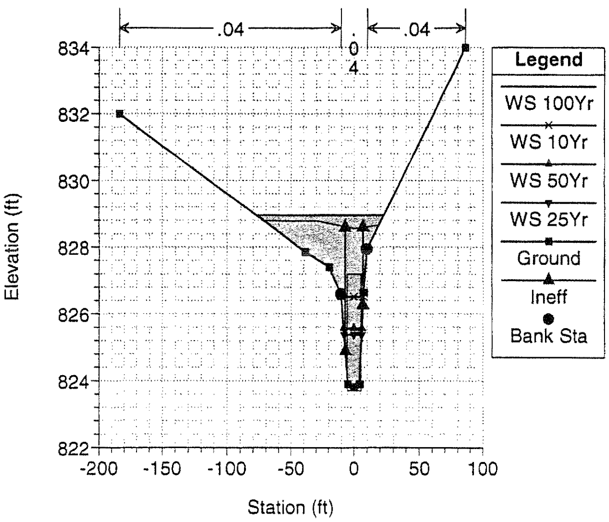
Highway Run Drain

River = Highway Run   Reach = Highway Run   RS = 2776   Cross Section #16 Upstream of Twin 3'x4' CMP Structure #7



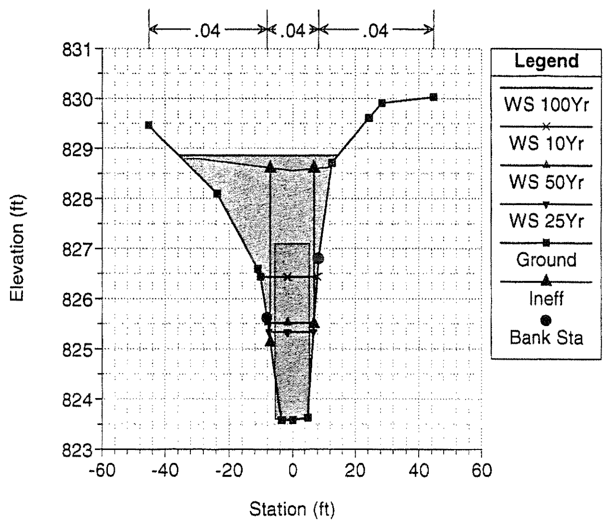
Highway Run Drain

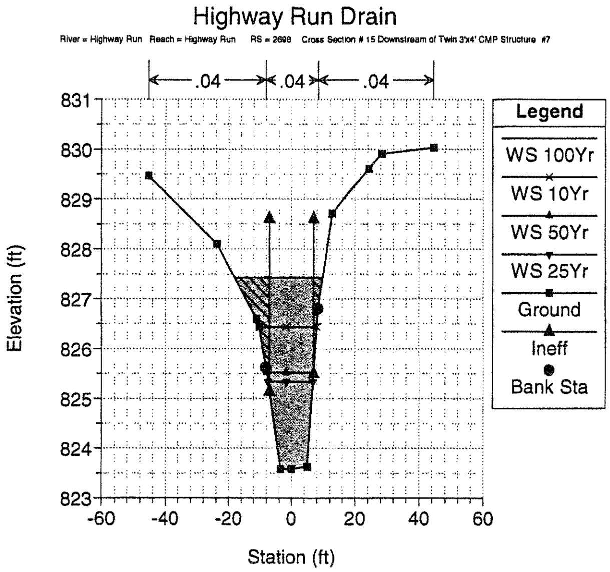
River = Highway Run   Reach = Highway Run   RS = 2737   PROPOSED 11' x 3.5' BOX CULVERT

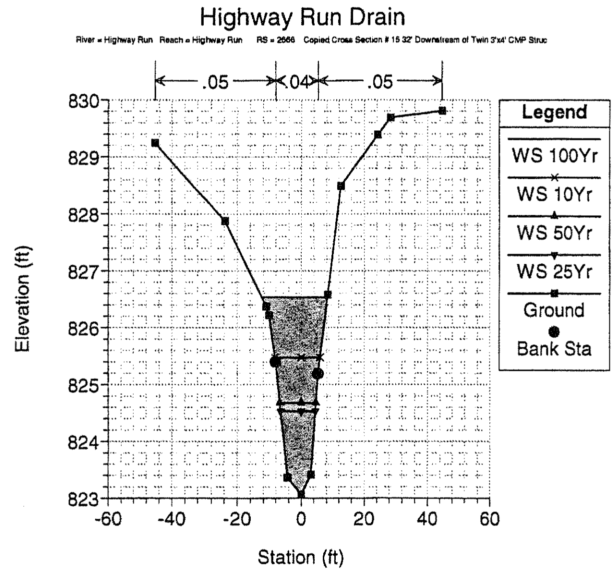


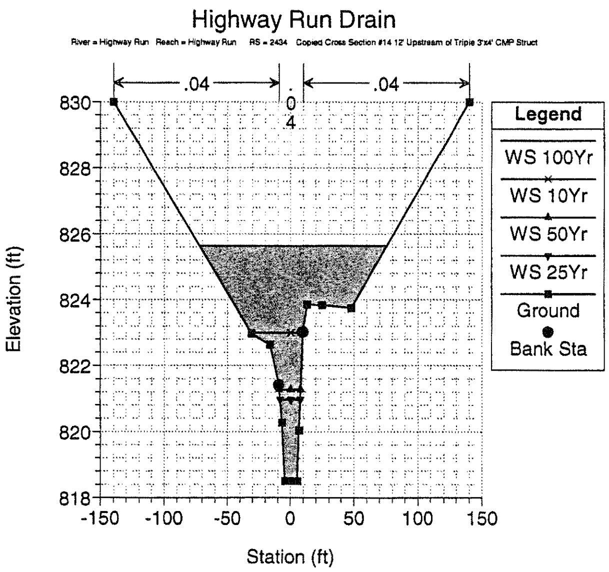
Highway Run Drain

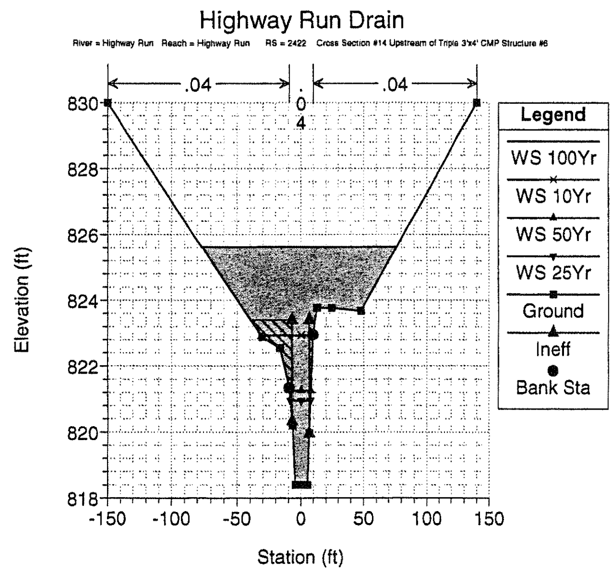
River = Highway Run   Reach = Highway Run   RS = 2737   PROPOSED 11' x 3.5' BOX CULVERT

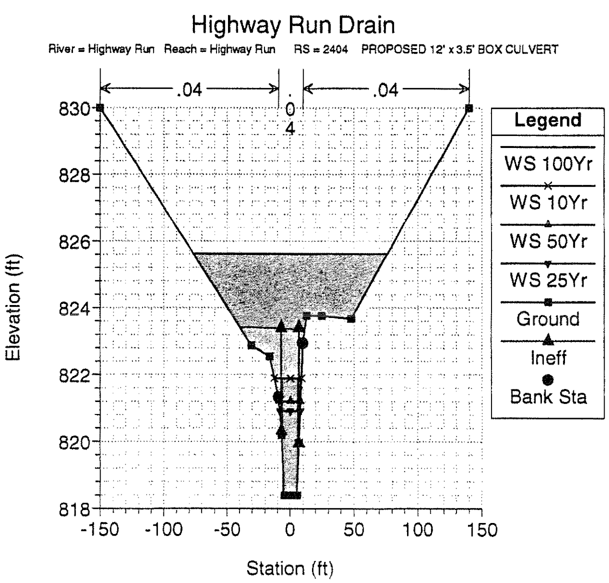


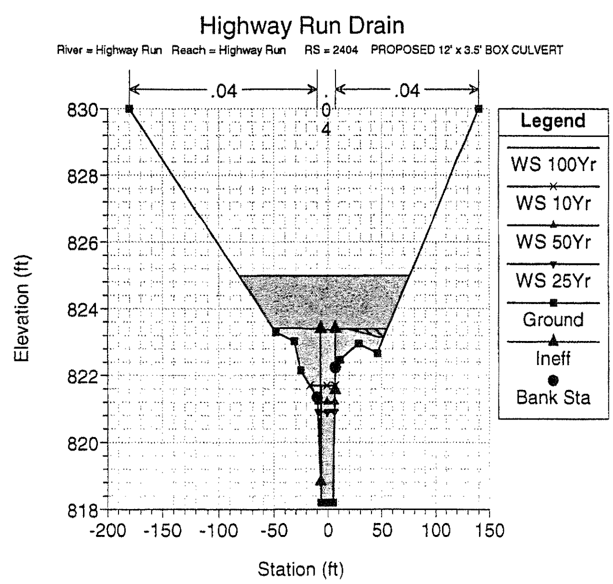

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2698 Cross Section # 15 Downstream of Twin 3'x4' CMP Structure #7
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

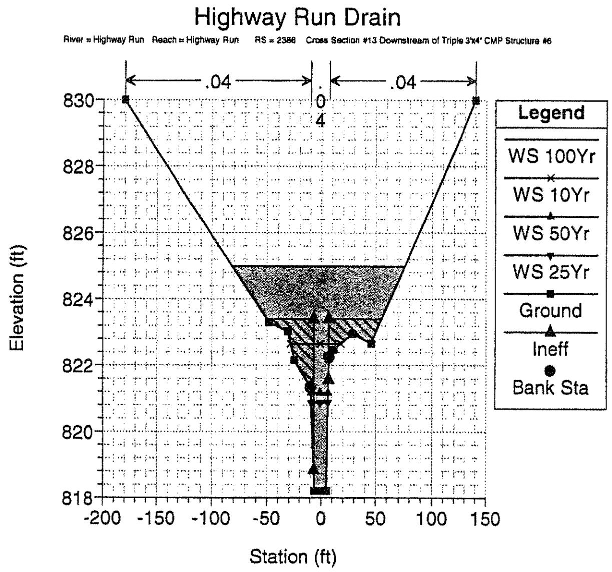

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2666 Copied Cross Section # 15 32' Downstream of Twin 3'x4' CMP Struc
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

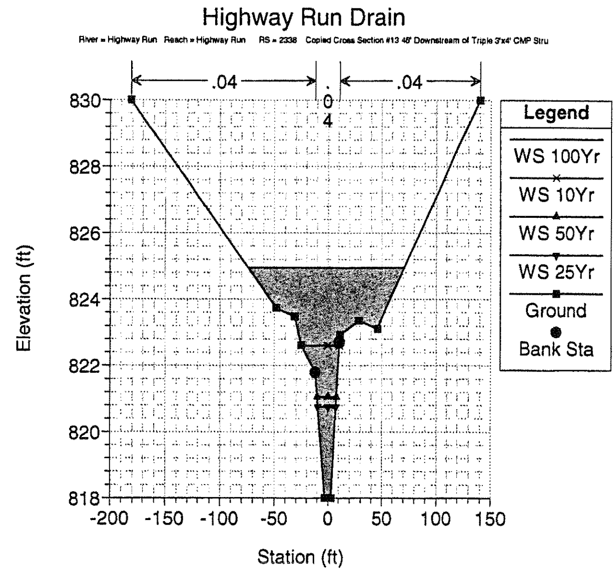

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2434 Copied Cross Section #14 12' Upstream of Triple 3'x4' CMP Struct
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

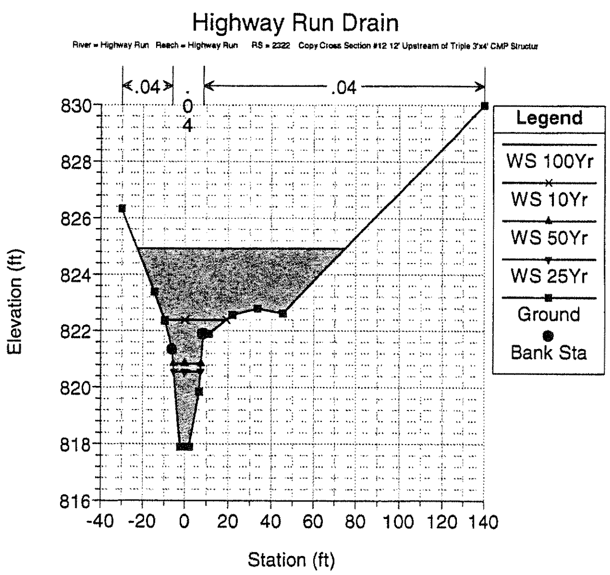

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2422 Cross Section #14 Upstream of Triple 3'x4' CMP Structure #6
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

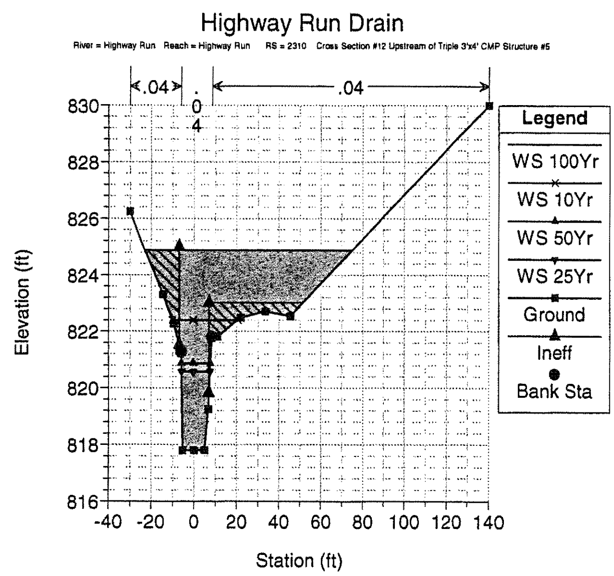

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2404 PROPOSED 12' x 3.5' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

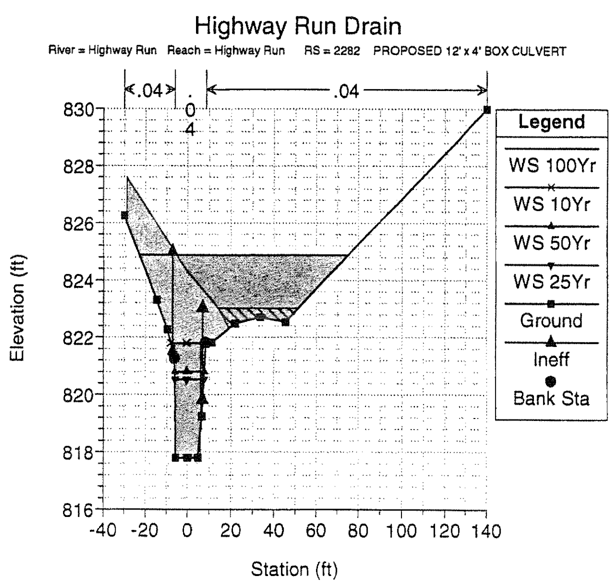

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2404 PROPOSED 12' x 3.5' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

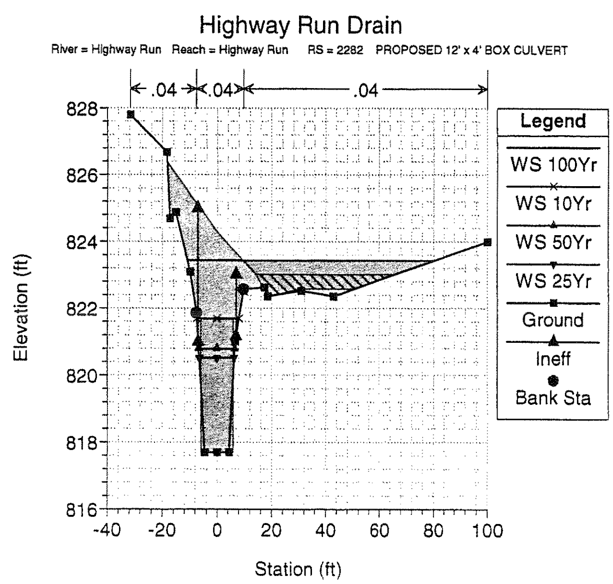

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2386 Cross Section #13 Downstream of Triple 3'x4' CMP Structure #6
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

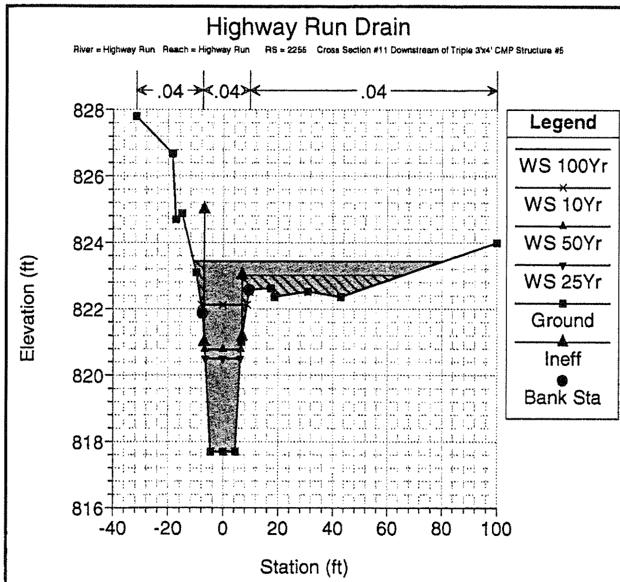

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2338 Copied Cross Section #13 48' Downstream of Triple 3'x4' CMP Stru
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

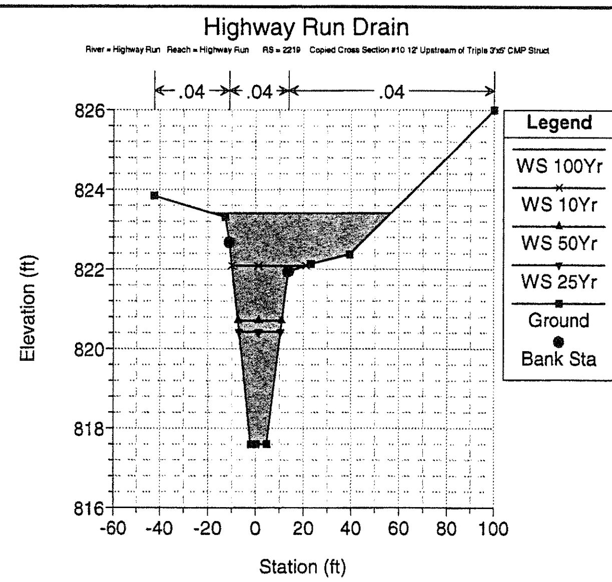

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2322 Copy Cross Section #12 12' Upstream of Triple 3'x4' CMP Structur
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

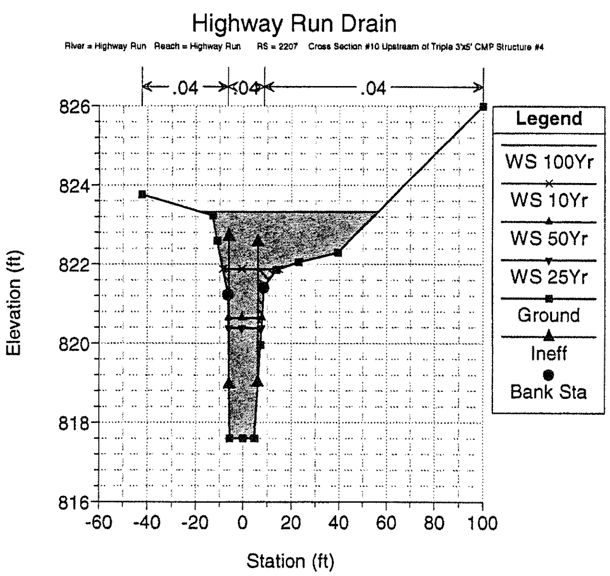

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2310 Cross Section #12 Upstream of Triple 3'x4' CMP Structure #5
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

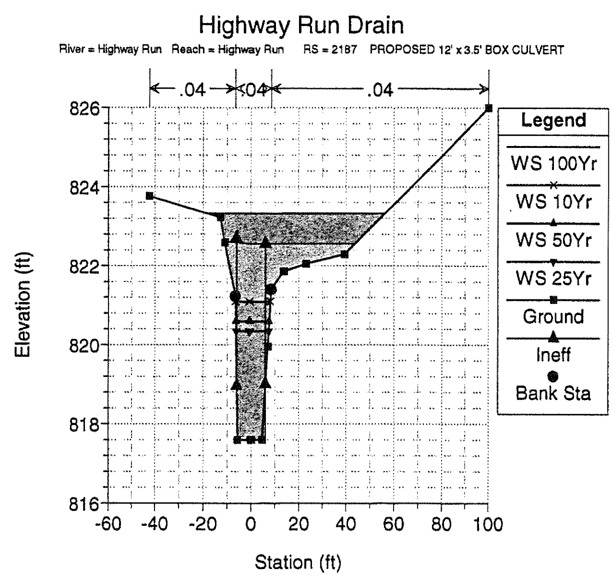

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2282 PROPOSED 12' x 4' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

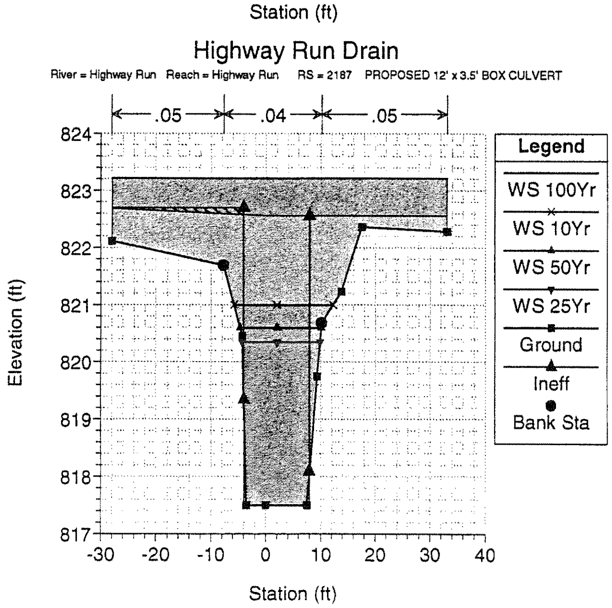

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2282 PROPOSED 12' x 4' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

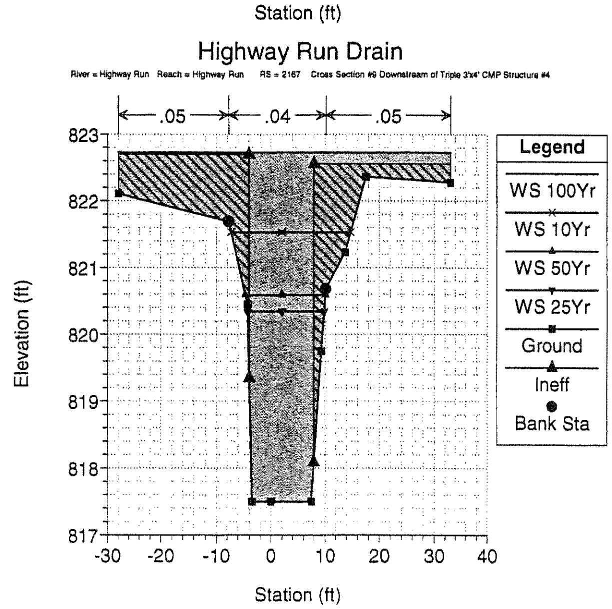

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2255 Cross Section #11 Downstream of Triple 3'x4' CMP Structure #5
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

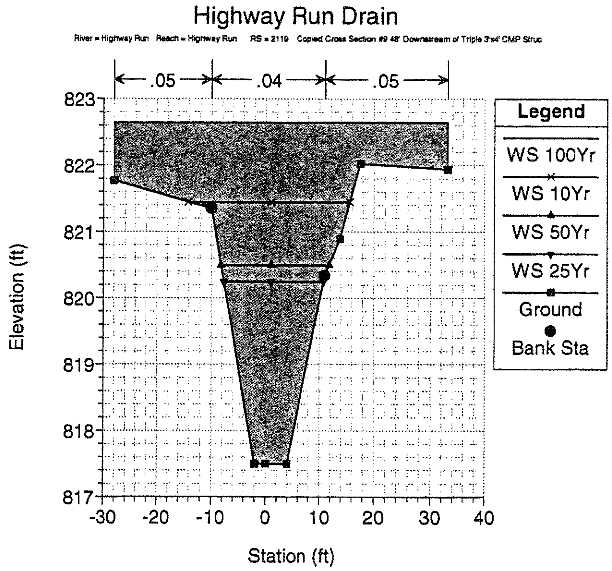

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2219 Copied Cross Section #10 12' Upstream of Triple 3'x5' CMP Struct
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

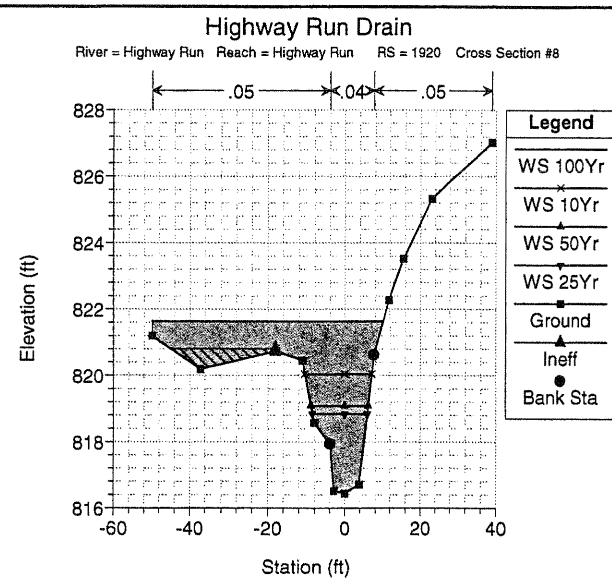

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2207 Cross Section #10 Upstream of Triple 3'x5' CMP Structure #4
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

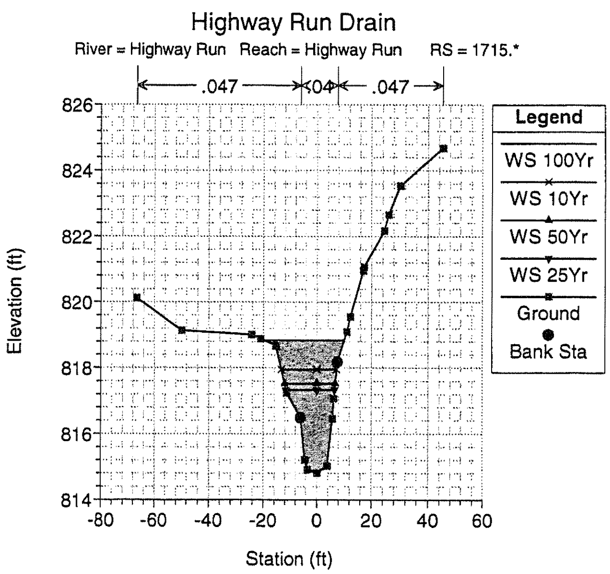

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2187 PROPOSED 12' x 3.5' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

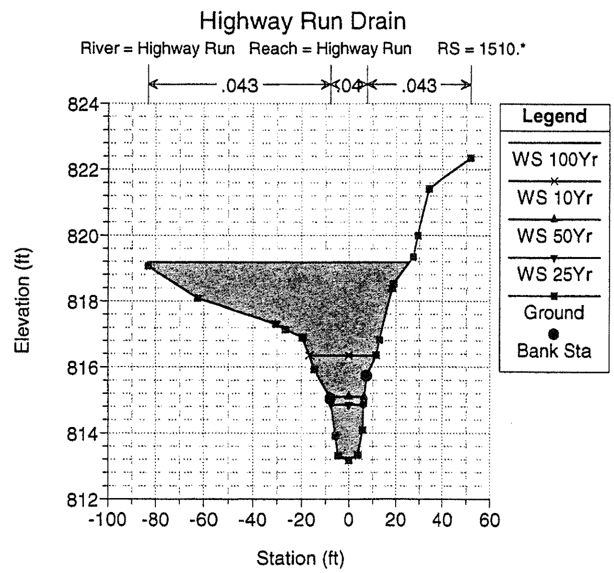

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2187 PROPOSED 12' x 3.5' BOX CULVERT
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

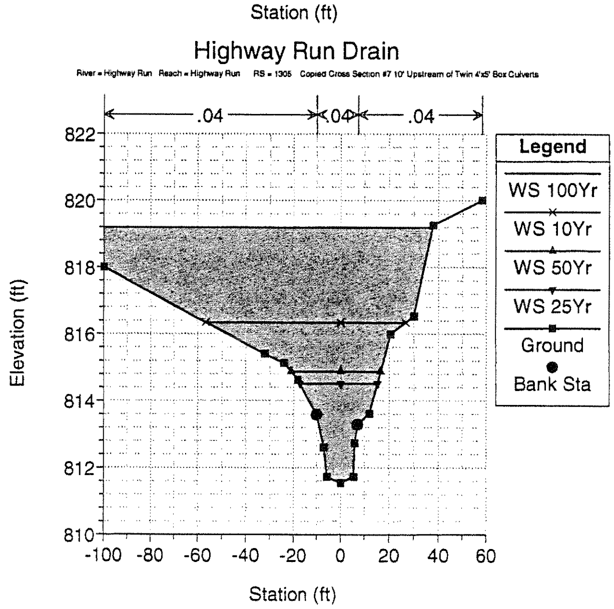

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2167 Cross Section #9 Downstream of Triple 3'x4' CMP Structure #4
.05
.04
.05
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

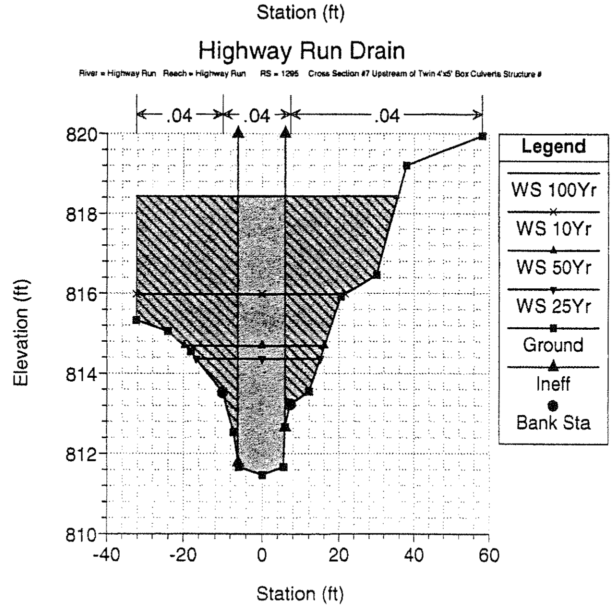

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 2119 Copied Cross Section #9 48' Downstream of Triple 3'x4' CMP Struc
.05 .04 .05
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

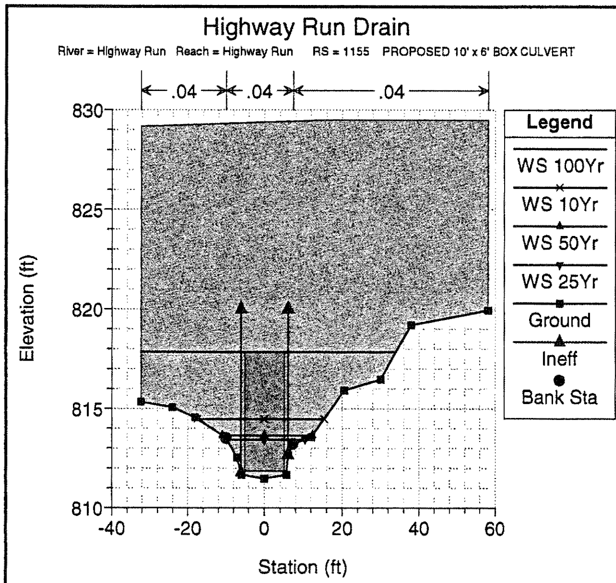

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1920 Cross Section #8
.05 .04 .05
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

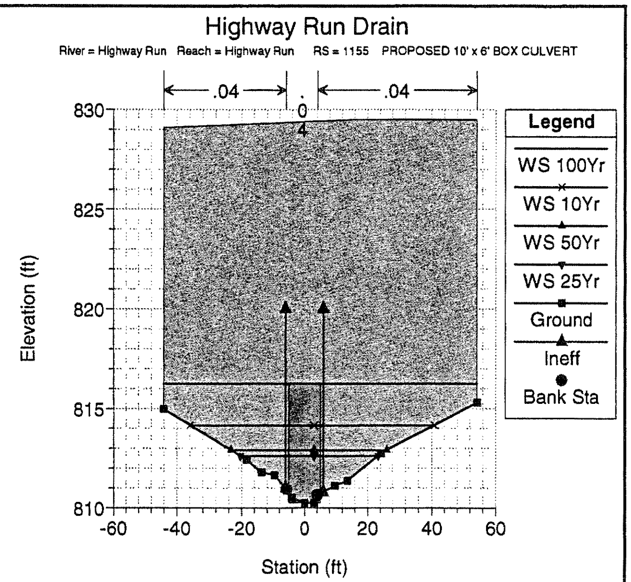

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1715.*
.047 .04 .047
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

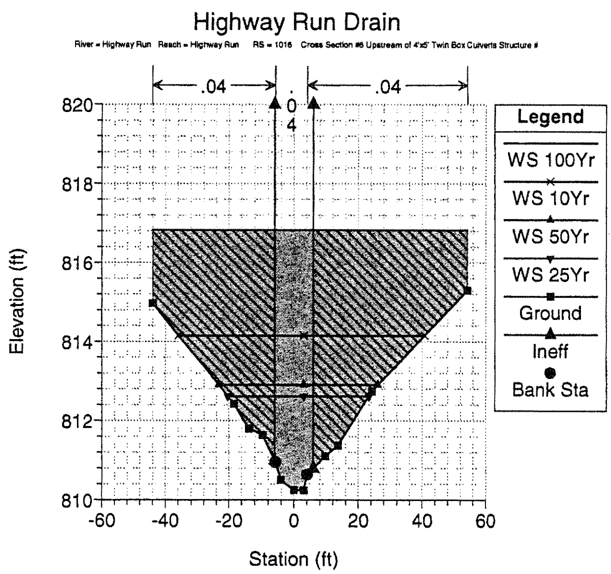

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1510.*
.043 .04 .043
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

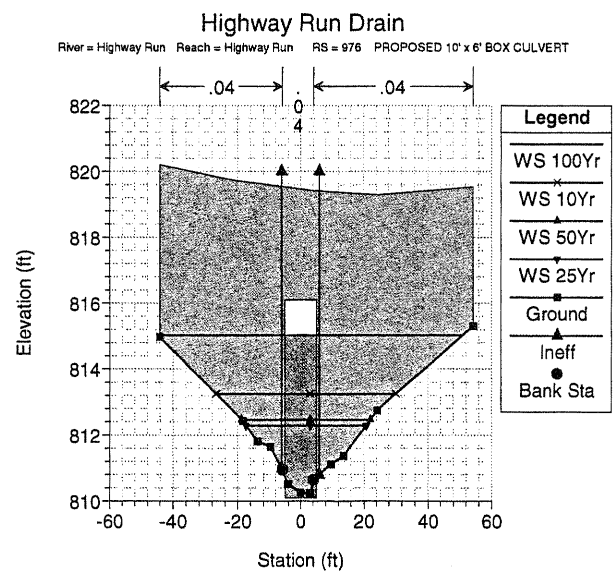

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1305 Copied Cross Section #7 10' Upstream of Twin 4'x5' Box Culverts
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

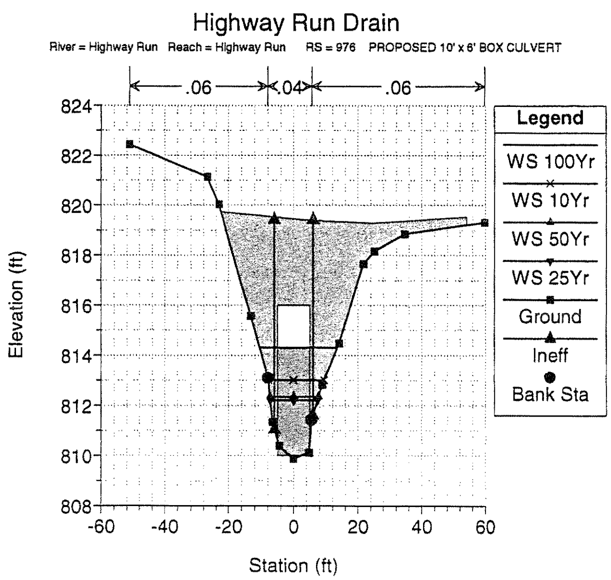

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1295 Cross Section #7 Upstream of Twin 4'x5' Box Culverts Structure #
.04 .04 .04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

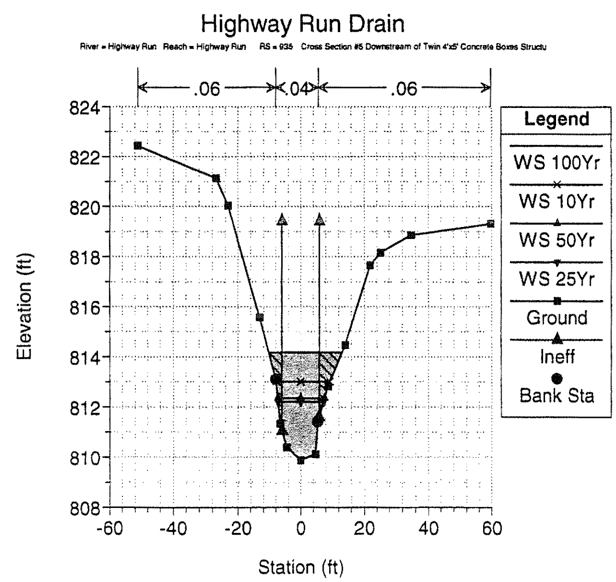

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1155 PROPOSED 10' x 6' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

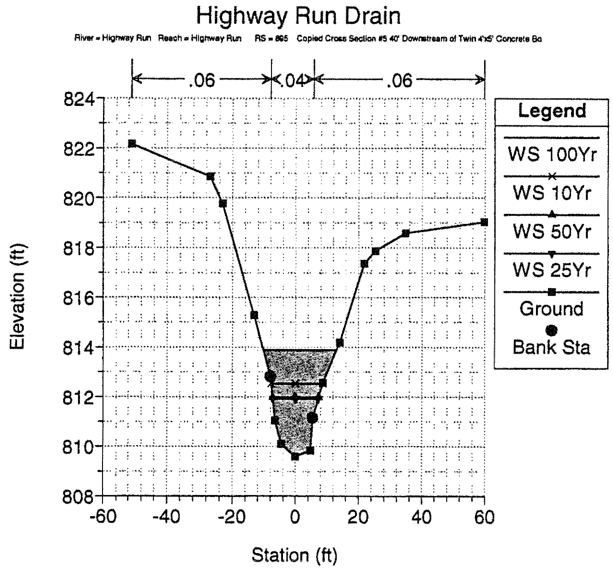

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1155 PROPOSED 10' x 6' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

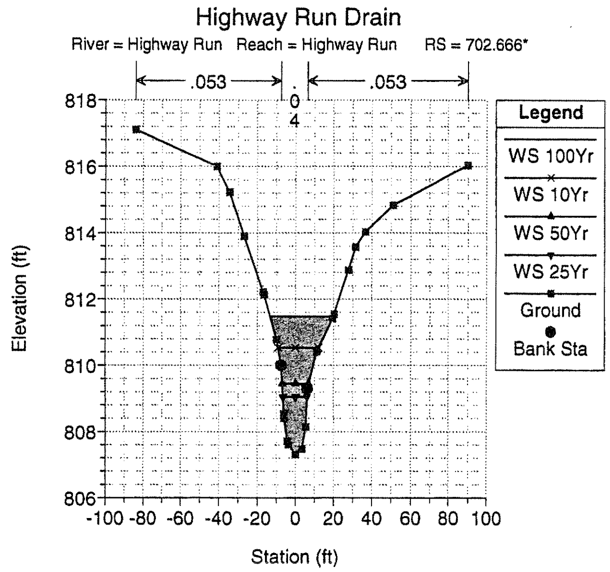

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 1016 Cross Section #6 Upstream of 4'x5' Twin Box Culverts Structure #
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

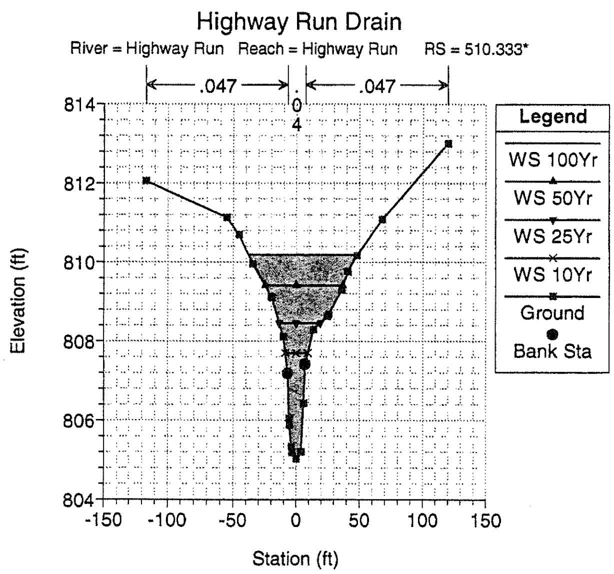

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 976 PROPOSED 10' x 6' BOX CULVERT
.04
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

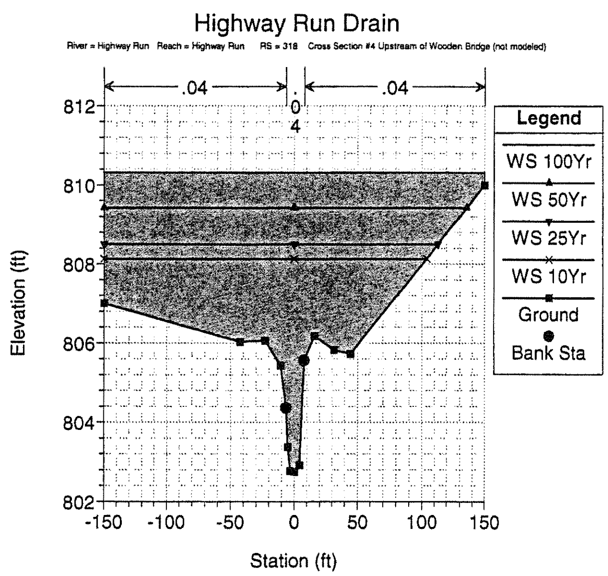

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 976 PROPOSED 10' x 6' BOX CULVERT
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

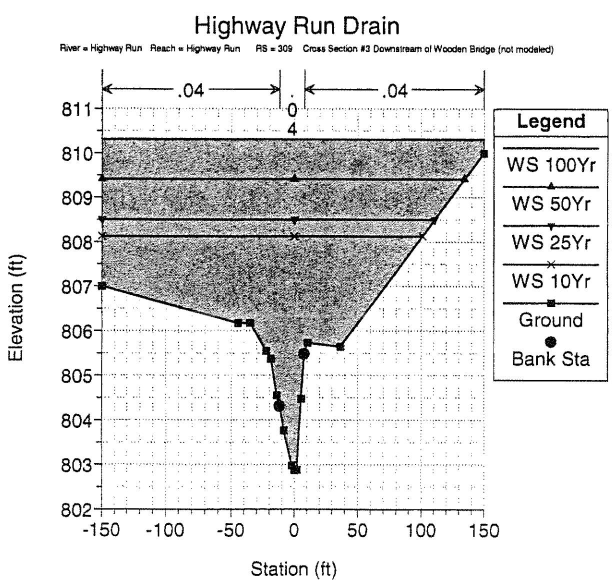

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 935 Cross Section #5 Downstream of Twin 4'x5' Concrete Boxes Structu
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Ineff
Bank Sta

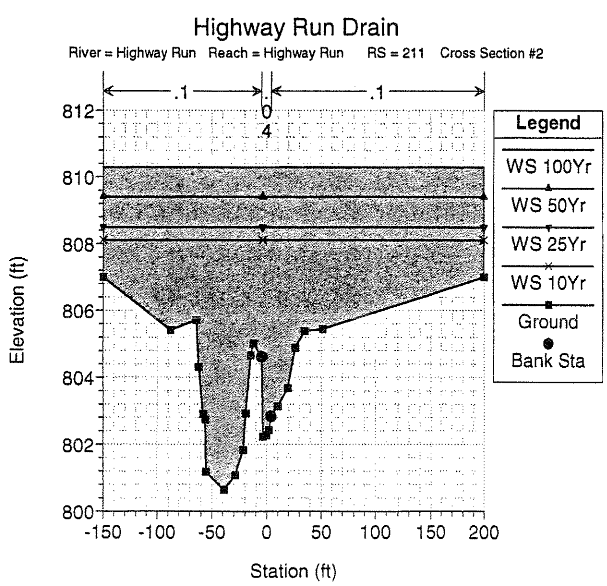

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 895 Copied Cross Section #5 40' Downstream of Twin 4'x5' Concrete Bo
.06
.04
.06
Elevation (ft)
824
822
820
818
816
814
812
810
808
-60
-40
-20
0
20
40
60
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta

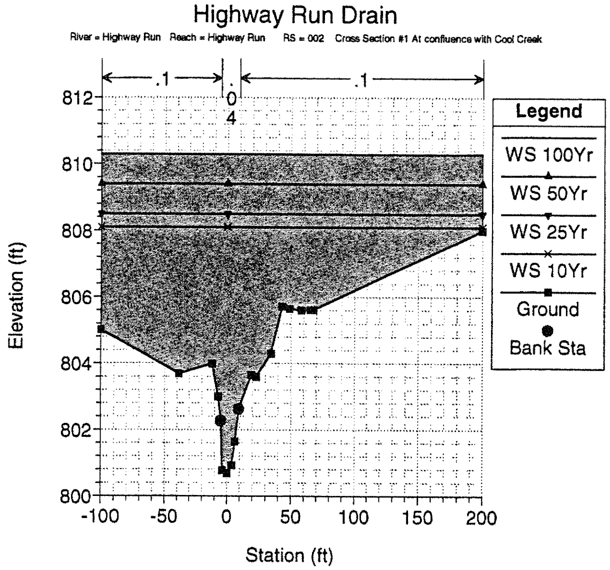

Highway Run Drain
River = Highway Run Reach = Highway Run RS = 702.666*
.053
.04
.053
Elevation (ft)
818
816
814
812
810
808
806
-100
-80
-60
-40
-20
0
20
40
60
80
100
Station (ft)
Legend
WS 100Yr
WS 10Yr
WS 50Yr
WS 25Yr
Ground
Bank Sta


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 510.333*
.047
.04
.047
Elevation (ft)
814
812
810
808
806
804
-150
-100
-50
0
50
100
150
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 318 Cross Section #4 Upstream of Wooden Bridge (not modeled)
.04
.04
.04
Elevation (ft)
812
810
808
806
804
802
-150
-100
-50
0
50
100
150
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 309 Cross Section #3 Downstream of Wooden Bridge (not modeled)
.04
.04
.04
Elevation (ft)
811
810
809
808
807
806
805
804
803
802
-150
-100
-50
0
50
100
150
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Highway Run Drain
River = Highway Run Reach = Highway Run RS = 211 Cross Section #2
.1
.04
.1
Elevation (ft)
812
810
808
806
804
802
800
-150
-100
-50
0
50
100
150
200
Station (ft)
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta


Highway Run Drain
River = Highway Run   Reach = Highway Run   RS = 002   Cross Section #1 At confluence with Cool Creek
.1
.04
.1
Legend
WS 100Yr
WS 50Yr
WS 25Yr
WS 10Yr
Ground
Bank Sta
Elevation (ft)
812
810
808
806
804
802
800
-100
-50
0
50
100
150
200
Station (ft)

HEC-RAS Plan: Proposed River: Highway Run Reach: Highway Run

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Highway Run	4733	186.00	845.28	853.06		853.06	0.000016	0.46	527.89	149.61	0.03
Highway Run	4733	67.00	845.28	849.04		849.05	0.000452	1.11	73.80	68.89	0.15
Highway Run	4733	56.00	845.28	848.58		848.61	0.001008	1.49	45.18	54.37	0.21
Highway Run	4733	88.00	845.28	849.96		849.97	0.000119	0.76	147.48	90.30	0.08
Highway Run	4723	186.00	845.21	853.04	848.57	853.05	0.000226	1.25	179.28	67.50	0.12
Highway Run	4723	67.00	845.21	848.82	847.04	849.00	0.001743	3.34	20.07	49.82	0.32
Highway Run	4723	56.00	845.21	848.39	846.87	848.55	0.001935	3.21	17.46	41.25	0.33
Highway Run	4723	88.00	845.21	849.73	847.36	849.91	0.001354	3.45	25.49	56.90	0.30
Highway Run	4688	Culvert									
Highway Run	4652	186.00	844.39	847.88	846.60	848.18	0.003291	4.40	42.31	44.40	0.44
Highway Run	4652	67.00	844.39	846.15	845.68	846.36	0.007090	3.68	18.21	31.93	0.57
Highway Run	4652	56.00	844.39	845.95	845.57	846.15	0.008294	3.62	15.47	27.73	0.60
Highway Run	4652	88.00	844.39	846.48	845.89	846.71	0.005776	3.86	22.81	33.25	0.53
Highway Run	4630	Culvert									
Highway Run	4607	186.00	844.09	846.37	846.37	847.37	0.019328	8.00	23.25	34.65	1.00
Highway Run	4607	67.00	844.09	845.80	845.39	846.05	0.007874	4.06	16.49	31.76	0.60
Highway Run	4607	56.00	844.09	845.68	845.28	845.89	0.007299	3.70	15.15	28.94	0.57
Highway Run	4607	88.00	844.09	845.90	845.59	846.29	0.010641	4.96	17.75	32.14	0.71
Highway Run	4567	186.00	843.81	845.83	845.83	846.34	0.017630	6.13	34.44	32.88	0.91
Highway Run	4567	67.00	843.81	845.09	845.09	845.49	0.023651	5.15	13.46	18.82	0.97
Highway Run	4567	56.00	843.81	844.98	844.98	845.36	0.024581	4.92	11.60	17.02	0.97
Highway Run	4567	88.00	843.81	845.31	845.31	845.71	0.019302	5.22	18.25	25.62	0.90
Highway Run	4352	186.00	840.19	845.61		845.65	0.000349	1.77	125.23	48.71	0.15
Highway Run	4352	67.00	840.19	842.97		843.03	0.001378	1.93	34.79	20.36	0.26
Highway Run	4352	56.00	840.19	842.69		842.75	0.001541	1.91	29.35	18.24	0.27
Highway Run	4352	88.00	840.19	843.47		843.53	0.001037	1.96	46.14	25.47	0.23
Highway Run	4344	186.00	840.13	845.43	842.57	845.61	0.001078	3.44	54.06	47.24	0.27
Highway Run	4344	67.00	840.13	842.91	841.54	843.01	0.001538	2.54	26.34	20.30	0.29
Highway Run	4344	56.00	840.13	842.64	841.40	842.72	0.001602	2.40	23.36	18.26	0.29
Highway Run	4344	88.00	840.13	843.38	841.76	843.50	0.001451	2.79	31.56	25.15	0.29
Highway Run	4306	Culvert									
Highway Run	4268	186.00	837.96	840.79	840.58	841.65	0.014843	7.44	25.00	17.24	0.87
Highway Run	4268	67.00	837.96	839.76	839.43	840.11	0.011116	4.76	14.07	13.88	0.70
Highway Run	4268	56.00	837.96	839.62	839.29	839.92	0.010657	4.42	12.68	13.42	0.68
Highway Run	4268	88.00	837.96	840.00	839.68	840.44	0.012001	5.35	16.44	14.65	0.74
Highway Run	4236	186.00	837.74	840.63		841.07	0.009419	5.36	34.68	17.41	0.67
Highway Run	4236	67.00	837.74	839.49		839.73	0.009387	3.95	16.97	13.71	0.63
Highway Run	4236	56.00	837.74	839.34		839.56	0.009482	3.75	14.95	13.23	0.62
Highway Run	4236	88.00	837.74	839.73		840.02	0.009466	4.31	20.43	14.51	0.64
Highway Run	3983.5*	186.00	835.30	838.13		838.58	0.010352	5.38	34.55	19.08	0.71
Highway Run	3983.5*	67.00	835.30	837.13		837.36	0.009360	3.84	17.46	15.06	0.63
Highway Run	3983.5*	56.00	835.30	837.00		837.20	0.009112	3.60	15.56	14.51	0.61
Highway Run	3983.5*	88.00	835.30	837.37		837.64	0.009312	4.16	21.17	16.08	0.64
Highway Run	3731.*	186.00	832.85	835.65		836.06	0.009515	5.11	36.43	20.71	0.68
Highway Run	3731.*	67.00	832.85	834.67		834.89	0.010186	3.76	17.80	17.21	0.65
Highway Run	3731.*	56.00	832.85	834.54		834.74	0.010441	3.59	15.59	16.52	0.65
Highway Run	3731.*	88.00	832.85	834.86		835.13	0.010617	4.17	21.10	17.92	0.68
Highway Run	3478.5*	186.00	830.41	832.94	832.62	833.39	0.011816	5.40	34.42	21.28	0.75
Highway Run	3478.5*	67.00	830.41	832.10		832.32	0.010184	3.72	18.02	17.76	0.65
Highway Run	3478.5*	56.00	830.41	832.00	831.71	832.18	0.009823	3.47	16.15	17.22	0.63
Highway Run	3478.5*	88.00	830.41	832.33	831.99	832.57	0.009619	3.97	22.17	18.90	0.65
Highway Run	3226	186.00	827.97	830.44	829.94	830.80	0.008813	4.84	38.39	22.30	0.65
Highway Run	3226	67.00	827.97	829.41		829.63	0.011127	3.79	17.66	17.93	0.67
Highway Run	3226	56.00	827.97	829.28	829.05	829.49	0.011605	3.62	15.46	17.40	0.68
Highway Run	3226	88.00	827.97	829.57		829.85	0.012108	4.27	20.61	18.62	0.72
Highway Run	3005.*	186.00	826.05	829.55		829.73	0.002831	3.39	56.55	30.60	0.39
Highway Run	3005.*	67.00	826.05	828.15	827.48	828.26	0.003771	2.69	24.90	18.74	0.41
Highway Run	3005.*	56.00	826.05	828.00	827.38	828.10	0.003784	2.54	22.05	18.21	0.41

HEC-RAS Plan: Proposed River: Highway Run Reach: Highway Run (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Highway Run	3005.*	88.00	826.05	828.62	827.65	828.72	0.002602	2.59	34.00	20.35	0.35
Highway Run	2784	350.00	824.13	829.31		829.40	0.001031	2.85	177.75	114.89	0.25
Highway Run	2784	85.00	824.13	825.76	825.76	826.30	0.024750	5.92	14.36	13.46	1.01
Highway Run	2784	71.00	824.13	825.62	825.62	826.11	0.025408	5.67	12.52	12.78	1.01
Highway Run	2784	180.00	824.13	826.91		827.37	0.010630	5.46	33.29	21.08	0.72
Highway Run	2776	350.00	823.80	828.97	826.82	829.30	0.003615	4.75	89.95	100.87	0.45
Highway Run	2776	85.00	823.80	825.71	825.11	825.94	0.006122	3.86	22.01	15.04	0.53
Highway Run	2776	71.00	823.80	825.49	824.98	825.70	0.006676	3.72	19.08	14.37	0.55
Highway Run	2776	180.00	823.80	826.91	825.84	827.25	0.004497	4.65	38.71	21.96	0.49
Highway Run	2737	Culvert									
Highway Run	2698	350.00	823.58	827.44	826.60	828.22	0.007581	7.12	49.17	27.99	0.67
Highway Run	2698	85.00	823.58	825.52	824.92	825.75	0.006177	3.80	22.37	14.90	0.53
Highway Run	2698	71.00	823.58	825.34	824.78	825.54	0.006294	3.58	19.84	14.30	0.53
Highway Run	2698	180.00	823.58	826.44	825.64	826.84	0.006125	5.12	35.18	18.20	0.57
Highway Run	2666	350.00	823.06	826.54	826.54	827.75	0.016148	8.92	42.03	20.85	0.94
Highway Run	2666	85.00	823.06	824.68	824.68	825.28	0.024562	6.22	13.67	11.56	1.01
Highway Run	2666	71.00	823.06	824.53	824.53	825.08	0.025082	5.93	11.97	11.11	1.01
Highway Run	2666	180.00	823.06	825.48	825.48	826.36	0.021777	7.56	23.89	14.31	1.00
Highway Run	2434	350.00	818.50	825.65		825.67	0.000188	1.57	340.03	148.37	0.11
Highway Run	2434	85.00	818.50	821.28		821.36	0.001629	2.31	36.80	17.28	0.28
Highway Run	2434	71.00	818.50	820.97		821.05	0.001718	2.24	31.68	16.26	0.28
Highway Run	2434	180.00	818.50	823.00		823.10	0.001013	2.52	78.70	41.53	0.24
Highway Run	2422	350.00	818.40	825.63	821.35	825.66	0.000266	1.76	309.03	153.29	0.13
Highway Run	2422	85.00	818.40	821.26	819.65	821.34	0.001268	2.35	36.20	17.48	0.26
Highway Run	2422	71.00	818.40	820.96	819.51	821.03	0.001336	2.22	31.99	16.47	0.26
Highway Run	2422	180.00	818.40	822.94	820.39	823.08	0.001070	3.01	59.74	41.87	0.26
Highway Run	2404	Culvert									
Highway Run	2386	400.00	818.20	825.00	821.38	825.02	0.000253	1.76	353.83	157.64	0.12
Highway Run	2386	110.00	818.20	821.17	819.57	821.30	0.001871	2.90	37.99	16.28	0.31
Highway Run	2386	91.00	818.20	820.88	819.41	820.99	0.001785	2.67	34.09	15.80	0.30
Highway Run	2386	220.00	818.20	822.65	820.36	822.87	0.001824	3.75	58.70	46.78	0.32
Highway Run	2338	400.00	818.00	824.96		825.01	0.000345	2.01	297.56	145.48	0.15
Highway Run	2338	110.00	818.00	821.05		821.19	0.002717	2.95	37.35	18.46	0.36
Highway Run	2338	91.00	818.00	820.76		820.88	0.002821	2.84	32.04	17.25	0.37
Highway Run	2338	220.00	818.00	822.60		822.75	0.001726	3.08	75.35	36.00	0.31
Highway Run	2322	400.00	817.90	824.93		824.99	0.000515	2.46	236.87	97.70	0.18
Highway Run	2322	110.00	817.90	820.84		821.11	0.005843	4.16	26.43	12.98	0.51
Highway Run	2322	91.00	817.90	820.56		820.80	0.006063	3.99	22.80	12.39	0.52
Highway Run	2322	220.00	817.90	822.39		822.69	0.003552	4.43	53.63	29.07	0.43
Highway Run	2310	400.00	817.80	824.89	821.08	824.98	0.000746	2.89	192.59	98.02	0.20
Highway Run	2310	110.00	817.80	820.87	819.26	821.00	0.002123	2.95	37.26	13.77	0.31
Highway Run	2310	91.00	817.80	820.58	819.09	820.70	0.002014	2.71	33.54	13.52	0.30
Highway Run	2310	220.00	817.80	822.40	820.06	822.62	0.002064	3.82	58.18	30.84	0.32
Highway Run	2282	Culvert									
Highway Run	2255	400.00	817.70	823.44	821.25	823.68	0.002298	4.26	128.33	91.45	0.35
Highway Run	2255	110.00	817.70	820.78	819.28	820.94	0.002747	3.18	34.62	13.39	0.35
Highway Run	2255	91.00	817.70	820.51	819.10	820.64	0.002567	2.93	31.02	13.01	0.33
Highway Run	2255	220.00	817.70	822.12	820.15	822.39	0.002793	4.13	53.31	16.93	0.37
Highway Run	2219	400.00	817.60	823.41		823.57	0.001451	3.41	143.00	75.59	0.30
Highway Run	2219	110.00	817.60	820.71		820.83	0.002383	2.82	39.01	18.60	0.34
Highway Run	2219	91.00	817.60	820.43		820.54	0.002380	2.68	33.96	17.52	0.34
Highway Run	2219	220.00	817.60	822.09		822.25	0.002040	3.21	68.98	31.09	0.33
Highway Run	2207	400.00	817.60	823.33	820.95	823.53	0.001876	4.03	134.01	75.00	0.31
Highway Run	2207	110.00	817.60	820.65	819.08	820.80	0.001986	3.12	35.29	14.09	0.32
Highway Run	2207	91.00	817.60	820.39	818.91	820.51	0.001849	2.83	32.17	13.76	0.30
Highway Run	2207	220.00	817.60	821.88	819.88	822.18	0.002466	4.39	50.12	23.45	0.38
Highway Run	2187	Culvert									

HEC-RAS Plan: Proposed River: Highway Run Reach: Highway Run (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Highway Run	2167	400.00	817.50	822.74	820.80	823.04	0.002989	4.67	109.48	61.10	0.40
Highway Run	2167	110.00	817.50	820.59	818.92	820.73	0.001781	3.01	36.49	14.81	0.30
Highway Run	2167	91.00	817.50	820.34	818.75	820.46	0.001620	2.72	33.50	14.18	0.29
Highway Run	2167	220.00	817.50	821.53	819.73	821.86	0.002906	4.61	47.75	22.07	0.41
Highway Run	2119	400.00	817.50	822.65		822.88	0.002219	4.18	122.77	61.10	0.37
Highway Run	2119	110.00	817.50	820.50		820.62	0.002581	2.87	38.41	20.02	0.36
Highway Run	2119	91.00	817.50	820.25		820.36	0.002597	2.71	33.60	18.47	0.35
Highway Run	2119	220.00	817.50	821.45		821.66	0.002930	3.77	60.58	29.79	0.40
Highway Run	1920	510.00	816.44	821.64	820.45	822.14	0.005788	6.65	114.45	60.08	0.56
Highway Run	1920	137.00	816.44	819.08	818.74	819.58	0.010937	5.85	25.55	15.15	0.70
Highway Run	1920	114.00	816.44	818.84	818.50	819.31	0.011148	5.57	22.04	14.55	0.70
Highway Run	1920	241.00	816.44	820.04	819.48	820.64	0.009415	6.52	41.27	17.59	0.68
Highway Run	1715.*	510.00	814.81	818.85	818.76	820.19	0.016058	9.80	61.33	30.12	0.94
Highway Run	1715.*	137.00	814.81	817.53	816.83	817.85	0.006347	4.66	31.72	19.04	0.55
Highway Run	1715.*	114.00	814.81	817.33	816.62	817.61	0.006005	4.32	28.08	18.28	0.53
Highway Run	1715.*	241.00	814.81	817.95	817.62	818.58	0.010626	6.59	40.20	20.72	0.73
Highway Run	1510.*	510.00	813.17	819.19		819.31	0.000976	3.41	234.88	109.00	0.26
Highway Run	1510.*	137.00	813.17	815.10		815.73	0.018952	6.36	21.56	14.89	0.92
Highway Run	1510.*	114.00	813.17	814.86	814.82	815.47	0.021478	6.27	18.19	13.74	0.96
Highway Run	1510.*	241.00	813.17	816.36		816.81	0.006813	5.54	48.29	28.55	0.60
Highway Run	1305	510.00	811.54	819.20		819.22	0.000127	1.49	495.40	137.69	0.10
Highway Run	1305	137.00	811.54	814.87		814.96	0.001152	2.42	65.40	37.69	0.25
Highway Run	1305	114.00	811.54	814.51		814.60	0.001376	2.41	52.77	32.56	0.27
Highway Run	1305	241.00	811.54	816.34		816.40	0.000573	2.25	149.60	83.48	0.19
Highway Run	1295	510.00	811.47	818.44	815.41	819.04	0.002310	6.20	82.28	68.05	0.42
Highway Run	1295	137.00	811.47	814.69	813.17	814.90	0.002343	3.68	37.23	35.94	0.37
Highway Run	1295	114.00	811.47	814.37	812.99	814.55	0.002338	3.42	33.37	31.70	0.36
Highway Run	1295	241.00	811.47	815.98	813.90	816.31	0.002268	4.57	52.76	54.03	0.38
Highway Run	1155	Culvert									
Highway Run	1016	510.00	810.24	816.83	814.27	817.52	0.002770	6.70	76.49	98.40	0.47
Highway Run	1016	137.00	810.24	812.91	812.05	813.24	0.004840	4.72	29.38	49.54	0.53
Highway Run	1016	114.00	810.24	812.62	811.87	812.92	0.005058	4.46	25.96	43.80	0.53
Highway Run	1016	241.00	810.24	814.15	812.78	814.61	0.003801	5.48	44.35	76.74	0.50
Highway Run	976	Culvert									
Highway Run	935	510.00	809.87	814.19	814.07	816.01	0.014919	10.87	47.46	23.48	0.96
Highway Run	935	137.00	809.87	812.35	811.82	812.81	0.008461	5.43	25.43	15.10	0.65
Highway Run	935	114.00	809.87	812.21	811.63	812.57	0.007373	4.85	23.71	14.67	0.60
Highway Run	935	241.00	809.87	813.02	812.56	813.84	0.010620	7.28	33.44	17.32	0.76
Highway Run	895	510.00	809.59	813.90		815.20	0.013108	9.41	61.47	23.42	0.86
Highway Run	895	137.00	809.59	811.98	811.55	812.44	0.010167	5.43	25.85	14.83	0.69
Highway Run	895	114.00	809.59	811.92	811.35	812.26	0.007797	4.67	24.94	14.64	0.60
Highway Run	895	241.00	809.59	812.53		813.35	0.014059	7.32	34.46	16.51	0.83
Highway Run	702.666*	510.00	807.31	811.48	811.48	812.68	0.012519	9.18	66.94	33.17	0.85
Highway Run	702.666*	137.00	807.31	809.45		810.03	0.015417	6.12	22.44	14.07	0.83
Highway Run	702.666*	114.00	807.31	809.06	809.06	809.73	0.023505	6.60	17.27	12.86	1.00
Highway Run	702.666*	241.00	807.31	810.53	809.98	811.13	0.008789	6.28	41.11	21.32	0.68
Highway Run	510.333*	510.00	805.03	810.19		810.50	0.002876	5.22	152.76	86.56	0.43
Highway Run	510.333*	137.00	805.03	809.41		809.46	0.000554	2.02	94.87	62.40	0.18
Highway Run	510.333*	114.00	805.03	808.46		808.56	0.001380	2.64	48.94	32.94	0.27
Highway Run	510.333*	241.00	805.03	807.70	807.67	808.66	0.018335	7.88	31.24	18.23	0.95
Highway Run	318	510.00	802.75	810.32		810.33	0.000027	0.67	1096.16	300.00	0.04
Highway Run	318	137.00	802.75	809.42		809.42	0.000005	0.25	829.94	285.78	0.02
Highway Run	318	114.00	802.75	808.51		808.51	0.000009	0.32	578.31	263.21	0.02
Highway Run	318	241.00	802.75	808.13		808.14	0.000070	0.84	481.25	253.97	0.07
Highway Run	309	510.00	802.87	810.32		810.32	0.000027	0.67	1093.47	300.00	0.05
Highway Run	309	137.00	802.87	809.42		809.42	0.000004	0.25	827.71	284.79	0.02
Highway Run	309	114.00	802.87	808.50		808.50	0.000009	0.31	579.03	261.09	0.02
Highway Run	309	241.00	802.87	808.13		808.13	0.000067	0.80	482.24	251.26	0.07

HEC-RAS Plan: Proposed River: Highway Run Reach: Highway Run (Continued)

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Highway Run	211	510.00	802.23	810.31		810.31	0.000037	0.80	1795.58	350.00	0.05
Highway Run	211	137.00	802.23	809.41		809.41	0.000005	0.27	1480.46	350.00	0.02
Highway Run	211	114.00	802.23	808.50		808.50	0.000007	0.30	1163.51	350.00	0.02
Highway Run	211	241.00	802.23	808.11		808.11	0.000047	0.72	1027.39	350.00	0.05
Highway Run	002	510.00	800.68	810.30	804.72	810.30	0.000042	1.00	1509.62	300.00	0.06
Highway Run	002	137.00	800.68	809.40	802.62	809.40	0.000005	0.34	1239.63	300.00	0.02
Highway Run	002	114.00	800.68	808.50	802.44	808.50	0.000007	0.36	969.62	300.00	0.02
Highway Run	002	241.00	800.68	808.10	803.32	808.10	0.000047	0.88	849.61	300.00	0.06

APPENDIX G

DETAILED COST ESTIMATES

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
151st Street				
Roadway Elevation Modification	TN	150	$40	$6,000
Milling, Striping, Surface Restoration, Traffic Control	LS	1	n/a	$1,000
			Subtotal	$7,000
			Contingency (20%)	$1,400
			Total Estimated Construction	$8,400
			Engineering, Legal, Administration (20%)	$1,680
			151st Street Project Total	**$10,080**
			SAY	**$10,000**
171st Street				
Roadway Elevation Modification	TN	750	$40	$30,000
Milling, Striping, Surface restoration, Traffic Control	LS	1	n/a	$3,000
Superstructure Removal	LS	1	n/a	$60,000
Superstructure	LS	1	n/a	$175,000
Roadway Approaches	LS	1	n/a	$40,000
New Abutments and Pier (including removal of existing)	LS	1	n/a	$175,000
Soil Borings	LS	1	n/a	$5,000
			Subtotal	$488,000
			Contingency (20%)	$97,600
			Total Estimated Construction	$585,600
			Engineering, Legal, Administration (20%)	$117,120
			171st Street Project Total	**$702,720**
			SAY	**$700,000**
Gurley Street				
Superstructure Removal	LS	1	n/a	$20,000
Superstructure	LS	1	n/a	$60,000
Roadway Approaches	LS	1	n/a	$40,000
New Abutments (including removal of existing)	LS	1	n/a	$70,000
Soil Borings	LS	1	n/a	$5,000
			Subtotal	$195,000
			Contingency (20%)	$39,000
			Total Estimated Construction	$234,000
			Engineering, Legal, Administration (20%)	$46,800
			Gurley Street Project Total	**$280,800**
			SAY	**$280,000**

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
Cherry Street				
Superstructure Removal	LS	1	n/a	$30,000
Superstructure	LS	1	n/a	$60,000
Roadway Approaches	LS	1	n/a	$40,000
Widening Abutments	LS	1	n/a	$100,000
Soil Borings	LS	1	n/a	$5,000
			Subtotal	$235,000
			Contingency (20%)	$47,000
			Total Estimated Construction	$282,000
			Engineering, Legal, Administration (20%)	$56,400
			Cherry Street Project Total	**$338,400**
			SAY	**$340,000**
Carmel Drive Overtopping (Hot Lick Creek)				
10' x 4' Concrete Box Culvert	LF	120	$350	$42,000
45^0 Wingwall	EA	2	$5,000	$10,000
Pavement Restoration	SY	70	$50	$3,500
Channel Regrading and Shaping	LS	1	n/a	$6,000
			Subtotal	$61,500
			Contingency (20%)	$12,300
			Total Estimated Construction	$73,800
			Engineering, Legal, Administration (20%)	$14,760
			Cherry Street Project Total	**$88,560**
			SAY	**$90,000**
Swimming Pool Inundation (Hot Lick Creek)				
Channel Regrading and Shaping	LS	1	n/a	$6,000
			Subtotal	$6,000
			Contingency (20%)	$1,200
			Total Estimated Construction	$7,200
			Engineering, Legal, Administration (20%)	$1,440
			Cherry Street Project Total	**$8,640**
			SAY	**$10,000**

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
Streambank Erosion D/S of Stonehedge Drive (Highway Run)				
Streambank Restoration/Improvements	LF	100	$35	$3,500
			Subtotal	$3,500
			Contingency (20%)	$700
			Total Estimated Construction	$4,200
			Engineering, Legal, Administration (20%)	$840
			Cherry Street Project Total	**$5,040**
			SAY	**$5,000**
Streambank Erosion D/S of Rolling Court (H.G. Kenyan)				
Streambank Restoration/Improvements	LF	250	$40	$10,000
			Subtotal	$10,000
			Contingency (20%)	$2,000
			Total Estimated Construction	$12,000
			Engineering, Legal, Administration (20%)	$2,400
			Cherry Street Project Total	**$14,400**
			SAY	**$15,000**
Streambank Erosion U/S of Confluence with White River				
Streambank Restoration/Improvements	LF	1500	$140	$210,000
			Subtotal	$210,000
			Contingency (20%)	$42,000
			Total Estimated Construction	$252,000
			Engineering, Legal, Administration (20%)	$50,400
			Cherry Street Project Total	**$302,400**
			SAY	**$300,000**

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
Streambank Erosion D/S of Gray Road				
Streambank Restoration/Improvements	LF	200	$250	$50,000
			Subtotal	$50,000
			Contingency (20%)	$10,000
			Total Estimated Construction	$60,000
			Engineering, Legal, Administration (20%)	$12,000
			Cherry Street Project Total	**$72,000**
			SAY	**$75,000**
Streambank Erosion Near Hot Lick Creek Confluence				
Streambank Restoration/Improvements	LF	575	$150	$86,250
			Subtotal	$86,250
			Contingency (20%)	$17,250
			Total Estimated Construction	$103,500
			Engineering, Legal, Administration (20%)	$20,700
			Cherry Street Project Total	**$124,200**
			SAY	**$125,000**
Streambank Erosion U/S of 131st Street				
Streambank Restoration/Improvements	LF	150	$90	$13,500
			Subtotal	$13,500
			Contingency (20%)	$2,700
			Total Estimated Construction	$16,200
			Engineering, Legal, Administration (20%)	$3,240
			Cherry Street Project Total	**$19,440**
			SAY	**$20,000**
Streambank Erosion U/S of Keystone Avenue				
Streambank Restoration/Improvements	LF	100	$180	$18,000
			Subtotal	$18,000
			Contingency (20%)	$3,600
			Total Estimated Construction	$21,600
			Engineering, Legal, Administration (20%)	$4,320
			Cherry Street Project Total	**$25,920**
			SAY	**$30,000**

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
171st Street Regional Stormwater Detention Pond				
Pond Construction/Excavation	CF	4,374,000	$0.35	$1,530,900
Inlet/Outlet Structure	EA	2	$10,000	$20,000
			Subtotal	$1,550,900
			Contingency (20%)	$310,180
			Total Estimated Construction	$1,861,080
			Engineering, Legal, Administration (20%)	$372,216
			Land Acquisition	$330,000
			Cherry Street Project Total	**$2,563,296**
			SAY	**$2,600,000**
Grassy Branch Road Regional Stormwater Detention Pond				
Pond Construction/Excavation	CF	2,646,000	$0.35	$926,100
Inlet/Outlet Structure	EA	2	$10,000	$20,000
			Subtotal	$946,100
			Contingency (20%)	$189,220
			Total Estimated Construction	$1,135,320
			Engineering, Legal, Administration (20%)	$227,064
			Land Acquisition	$480,000
			Cherry Street Project Total	**$1,842,384**
			SAY	**$1,800,000**
Existing Pond Retrofit - Anna Kendall Drain - Railroad Impoundment				
Soil Analysis - Existing Embankment	LS	1	$15,000	$15,000
Dambreak Analysis (Pre-design requirement)	LS	1	$15,000	$15,000
Obtain IDNR Dam Safety Permit	LS	1	$12,000	$12,000
Clearing and Grubbing	LS	1	$10,000	$10,000
Remove Existing Embankment	CY	6000	$8.00	$48,000
Construct New Embankment (Engineered Fill)	CY	12000	$15.00	$180,000
Primary Outlet Structure	LS	1	$30,000	$30,000
Primary Outlet Pipe (72" - 84" diam.)	LF	180	$300.00	$54,000
Emergency Spillway	LS	1	$50,000	$50,000
Restoration and Erosion Control	LS	1	$17,500	$17,500
			Subtotal	$431,500
			Contingency (20%)	$86,300
			Total Estimated Construction	$517,800
			Engineering, Legal, Administration (20%)	$103,560
			Land Acquisition	$75,000
			Anna Kendall Pond Retrofit Project Total	**$696,360**
			SAY	**$700,000**

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
Private Drive Culvert Replacement - Immediately Downstream of US 31 (Highway Run)				
Remove and dispose of existing culvert	LS	1	$4,000	$4,000
Construct new 10' x 6' box culvert (includes excavation)	LF	76	$500	$38,000
Headwall/wingwall	EA	2	$7,500	$15,000
Riprap (w/geotextile fabric)	CY	75	$50	$3,750
Driveway regrading and restoration	LS	1	$7,500	$7,500
			Subtotal	$68,250
			Contingency (20%)	$13,650
			Total Estimated Construction	$81,900
			Engineering, Legal, Administration (20%)	$16,380
			Private Drive @ US 31 Project Total	**$98,280**
			SAY	**$100,000**
US 31 Culvert Replacement (Highway Run)				
Channel Reshaping near culverts	LS	1	$10,000	$10,000
Bore and Jack 84" Casing, 60" RCP	LF	270	$1,600	$432,000
Headwall/wingwall	EA	2	$15,000	$30,000
Riprap w/geotextile fabric	CY	100	$50	$5,000
Restoration	LS	1	$7,500	$7,500
			Subtotal	$484,500
			Contingency (20%)	$96,900
			Total Estimated Construction	$581,400
			Engineering, Legal, Administration (20%)	$116,280
			US 31 Project Total	**$697,680**
			SAY	**$700,000**
Walter Street / Walter Court / Private Crossing Culvert Replacements (Highway Run)				
Sawcut Roadways, Driveways	LF	150	$4	$600
Remove and dispose of existing culverts	EA	3	$2,000	$6,000
Channel reshaping	LF	400	$60	$24,000
12' x 4' Reinforced Concrete Box Culvert	LF	135	$400	$54,000
Headwall/wingwall	EA	6	$5,000	$30,000
Riprap (replace existing riprap in channel)	CY	75	$50	$3,750
Roadway/Driveway Patches	EA	3	$2,000	$6,000
Restoration	LS	1	$10,000	$10,000
			Subtotal	$134,350
			Contingency (20%)	$26,870
			Total Estimated Construction	$161,220
			Engineering, Legal, Administration (20%)	$32,244
			Walter Street Area Culvert Replacement Project Total	**$193,464**
			SAY	**$200,000**

Project Cost Estimates
Cool Creek Watershed Management Plan

Description	Unit	Quantity	Unit Price	Total
Thornberry Drive Culvert Replacement (Highway Run)				
Channel Reshaping near culvert	LS	1	$2,000	$2,000
Sawcut pavement, excavation, culvert removal	LS	1	$4,000	$4,000
11' x 3.5' Reinforced Concrete Box Culvert	LF	78	$400	$31,200
Headwall/wingwall	EA	2	$6,000	$12,000
Riprap w/geotextile fabric	CY	50	$50	$2,500
Pavement patch	SF	600	$5	$3,000
Restoration	LS	1	$3,000	$3,000
			Subtotal	$57,700
			Contingency (20%)	$11,540
			Total Estimated Construction	$69,240
			Engineering, Legal, Administration (20%)	$13,848
			US 31 Project Total	**$83,088**
			SAY	**$80,000**
SR 32 (Main Street) Culvert Replacement (J.M. Thompson Drain)				
Channel Reshaping near culvert	LS	1	$5,000	$5,000
Sawcut pavement, excavation, culvert removal	LS	1	$15,000	$15,000
12' x 8' Reinforced Concrete Box Culvert	LF	200	$650	$130,000
Headwall/wingwall	EA	2	$20,000	$40,000
Riprap w/geotextile fabric	CY	100	$50	$5,000
Pavement patch	SF	1500	$5	$7,500
Traffic Control	LS	1	$5,000	$5,000
Restoration	LS	1	$5,000	$5,000
			Subtotal	$212,500
			Contingency (20%)	$42,500
			Total Estimated Construction	$255,000
			Engineering, Legal, Administration (20%)	$51,000
			US 31 Project Total	**$306,000**
			SAY	**$310,000**

TOTAL OF ALL COST ESTIMATES	**$8,490,000**

APPENDIX H

ADDITIONAL 319 UPDATE INFORMATION

APPENDIX H.1

PUBLIC MEETING EXHIBITS

PUBLIC MEETING 1

HAMILTON COUNTY DRAINAGE BOARD, CITY of CARMEL and the TOWN of WESTFIELD

SIGN-IN SHEET FOR COOL CREEK WATERSHED STUDY

Location:	**Cool Creek Nature Center Auditorium, 2000 E. 151st Street, Carmel, In**		
Consultant:	**Clark-Dietz, Inc.**	**Presenters: Hans Peterson, P.E.**	
Date:	**4/13/2005**	**Start Time: 7:00 PM**	**End Time:**

	FIRST NAME (Please print)	LAST NAME (Please print)	ADDRESS (Please print)	PHONE #	EMAIL (Please print)
1.	CARRIE	COUGHLIN	TOWN OF WESTFIELD	896-5577	ccoughlin@westfieldtown.org
2.	Ted	Engelbrecht	522 Wind Skip Circle Westfield	896-9295	saale@hotmail.com
3.	Paul/Audrey	Woodward	9311 E. 221st St. Cicero	984-8135	
4.	Jerry/Carol	Rulon	9990 E 256 St Cicero	984-3902	
5.	Sarah	Baxter	919. N. East St. Indy 46202	317-450-7245	sbaxter@williamscreek...
6.	Kurt	Wanninger	Town of Westfield	896-5452	—
7.	Amanda	Foley	City of Carmel	571-2441	
8.	Benbury	Carstensen	10826 E 166th St Noblesville	770-9075	
9.	Eric	Carstensen	10826 E 166th St Noblesville	770-9075	
10.	Mic	Mead	15466 Oak Rd Carm	846-6257	MICMEAD1@aol...
11.	Bob	Thompson			
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					

PUBLIC MEETING SUMMARY

Project:	Cool Creek Watershed Management Plan
Date:	April 13, 2005
Time:	7:00 p.m.
Location:	Cool Creek Nature Center Auditorium
	2000 E. 151st Street, Carmel, In
Staff Attendees:	Bob Thompson – Hamilton County
	Hans Peterson – Clark Dietz
	Sam Robertson – Clark Dietz

A public information meeting was held to introduce the update of the Cool Creek Watershed Management Plan. Approximately 13 people attended the meeting. A list of attendees who signed in is attached to this meeting summary. The following is a summary of the meeting and follow up question and answer period.

Bob Thompson kicked off the meeting by introducing the project and the consultant preparing the management plan, Clark Dietz.

Hans Peterson gave a presentation covering the Cool Creek Watershed Study including summary of the findings, alternatives, and recommended solutions. Following the presentation the floor was opened to questions and/or comments from the public. The following were the general questions and answers:

- Is Cool Creek an impaired Stream?
  Yes, it is on the latest IDEM 303(d) list of impaired streams, with E. coli being the parameter of concern.

- What contaminants were found during sampling?
  Somewhat high levels of nutrients (nitrogen and phosphorus) were found for the spring storm that was sampled. Potential sources include residential and/or agricultural fertilizers. Higher levels were found in the upper watershed sampling location, which may point to agricultural sources. E. coli was also found to be above full body contact limits (235 cfu/100 ml).

- Are the contaminants due to Golf Courses? How many golf courses are there in the watershed?
  High levels of containments were found upstream of the only golf course in the watershed.

- Is there funding set aside to clean up damage along the stream due to ice storms?
  Currently there is no funding set aside for this type of damage, unless the damage was in a stream reach that is on a regulated drain maintenance fund.

- Is Cool Creek on a County regulated maintenance fund?
  The main channel of Cool Creek is not currently on a regulated drain maintenance fund. Some of the smaller tributary drains may be on a fund. It was noted that residents can petition the County to have a drain place on a maintenance fund.

- Where is money coming from for the project?
  Funding for projects will be a challenge and will have to be a combination of funds. Grants and regulated drain funds were mentioned. The current upgrade of the Cool Creek Plan is being funded under a Section 319 Grant administered by IDEM. It may be feasible to obtain Section 319 grants for some implementation projects as well. Stormwater fees are also being considered by many communities in Indiana, particularly as a result of increased emphasis on stormwater quality (Phase II NPDES requirements). The County is also looking to coordinate with developers to help share costs of stormwater BMPs.

- How Many watersheds are in Hamilton County?
  It was estimated that are perhaps a dozen watersheds the size of Cool Creek in Hamilton County. Watersheds can be divided into sub-watersheds, so it is difficult to identify a specific number.

- Will willow trees take over the channel eventually if not controlled?
  Recommendations for stream bank stabilization will require selective plant species to avoid the problem that can occur when willow trees become invasive.

- Invasive species such as Honey Suckle are very damaging. Is there any chance for an "adopt a stream" program to help remove some of these species along stream reaches? *This was generally thought to be a good idea and perhaps the County could work with local citizens in this effort.*

- What is being done to address the beaver problem?
  If the beaver problem is located in a regulated drain, Hamilton County has a trapper under contract to remove the beavers.

- How closely are you working with the Soil and Water Conservation?
  Hamilton County is working closely with the SWCD which is an organization of Hamilton County. SWDC was the organization responsible for the pilot stream bank stabilization project completed in Cool Creek Park.

- Is INDOT working with IDNR on the S.R. 31 improvements to included some type of wetland plants instead of the usually grass plantings?
  INDOT is now a Phase II stormwater permittee and as such, they are now required to consider stormwater quality impacts in the project planning and construction.

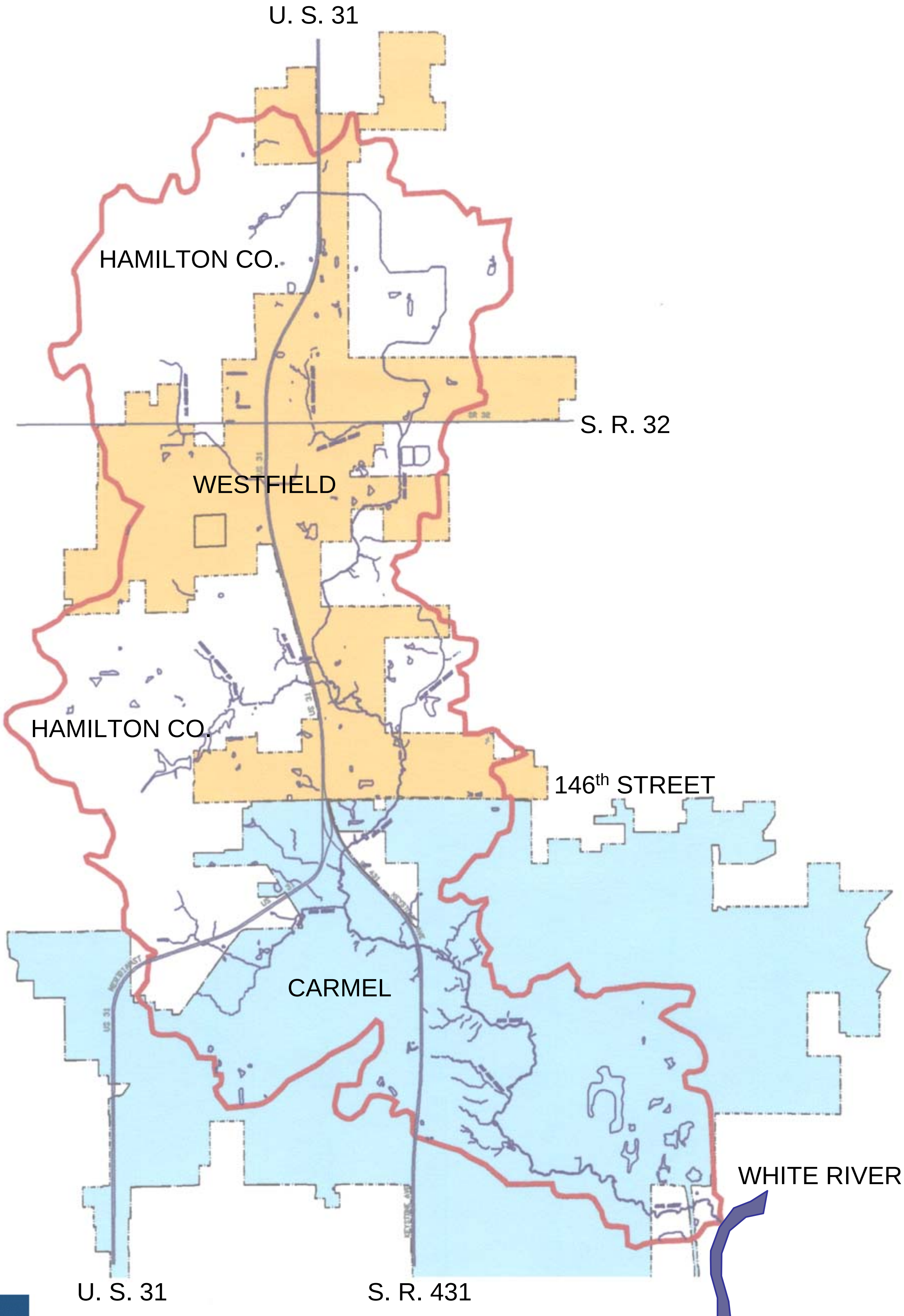
- Is there a way wetlands can be used as retention?
  Yes the county is currently looking at regional dentition ponds that act as retention and have wetland incorporated.

- Do lakes such as Morris Reservoir improve water quality and has there been testing upstream and downstream of reservoirs to determine this?
  In general lakes improve water quality by providing quiescent settling conditions. The Morse Reservoir may have been recently sampled because it is a reservoir used to supply source water for drinking water. It was mentioned that Dr. Tedesco of IUPUI Center for Earth and Environmental Science is involved in a water quality research partnership with US Filter Indianapolis Water to evaluate nutrients in three reservoirs (including Morse Reservoir).

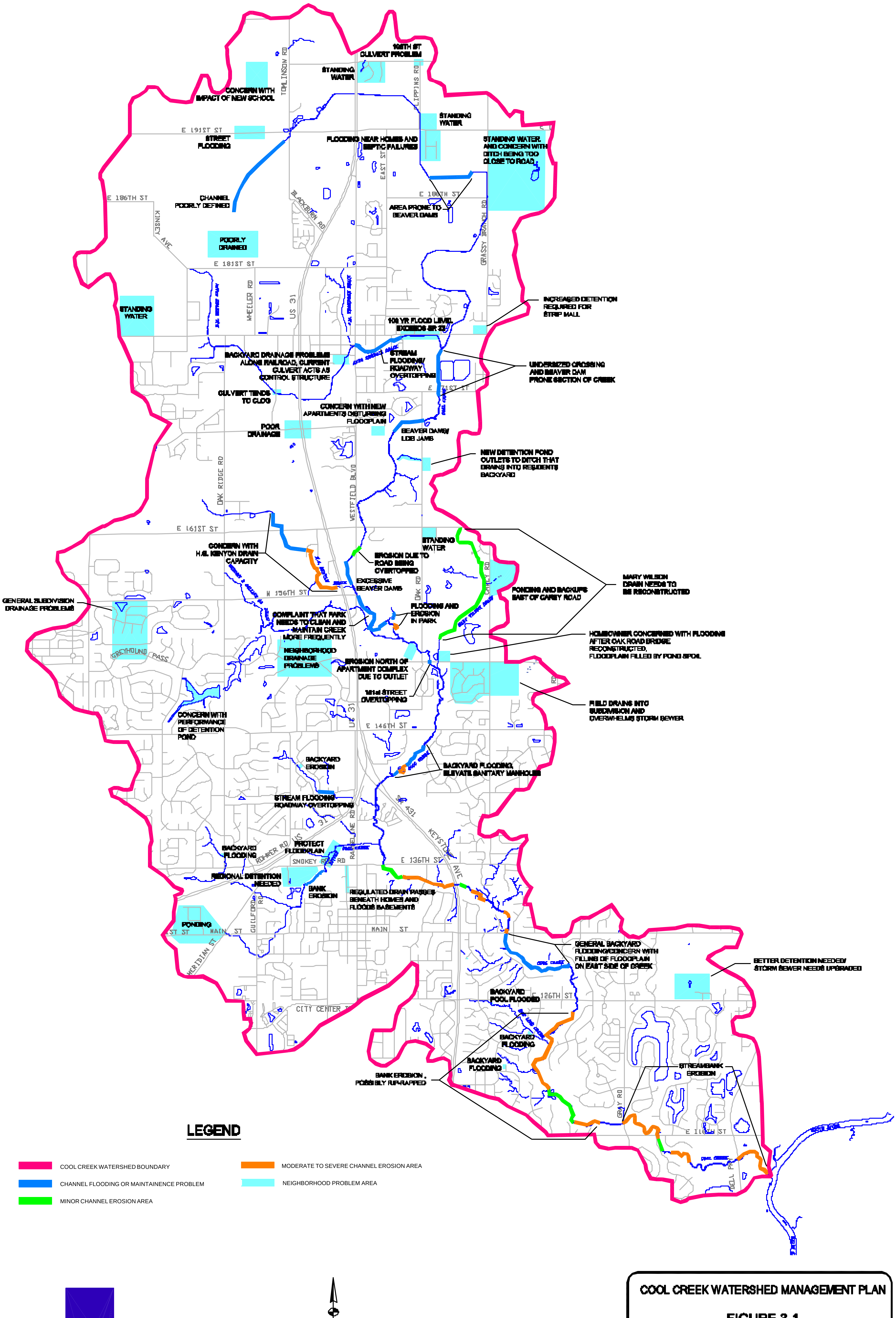
- Are there old wetland areas that have been drained for agricultural use that can be turned back into wetlands?
  Recently several farm field drains (in the northern part of the County) have failed and the fields have reverted into wetlands.

Two stations with watershed maps were setup and occupied by project personnel to discuss individual problems, concerns, or questions. Several individual concerns were recorded. Of particular note was a suggestion by a citizen (Ted Engelbrecht) identifying a the southeast corner of 161st Street and Westfield Boulevard (north of Cool Creek Park). This site is apparently owned by the Town of Westfield and could be a good location for a constructed wetland. He also mentioned it may be possible to locate BMPs at the Washington Elementary School west of Grassy Branch Road.

Cool Creek Watershed



COOL CREEK WATERSHED



LEGEND

- COOL CREEK WATERSHED BOUNDARY
- CHANNEL FLOODING OR MAINTAINENCE PROBLEM
- MINOR CHANNEL EROSION AREA
- MODERATE TO SEVERE CHANNEL EROSION AREA
- NEIGHBORHOOD PROBLEM AREA

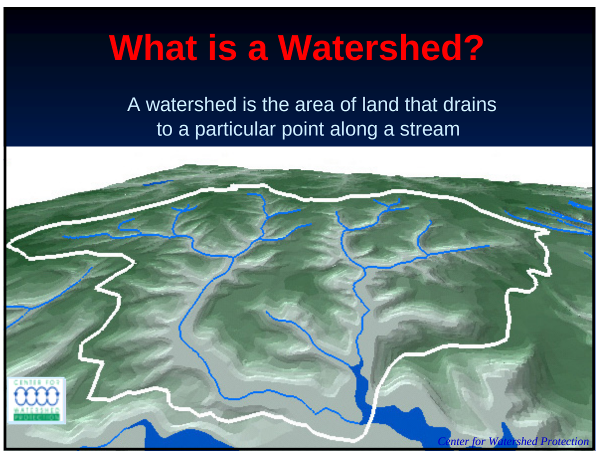
Clark Dietz

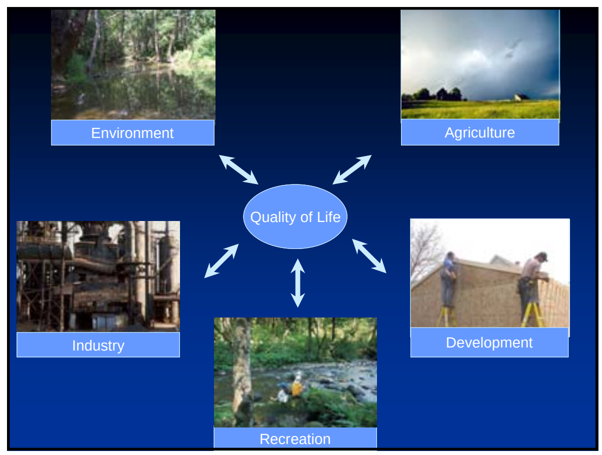
COOL CREEK WATERSHED MANAGEMENT PLAN

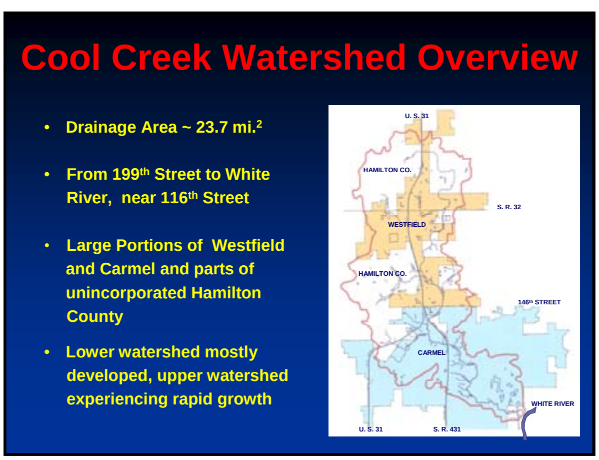
FIGURE 3-1
PROBLEM AREA MAP

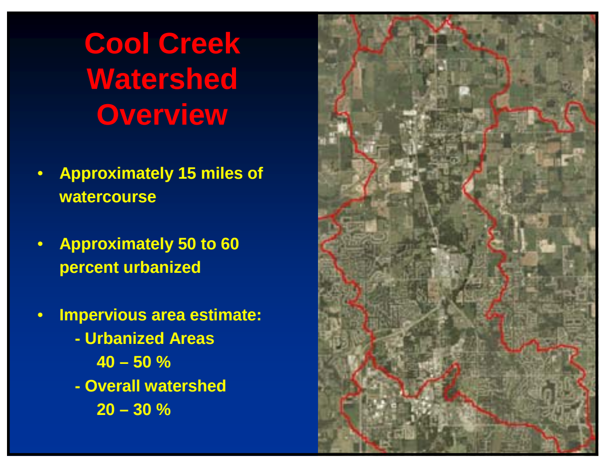

Cool Creek Watershed Management Plan
City of Carmel
Town of Westfield
Hamilton County
Public Meeting
Section 319 Grant
April 13, 2005


Agenda
• Cool Creek Watershed Overview
• Previous Cool Creek Planning Efforts
• Public Input
- Questions
- Specific Problem Areas
- Overall Watershed Concerns
- Priorities
• Closing / Follow Up


What is a Watershed?
A watershed is the area of land that drains to a particular point along a stream
Center for Watershed Protection


Environment
Agriculture
Quality of Life
Industry
Development
Recreation


Cool Creek Watershed Overview
• Drainage Area ~ 23.7 mi.²
• From 199th Street to White River, near 116th Street
• Large Portions of Westfield and Carmel and parts of unincorporated Hamilton County
• Lower watershed mostly developed, upper watershed experiencing rapid growth
U. S. 31
HAMILTON CO.
S. R. 32
WESTFIELD
HAMILTON CO.
146th STREET
CARMEL
WHITE RIVER
U. S. 31
S. R. 431


Cool Creek Watershed Overview
• Approximately 15 miles of watercourse
• Approximately 50 to 60 percent urbanized
• Impervious area estimate:
- Urbanized Areas 40 – 50 %
- Overall watershed 20 – 30 %

Previous Cool Creek Planning Efforts

Purpose of Previous Planning Efforts (2003 Plan)

- Address Existing Stormwater Flooding Problems
- Prevent Future Problems as the Watershed Continues to Develop
- Compliance with New Federal Regulations Governing Stormwater Quality

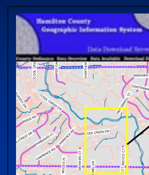
Scope of the Previous Study

- Inventory and Problem Identification
- Problem Analysis
- Solution Development
- Recommendations

Inventory & Problem Identification

Map & Plans

- GIS
- USGS
- National Wetland Inventory
- Flood Insurance Rate
- Zoning Maps
- Aerial Photographs



http://www.co.hamilton.in.us/gis/start.html

Inventory & Problem Identification

Previous Reports & Studies

- IDNR Memorandum – Grassy Branch
- Hydraulic Report for Village Farms Wilfong
- Countryside Overall System Drainage Report
- Soil Survey of Hamilton County, Indiana
- FEMA Flood Insurance Study
- US 31 Improvement Project documents

Inventory & Problem Identification

Ordinances & Standards

- Consistent Stormwater Management Controls.
- Detention Facility Requirements.
- Downstream Channel Protection.
- Water Quality Enhancement.
- Prohibition on Development in Floodplains.

Inventory & Problem Identification

Public Input

- Public Meetings
- Developer Input
- Interviews with:
  - Local Staff
  - Citizens

Inventory & Problem Identification

Problem Area Map

See Map

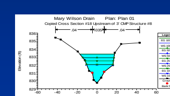
Problem Analysis

- Water Quantity Evaluation
  - Hydrologic/hydraulic modeling
  - Impacts of future development
- Water Quality Evaluation
  - Sampling
  - Existing conditions
  - Policies impacting future conditions

Problem Analysis

Hydrologic/Hydraulic Analysis

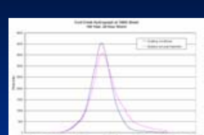
- Assess the volume and rate of runoff for various storm events
- Evaluate existing stormwater conveyance and storage facilities
- Evaluate stormwater runoff impacts from future development
- Determine appropriate control measures



Problem Analysis

Effects of Urbanization

- Higher peak flows as a result of urbanization
- County detention policy is effective in controlling peak flows
- Longer flow durations
- More frequent "bank-full" conditions tend to exacerbate erosion

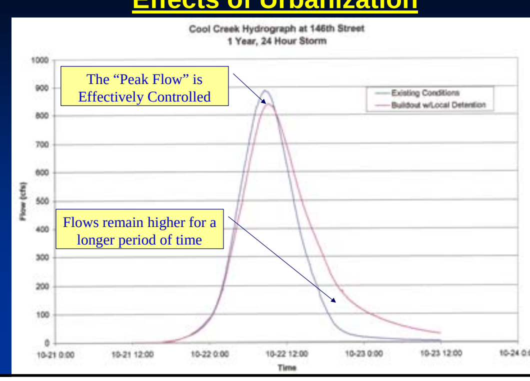


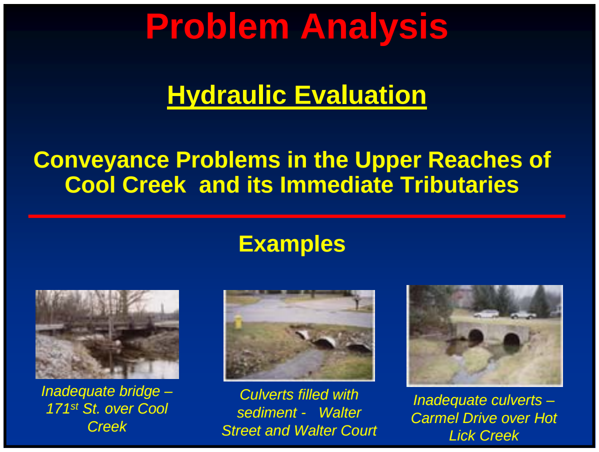
Cool Creek Upstream of White River confluence

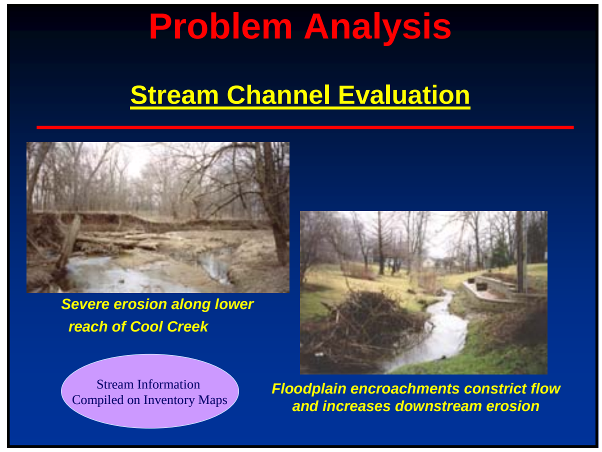
Cool Creek Upstream of 116th Street in Golf Course

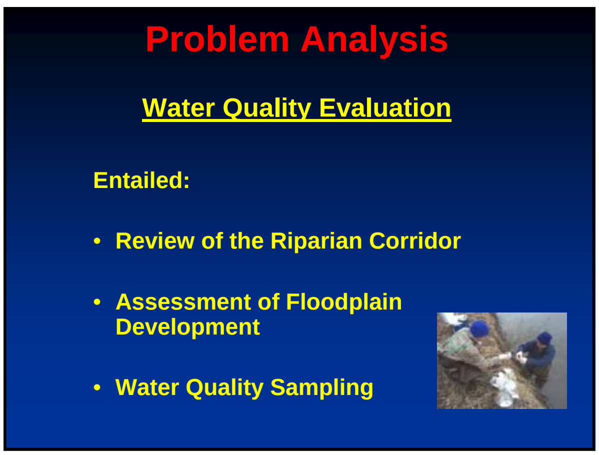
Problem Analysis

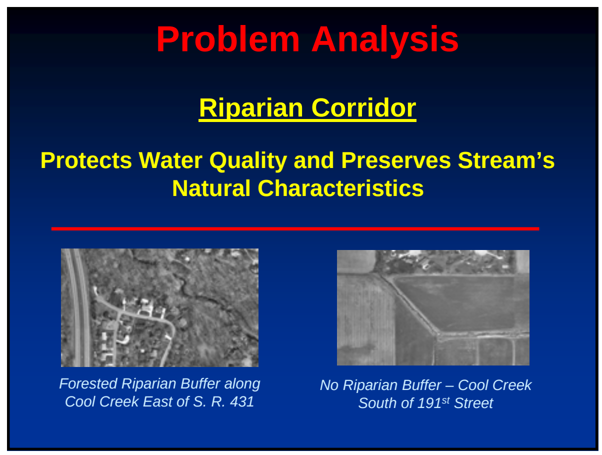
Effects of Urbanization

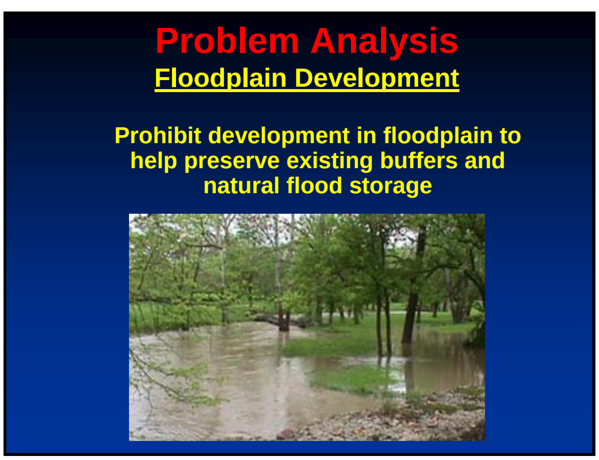


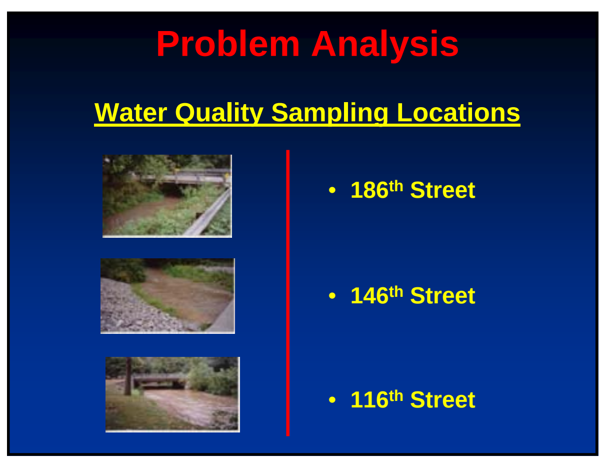

Problem Analysis
Hydraulic Evaluation
Conveyance Problems in the Upper Reaches of Cool Creek and its Immediate Tributaries
Examples
Inadequate bridge – 171st St. over Cool Creek
Culverts filled with sediment - Walter Street and Walter Court
Inadequate culverts – Carmel Drive over Hot Lick Creek


Problem Analysis
Stream Channel Evaluation
Severe erosion along lower reach of Cool Creek
Stream Information Compiled on Inventory Maps
Floodplain encroachments constrict flow and increases downstream erosion


Problem Analysis
Water Quality Evaluation
Entailed:
• Review of the Riparian Corridor
• Assessment of Floodplain Development
• Water Quality Sampling


Problem Analysis
Riparian Corridor
Protects Water Quality and Preserves Stream's Natural Characteristics
Forested Riparian Buffer along Cool Creek East of S. R. 431
No Riparian Buffer – Cool Creek South of 191st Street


Problem Analysis
Floodplain Development
Prohibit development in floodplain to help preserve existing buffers and natural flood storage


Problem Analysis
Water Quality Sampling Locations
• 186th Street
• 146th Street
• 116th Street

Solution Development

Land Use Planning Recommendations

- **Detention Requirements**
  Improve control of smaller storms (first flush)
- **Stream Buffer Ordinance**
  Grass filter strips, preservation
- **Floodplain Protection**
  Prohibit fill in the floodplain
- **Other Best Management Practices**
  Improve water quality

Recommendations

Cost of Improvements

Stream Flooding/ Roadway Overtopping Solutions -	$2,720,000
Neighborhood Solutions -	$100,000
Streambank Erosion Solutions -	$570,000
Regional Detention Solutions -	$5,100,000
Total of All Solutions -	**$8,490,000**

Recommendations

Implementation

- Coordinate water quality recommendations with NPDES / Rule 13 program
- Implement bridge/culvert improvements projects in conjunction with planned roadway projects
- Implement neighborhood projects as local funding allows
- Coordinate streambank stabilization projects with local property owners
- Coordinate regional detention solutions with planned development projects
- *Obtain additional input on improvements and funding, priorities (this project – Section 319)*

Problem Analysis

Water Quality Sampling Conclusions

- Pollutant constituents and concentrations in Cool Creek – generally comparable to other urban streams across country
- Nutrients levels somewhat high, possibly from excess fertilizer
- Bacteria levels exceed standards for recreational contact during wet weather *(problem is common to nearly all urban watersheds)*
- Stormwater Best Management Practices will help improve water quality

Solution Development

- Stream Flooding/Road Overtopping Solutions
- Neighborhood Problem Solutions
- Stream Bank Erosion Solutions
- Regional Stormwater Detention
- Future Land Use & Planning Recommendations

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace 171st Street Bridge and Regrade Roadway
- Regrade Roadway at 151st Street bridge
- Replace Gurley Street bridge (Anna Kendall Drain)
- Replace Cherry Street bridge (Anna Kendall Drain)

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace SR 32 Culvert (J.M. Thompson Drain)
- Replace Culvert Downstream of US 31 (Highway Run)
- Add Culvert to US 31 (Highway Run)
- Replace Walter Street and Walter Court Culverts (Highway Run)
- Replace Private Drive Culvert between Walter Street and Walter Court (Highway Run)
- Replace Thornberry Drive Culvert (Highway Run)

Solution Development

Neighborhood Problem Solutions

- Replace Carmel Drive Culvert (Hot Lick Creek)

Solution Development

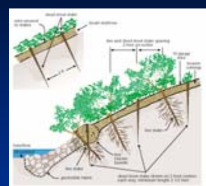
Streambank Erosion Solutions

Restoration Projects at:

- Highway Run –
  - Downstream of Stonehedge Drive
- H.G. Kenyon Drain –
  - Downstream of Rolling Court
- Cool Creek –
  - Upstream of confluence with the White River,
  - Downstream of Gray Road (at bend),
  - Upstream and downstream of Hot Lick Creek
  - Upstream of 131st Street (Main Street) and
  - Upstream of Keystone Avenue

Streambank Stabilization Techniques

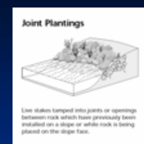
Riprap and Live Stakes (Joint Plantings)
Source: Federal Interagency Stream Restoration Working Group, 1998



Brushmattress Technique (Source: USDA-NRCS 1996)

Source: Chattanooga Public Works Department

Streambank Stabilization Techniques



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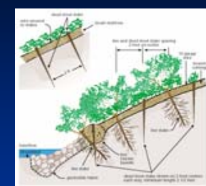

Brushmattress Technique (Source: USDA-NRCS 1996)

Source: Chattanooga Public Works Department

Cool Creek Demonstration Project (Hamilton County SWCD)

Cool Creek Demonstration Project (Hamilton County SWCD)

Solution Development

Regional Stormwater Detention

- **Two (2) off-line Regional Detention Basins to Control the Magnitude of Stormwater Flows and Reduce downstream channel erosion**
  - **Immediately Downstream of 171st Street**
  - **West of Grassy Branch Road**
- **Retrofit existing regional on-line detention provided by RR embankment on Anna Kendall Drain**

Solution Development

Regional Stormwater Detention

HAMILTON COUNTY SURVEYOR'S OFFICE

One Hamilton County Square, Suite 188
Noblesville, Indiana 46060
Phone (317) 776-8495
Fax (317) 776-9628

Press Release

Contact: Robert Thompson,RLA
Phone: (317) 776-8495

FOR IMMEDIATE RELEASE

HAMILTON COUNTY PARKS TO HOST COOL CREEK WATERSHED PUBLIC MEETING

The Hamilton County Surveyor's Office invites the public to participate in a meeting to discuss stormwater management issues in the Cool Creek Watershed. On April 13th a public meeting will be held at 7 PM in the Cool Creek Nature Center Auditorium, 2000 E. 151st Street in Carmel.

On January 1st, the Surveyor's Office obtained a Section 319 Watershed grant to work with Clark Dietz, a local environmental firm, to identify stormwater pollution reduction strategies in the Cool Creek Watershed. To help us develop the watershed management plan, we would like feedback from the community on key issues identified in the original Cool Creek Study plan as well as additional concerns that may not have been identified. Key areas of interest include:

- Existing stormwater problems in the watershed (Stream bank erosion, flooding, etc.)
- The effect of urbanization on water quality (Cool Creek is on the State's list of impaired water bodies)
- Best Management Practices (ways to reduce stormwater pollution)

Hamilton County believe that the residents of the Cool Creek Watershed play a critical role in improving water quality in the watershed and that public input is vital in developing a watershed management plan. For further information contact:

Robert Thompson, Program Manager, Hamilton County Surveyors Office
E-mail: RCT@co.hamilton.in.us
Telephone: (317)776-8495
Fax: (317)776-9628

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News and Announcements:

News:

- The Treasurer's Office has Extended Hours for the Spring Tax Collection (4/8/2005)
- New Online Service available! Report-a-Polluter (4/7/2005)
- Cool Creek Watershed Public Meeting (3/29/2005)
- New Food Regulations Available for 2004-5 (12/27/2004)
- Surveyor's Office - New Form Requirements (12/27/2004)
- 2004 Election Results (11/3/2004)

Announcements:

- Public Notices
- Employment Opportunities
- Bids and RFPs
- Construction Related Travel Advisories
- Weather Related Travel Advisories

Meetings and Events:

Meetings & Events:

Hamilton County Board of Zoning Appeals Meeting (4/19/2005)
Community Corrections Board Meeting (4/21/2005)
Commissioner's Meeting (4/25/2005)
Drainage Board Meeting (4/25/2005)
Solid Waste Board (4/25/2005)

Parks & Recreation Calendar

April 2005

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

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Online Registered Voter Information
Online Requests for Services
Online Food Facility Inspections

Areas of Interest:
Current Legislation
History, Demographics, Community
Citizen Issues
Permits, Inspections & Business Issu
Visitor and Lodging Info.

Other Sites:
Community Calendar (HC Conventio Visitors Bureau)
Homeland Security Threat Advisory
USGS Flood Watch

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Town of Westfield Department of Public Works - Microsoft Internet Explorer

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Address http://www.wpwd.org/PressRelease.asp

Westfield Public Works Department

2728 E. 171st Street
Westfield, IN 46074
317-867-1116

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- Westfield-Washington

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Hamilton County believes that the residents of the Cool Creek Watershed, which include the Carmel, Westfield and Unincorporated communities of Hamilton County, play a critical role in improving water quality in the watershed and that public input is vital in developing a watershed management plan. For further information contact:

Internet

start 2 Microsoft Outl... P:\H21013\Newsp... Cool Creek 319 - ... Adobe Reader - [s... Town of Westfield... 9:34 AM

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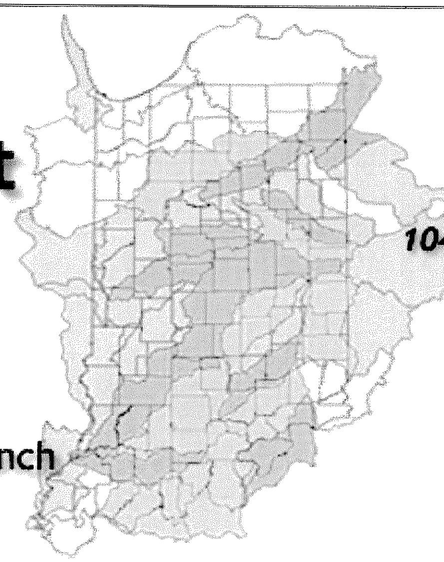
Watershed Management Section

Watershed Management Section



Watershed Planning Branch
Office of Water Quality

319 Grant Program

205(j) Grant Program

104(b)(3) Grant Program

Nonpoint Source Plan

WM Information

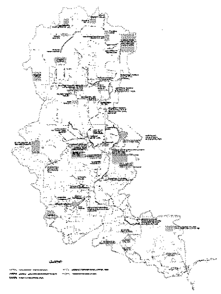
WM Staff

NEW! - Section 205(j) Solicitation for Proposals for FFY 2005 - NEW!

NEW! - Hamilton County Parks to host Cool Creek watershed public meeting. - NEW!

The Watershed Management Section administers the Clean Water Act Section 104(b)(3), 205(j), and 319 programs which provide federal funding for watershed planning, water quality management planning, NPDES

PUBLIC MEETING 2



SIGN IN SHEET

Cool Creek Public Meeting

Cool Creek Watershed Management Plan
Hamilton County, Indiana

December 14th, 2005
7:00 p.m.

Name	Organization	Address	E-mail	In-Kind Travel Time
Sam Robertson	Clark Dietz	9000 Keystone Crossing, Suite 350	samuelr@clark-dietz.com	
Hans Peterson	Clark Dietz	9000 Keystone Crossing, Ste 350	hansp@clark-dietz.com	
Bob Thompson	HCSC	1 Hamilton County Sq	RCT@CO.HAMILTON.IN.US	
Amanda Smith	HCPR	2000-1 E. 151st St.	ads@co.hamilton.in.us	
Amanda Foley	Carmel Eng.	One Civic Square Carmel	afoley@carmel.in.gov	
Carrie Cason	WESTFIELD	130 Penn Street	ccason@WESTFIELD.IN.GOV	
Sky Schelle	IDEM	100 N. Senate Ave	sschelle@idem.state.gov	

PUBLIC MEETING SUMMARY

Project:	Cool Creek Watershed Management Plan
Date:	December 14th, 2005
Time:	7:00 a.m.
Location:	Cool Creek Nature Center
Attendees:	Bob Thompson – Hamilton County Surveyor's Office Hans Peterson – Clark Dietz Sam Robertson – Clark Dietz Sky Schelle – IDEM Amanda Foley – City of Carmel Amanda Smith – Hamilton County Parks & Recreation Dept. Carrie Cason – Town of Westfield

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On December 14th, 2005, a public meeting was held at the Cool Creek Park Nature Center to present to the public the final Cool Creek Watershed Management Plan. A list of the attendees is attached to this summary. Attendees included project stakeholders only. No public participants came to the meeting and the presentation was not given since the project stakeholders had previously seen the presentation materials. Mr. Thompson would have the presentation put on the County's website and also see if Carmel and Westfield could do the same.

Cool Creek Watershed Management Plan

Public Meeting

Cool Creek Nature Center

December 14, 2005

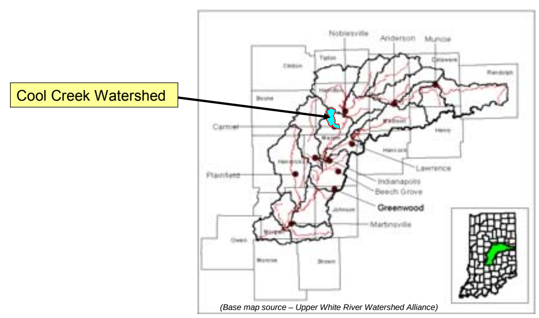
Agenda

- Cool Creek Watershed Overview
- IDEM Section 319 Grant Requirements
- Recent Watershed Activities
- Section 319 Updates to the Cool Creek Plan
- Summary, What's Next
- Input/Feedback/Questions

Project Overview

- Section 319 Grant
  - Section 319(h) of Clean Water Act provides funding for projects that reduce nonpoint source water pollution
  - Cool Creek 319 Grant - January 1, 2005 to December 31, 2005
- Grant Contract Tasks
  - Produce a Watershed Management Plan (Update to November 2003 Plan)
  - Stakeholder Committee Meetings (4)
  - Interviews (Hamilton County, Westfield, Carmel)
  - Public Meetings (2)
  - Newspaper Articles (4)

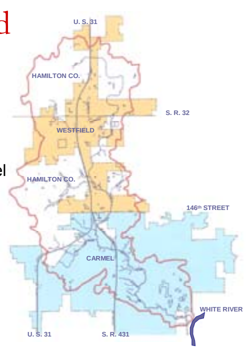
Cool Creek Watershed



(Base map source – Upper White River Watershed Alliance)

Cool Creek Watershed

- Drainage Area ~ 23.7 mi.^{2}
- From 199th Street to White River, near 116th Street
- Large Portions of Westfield and Carmel and parts of unincorporated Hamilton County
- Lower watershed mostly developed, upper watershed experiencing rapid growth



Cool Creek Watershed

- Approximately 15 miles of watercourse
- Approximately 50 to 60 percent urbanized
- Impervious area estimate:
  - Urbanized Areas 40 – 50 %
  - Overall watershed 20 – 30 %

Recent Watershed Activities

April 2005 *September 2005*

Streambank Restoration – Cool Creek Park
by Hamilton County SWCD

Public Meeting
Cool Creek Watershed Management Plan Update
December 14, 2005

Recent Watershed Activities

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Recent Watershed Activities

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Streambank Restoration – Cool Creek Park
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December 14, 2005

Recent Watershed Activities

- Removal of Invasive Species in Cool Creek Park
  - Brush Honeysuckle
  - Garlic Mustard Plant
- On-Going Program by Hamilton County Parks and Recreation Department

Public Meeting
Cool Creek Watershed Management Plan Update
December 14, 2005

Recent Watershed Activities

PERMIT #	FACILITY NAME	COUNTY	BYPASS DATE	DURATION	GALLONS	LOCATION	RECEIVING AREA	REASON	ACTIONS
	WESTFIELD PUBLIC UTILITIES	HAMILTON	9/18/2005	7:30P - 1:30A	2000	MANHOLE APARTMENT COMPLEX PRIVATE SEWER	TRIB TO COOL CREEK	GREASE BACKUP IN PRIVATE SANITARY SEWER	NOTIFIED APARTMENT TO CONDUCT MAINTENANCE

Public Meeting
Cool Creek Watershed Management Plan Update
December 14, 2005

Recent Watershed Activities


Noblesville Daily Times
One of the nation's fastest-growing daily newspapers

Cool Creek polluted

By Bob Hansen | Editor

WESTFIELD — Rainwater mixed with crop residue apparently created a toxic substance that killed fish in Cool Creek Wednesday.

About 70 to 100 fish were killed, and the water for about three miles was discolored. According to Barry Sneed, a public information officer at the Indiana Department of Natural Resources, water laden with ammonium nitrate flowed into a storm sewer outlet at Witt Elevator, located at 1131 State Road 32 East in Westfield. Workers from that agency were called to the scene after local officials found the source of the spill. They were still investigating Thursday.

"At this time, we don't believe there are any continuing effects," Sneed said Thursday afternoon.

An area resident called the Town of Westfield's public works department complaining that a creek had turned black and smelled like petroleum, said Kurt Wanninger, operations manager for the Department of Public Works.

The public works department located the source of the problem and called the state agency.


LEDGER.COM

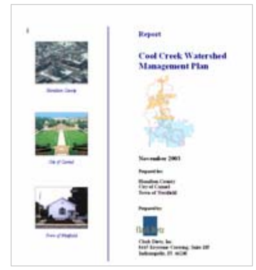
Fish kill toll grows

534 fish dead; fines expected

By Diana Lammond

Cool Creek Watershed Management Plan Updates

- Adding New Chapter 9.0 to address Section 319 requirements
- Keeps the integrity/history of the original 2003 document
- Final report will be available on Hamilton County Surveyor's website (hard copies will also be available)



Chapter 9.0 Contents

9.1 Project Introduction
9.2 Watershed Description
9.3 ***Water Quality Evaluation and Benchmarks***
9.4 ***Problem Statements and Goals***
9.5 Critical Area Identification
9.6 ***Implementation Measures***
9.6 Evaluating, Monitoring, and Adapting the Plan

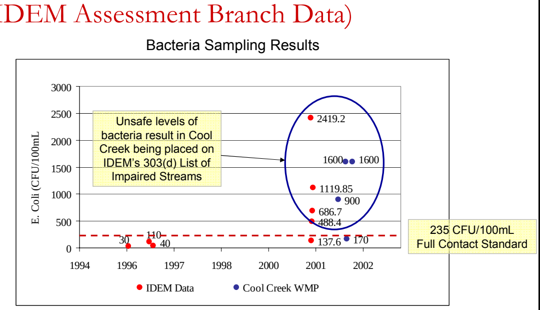
Water Quality Benchmarks

- Utilized sampling data from 2003 Cool Creek Plan
  - 2002
- IDEM Assessment Branch Data
  - 1992, 1996, and 2001
- Volunteer Monitoring (Hoosier River Watch)
  - 2001, 2002, 2004, 2005

Water Quality Benchmarks
(2003 Cool Creek Plan)

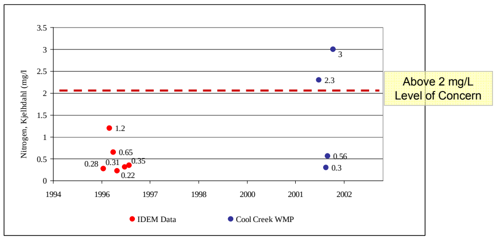
Parameter		Typical Wet Weather Values Reported in Literature	116th Street Crossing				146th Street Crossing				186th Street Crossing			
			Dry Weather		Wet Weather		Dry Weather		Wet Weather		Dry Weather		Wet Weather	
			06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02
BOD	mg/L	12 (1)	<5	<5	5.1	5.5	<5	<5	5	6.9	<5	<5	5	5.4
COD	mg/L	91 (1)	<10	<10	10	59	<10	9.8	10	81	<10	11	10	32
Nitrogen, Kjelhdahl	mg/L	2.35 (1)	0.56	0.3	2.3	3.0	0.84	0.54	2.1	3.6	0.73	0.69	1.1	2.1
Nitrogen, Nitrate	mg/L	0.96 (1)	0.65	0.47	0.9	0.69	0.85	0.16	1.2	0.81	**1.8**	0.65	**2.2**	1.2
Nitrogen, Ammonia	mg/L	0.26 - 1.1 (2)	<0.10	<0.10	0.88	0.14	<0.10	<0.10	**5.1**	0.16	<0.10	<0.10	**4.3**	0.29
Nitrogen, Total	mg/L	3.31 (1)	1.2	0.77	3.2	3.7	1.7	0.7	3.3	4.4	2.5	1.3	3.3	3.3
Nitrogen, Organic	mg/L	1.25 (3)	0.56	0.3	1.4	2.9	0.84	0.49	<0.10	3.4	0.73	0.66	<0.10	1.8
Phosphorus, Dissolved	mg/L	0.16 (1)	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.21	0.067	0.07	<0.05	0.28
Suspended Solids	mg/L	100 (4)	<5	<5	120	**490**	<5	<5	61	**580**	<5	10	11	160
Dissolved Solids	mg/L	N/R	440	530	280	120	390	430	290	210	360	490	390	140
E coli	/100 mL	11,000 (5)	170	>1600	900	1600	220	>1600	300	1600	170	>1600	900	>1600
Fecal Streptococcus	/100 mL	35,000 (5)	13	3	120	920	12	<1	240	960	5	4	<10	1700
Chromium, Hex	mg/L	0.007 (6)	0.01	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Phenol	mg/L	0.008 - 0.115 (6)	0.012	0.022	<0.01	0.025	<0.01	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	0.018
Copper	mg/L	0.047 (1)	<0.02	<0.02	<0.02	0.033	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02	<0.02
Nickel	mg/L	0.012 (6)	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.176 (1)	<0.05	<0.05	<0.05	0.095	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Water Quality Benchmarks
(IDEM Assessment Branch Data)



Water Quality Benchmarks (IDEM Assessment Branch Data)

Total Kjelhdahl Nitrogen Sampling Results

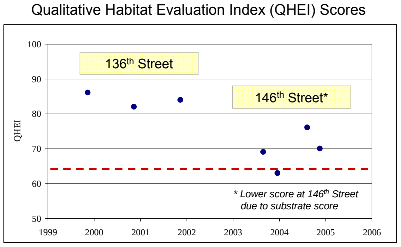


Water Quality Benchmarks (IDEM Assessment Branch Data)

- Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI)
- Biological survey designed to quantify the quality of benthic aquatic macroinvertebrate communities
  - Sampling conducted in 1992
  - Cool Creek at 116th Street
- Interpretation
  - Fully Supporting: mIBI ≥ 4
  - Partially Supporting: mIBI < 4 and ≥ 2
  - Not Supporting: mIBI < 2
- Cool Creek Score: 4 (Fully Supporting)

Water Quality Benchmarks (Volunteer Monitoring – Habitat Data)

Qualitative Habitat Evaluation Index (QHEI) Scores

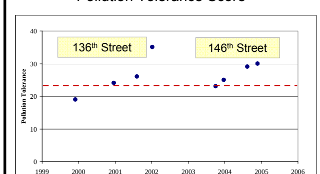


Scoring Factors
- Substrate
- In-stream cover
- Channel morphology
- Riparian zone & bank erosion
- Pool/glide and riffle/run
- Stream gradient

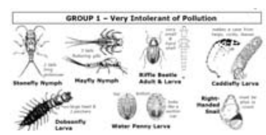
Scoring Criteria
>64 Fully Supporting
51-64 Partially Supporting
<51 Not Supporting

Water Quality Benchmarks (Volunteer Monitoring – Biological Data)

Pollution Tolerance Score



23 or More	Excellent
17 - 22	Good
11 - 16	Fair
10 or Less	Poor



Problem Statements and Goals

- Key Problems
  - Streambank Erosion
  - Sedimentation
  - Elevated nutrients in wet weather runoff
  - Bacteria (now listed as non-supportive for primary contact on 305(b) report, on 303(d) list for E.Coli)
  - Flooding problems
  - Loss of Ecological Diversity in Riparian Areas

Goals and Implementation Measures

1. Develop comprehensive erosion and sediment control program in Carmel and Westfield (ordinance, plan review, inspection, enforcement)
   - All three entities (Hamilton Co., Carmel, Westfield) currently developing programs, will be responsible on January 1, 2006
2. Implement the Regional Stormwater Quality Facilities identified in the plan to reduce downstream channel erosion and reduce non-point source pollutant levels (bacteria, sediment, nutrients, metals)
   - Two sites currently under design
     - Oak Manor
     - 161st Street and Westfield Blvd.

Goals and Implementation Measures

3. Provide public education and outreach to residents and business in Cool Creek Watershed to promote good watershed behavior (disposal of pet waste, proper lawn chemical use, illicit discharges, etc.)
   - All three entities are already doing as part of Rule 13
     - http://www.co.hamilton.in.us/services.asp?id=3921&entity=2200
     - http://www.ci.carmel.in.us/government/deptcommunityrelations3.html
     - http://www.westfield.in.gov/egov/apps/directory/list.exe?path=divs&action=47&fDD=8-47
4. Repair/restore severe channel erosion in the lower reaches of Cool Creek to improve aquatic habitat, reduce sedimentation, and protect public and private facilities
   - Demonstration project in Cool Creek Park, target additional high priority areas, promote SWCD cost share programs

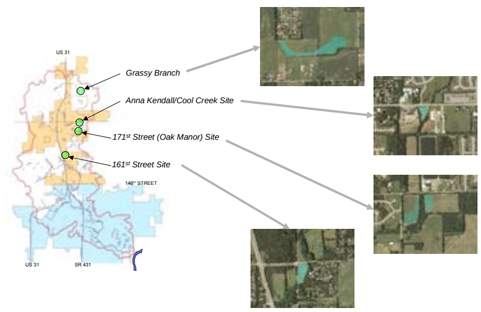
Goals and Implementation Measures

5. Reduce impact of urbanization by modifying stormwater detention policy to control smaller storms and treat the first flush of runoff
   - New design standards required January 1, 2006
6. Continue Hamilton County Parks and Recreation Department water quality and ecological enhancement programs
   - Service learning projects, invasive species removal, water quality sampling, stream clean ups, etc.
7. Provide sanitary sewer service to the limited neighborhood areas in Westfield still on septic systems
   - Five neighborhoods in Westfield, have plans to sewer areas as funds allow

Goals and Implementation Measures

8. Implement consistent floodplain development restrictions by adopting necessary legal authority
   - County has restrictive floodplain ordinance, Carmel and Westfield considering restrictions
9. Construct the bridge and culvert conveyance improvement projects to reduce flood hazards
   - As local funds allow, complete in conjunction with roadway projects
10. Improve riparian habitat in upper watershed by establishing stream buffers as areas are developed adjacent to Cool Creek
    - Work with developers in planning stages to incorporate stream buffers into site development plans

Regional Water Quality Facilities



Regional Water Quality Facilities

Oak Manor Stormwater Quality Facility

Regional Water Quality Facilities

High Priority Streambank Erosion Areas


Cool Creek upstream of confluence with White River


Cool Creek upstream and downstream Hot Lick Creek


Cool Creek upstream of 131st Street


Cool Creek downstream of Gray Road


Cool Creek upstream of Keystone Avenue


H.G. Kenyon Drain downstream of Rolling Court

Summary

Mission Statement

Preserve and improve the overall health of the Cool Creek watershed by addressing existing stormwater quantity and quality concerns and by proactively guiding future stormwater management practices and decisions.

- What's Next?
  - Begin Implementing Goals and Action Plans
  - On-Going Stakeholder Involvement
  - Explore Funding Opportunities
  - Continue Sampling and Field Observations
  - Monitor Effectiveness of Proposed Measures
  - Re-visit, Update Plan as Needed

Public Meeting
Cool Creek Watershed Management Plan Update
December 14, 2005

Contact Information

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Fax: 317-776-9628
E-mail: rct@co.hamilton.in.us

City of Carmel
Amanda Foley
Stormwater Administrator
Department of Engineering
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Public Meeting
Cool Creek Watershed Management Plan Update
December 14, 2005

Input, Feedback, Questions?

Public Meeting
Cool Creek Watershed Management Plan Update
December 14, 2005

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News Briefs

Posted: 12/14/05 - 11:23:20 am EST

Meeting on Cool Creek watershed set

The Hamilton County Surveyor's Office invites the public to attend a meeting to discuss findings and provide additional feedback on the Cool Creek watershed management plan at 7 p.m. tonight in the Cool Creek Nature Center Auditorium, 2000 E. 151st Street in Westfield.

Topics of discussion include existing stormwater problems in the watershed, the effect of urbanization on water quality, ways to reduce stormwater pollution and reduction of invasive species.

For further information, contact Program Manager Robert Thompson at the Hamilton County Surveyor's Office,

776-8495.

New church to offer gift wrapping

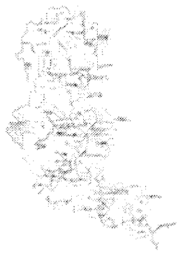
DeerCreek Community Church, a new church in Fishers, is partnering with three Fishers Cynthia's Hallmark Shops to offer free gift wrapping of purchases made at Cynthia's from 11 a.m. to 2 p.m. Saturday.

Visit any of the stores

APPENDIX H.2

STAKEHOLDER MEETING EXIHIBITS

STAKEHOLDER MEETING 1



AGENDA

Stakeholders Steering Committee Kickoff Meeting
Cool Creek Watershed Management Plan
Hamilton County, Indiana

March 15, 2005 – 1:30 p.m.

Conference Room 1-A
Hamilton County Government & Judicial Center (see map)

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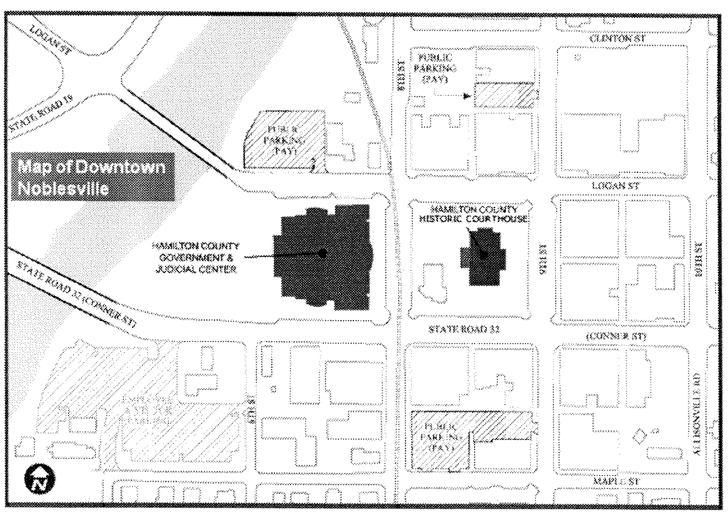
1. Introductions and Sign-in-Kent Ward
2. Role of the Steering Committee-IDEM
3. Cool Creek Watershed Overview-Hans Peterson
4. Previous Cool Creek Watershed Planning Efforts-Hans Peterson
5. IDEM Section 319 Watershed Management Plan Components-IDEM
6. Closing and Follow Up Action Items-Hans Peterson



Watershed Planning

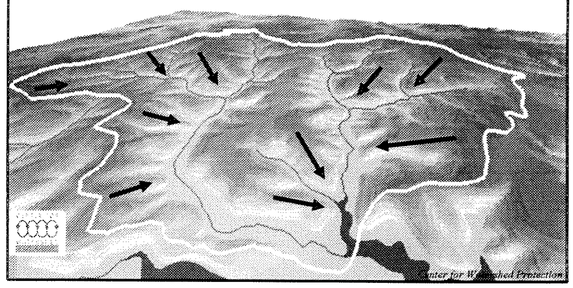
Eric Oliver
eoliver@dem.state.in.us
(317) 233-2472

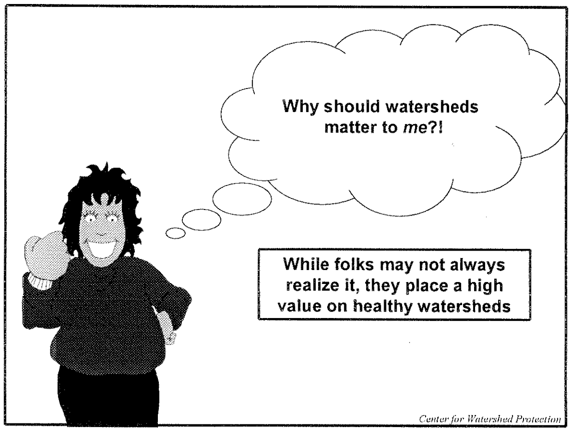
Watershed Specialist

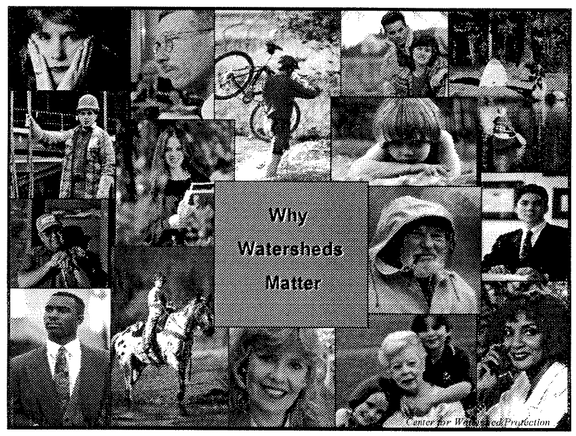
Indiana Department of
Environmental Management

What Is a Watershed?

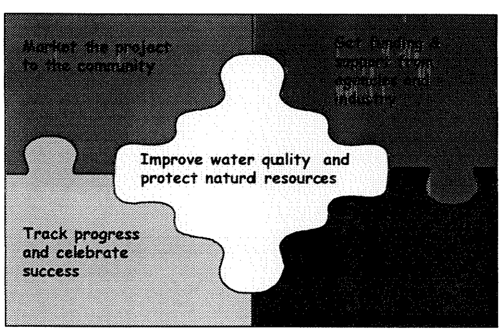
A watershed is the area of land that drains to a particular point along a stream

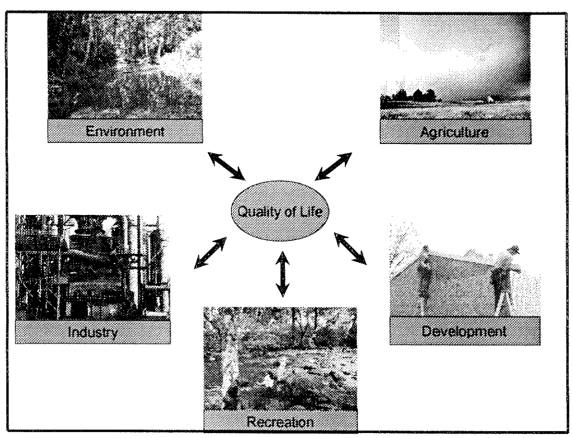






Reasons for a Watershed Plan





When are you ready to write a plan?

- Group works together with respect and trust
- All major interests are represented
- Group is able to make and support decisions

Reasons for a Watershed Plan...

Create a Roadmap

- Where are we now?
- Where do we want to be?
- How are we going to get there?
- How will we know when we have arrived?

Some basic steps...

- Asset Mapping, who needs to be at the table?
- Voice concerns; develop vision; draw up problem statements
- Inventory the watershed
- Set measurable goals
- Sort through alternatives [to implement]

Things to Capture in the Plan

- Concerns of the community
- Information gathered in the inventory
- Problem statements
- Causes of water quality problems
- Sources of pollutants or impacts
- Critical areas that need treatment

Goals of the Plan

- Measurable water-quality and other goals
- Prioritize the goals
- Specific, realistic targets with end dates

"How do we get there?"

- Practices, planning activities, ordinances, or other tasks the group wants to implement
- Action plan: table showing who will do tasks, when they will get them done, what resources will be required
- Estimated cost of carrying out the plan, and proposed sources of funding or support
- Permits, easements, agreements, acquisitions or other things that have to happen to make the plan work

"How do we know when we get there?"

- Methods of measurement: water quality monitoring, spot checking, participation in events, adoption of practices, etc.
- For each goal or target, there should be a measurement!
- Follow-up on implemented items
- Maintenance issues
- When will the plan be evaluated? Who will do it? When will you be 'done'?

....& most important....

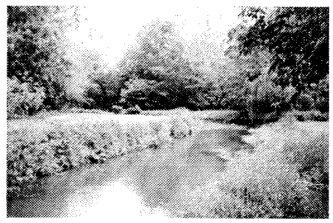
- Prepare funding requests
- Review the plan regularly
- Don't hesitate to revise and update.
- Implement the plan!

Cool Creek Watershed Management Plan

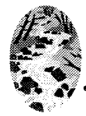
City of Carmel

Town of Westfield

Hamilton County

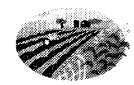


Stakeholder Steering Committee
Kickoff Meeting – Section 319 Grant
March 15, 2005



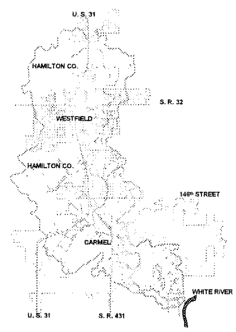
Agenda

- Introductions
- Role of Steering Committee
- Cool Creek Watershed Overview
- Previous Cool Creek Planning Efforts
- IDEM Section 319 Watershed Management Plan Components
- Closing / Follow Up



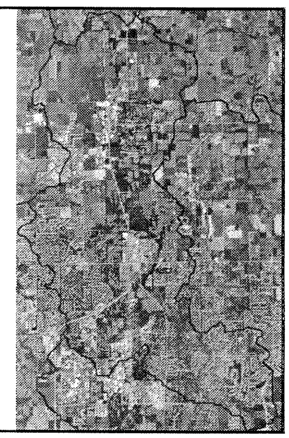
Cool Creek Watershed Overview

- Drainage Area ~ 23.7 mi.^{2}
- From 199th Street to White River, near 116th Street
- Large Portions of Westfield and Carmel and parts of unincorporated Hamilton County
- Lower watershed mostly developed, upper watershed experiencing rapid growth

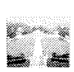


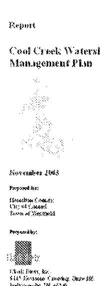
Cool Creek Watershed Overview

- Approximately 15 miles of watercourse
- Approximately 50 to 60 percent urbanized
- Impervious area estimate:
  - Urbanized Areas 40 – 50 %
  - Overall watershed 20 – 30 %



Previous Cool Creek Planning Efforts



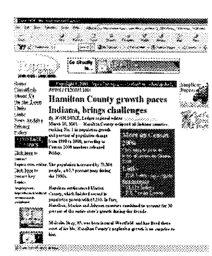

Report

Cool Creek Watershed Management Plan

November 2003

Purpose of Previous Planning Efforts (2003 Plan)

- Address Existing Stormwater Flooding Problems
- Prevent Future Problems as the Watershed Continues to Develop
- Compliance with New Federal Regulations Governing Stormwater Quality



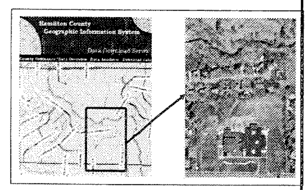
Scope of the Previous Study

- Inventory and Problem Identification
- Problem Analysis
- Solution Development
- Recommendations

Inventory & Problem Identification

Map & Plans

- GIS
- USGS
- National Wetland Inventory
- Flood Insurance Rate
- Zoning Maps
- Aerial Photographs



Inventory & Problem Identification

Previous Reports & Studies

- IDNR Memorandum – Grassy Branch (2001)
- Hydraulic Report for Village Farms Wilfong (1996)
- Countryside Overall System Drainage Report (2001)
- Soil Survey of Hamilton County, Indiana (1978)
- Flood Insurance Studies (study incorporates recent FEMA updates)
- US 31 Improvement Project documents

Inventory & Problem Identification

Ordinances & Standards

- Consistent Stormwater Management Controls.
- Detention Facility Requirements.
- Downstream Channel Protection.
- Water Quality Enhancement.
- Prohibition on Development in Floodplains.

Inventory & Problem Identification

Public Input

- Public Meetings
- Developer Input
- Interviews with:
  - Local Staff
  - Citizens

Inventory & Problem Identification

Problem Area Map

See Map

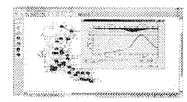
Problem Analysis

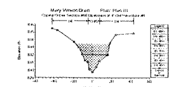
- Water Quantity Evaluation
  - Hydrologic/hydraulic modeling
  - Impacts of future development
- Water Quality Evaluation
  - Sampling
  - Existing conditions
  - Policies impacting future conditions

Problem Analysis

Hydrologic/Hydraulic Analysis

- Assess the volume and rate of runoff for various storm events
- Evaluate existing stormwater conveyance and storage facilities
- Evaluate stormwater runoff impacts from future development
- Determine appropriate control measures

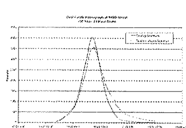


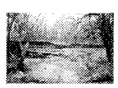


Problem Analysis

Effects of Urbanization

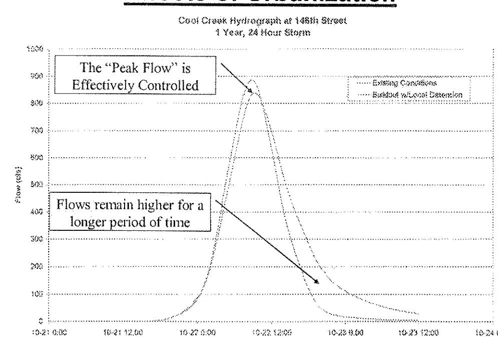
- Higher peak flows as a result of urbanization
- County detention policy is effective in controlling peak flows
- Longer flow durations and more frequent "bank-full" conditions tend to exacerbate erosion, especially along the downstream channels.





Problem Analysis

Effects of Urbanization

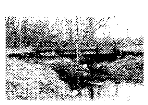


Problem Analysis

Hydraulic Evaluation

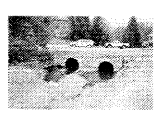
Conveyance Problems in the Upper Reaches of Cool Creek and its Immediate Tributaries

Examples



Inadequate bridge – 171st St. over Cool Creek

Culverts filled with sediment - Walter Street and Walter Court

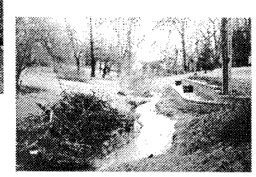


Inadequate culverts – Carmel Drive over Hot Lick Creek

Problem Analysis

Stream Channel Evaluation

Severe erosion along lower reach of Cool Creek



Floodplain encroachments constrict flow and increases downstream erosion

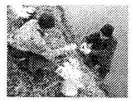
Stream Information Compiled on Inventory Maps

Problem Analysis

Water Quality Evaluation

Entailed:

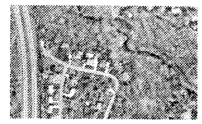
- Review of the Riparian Corridor
- Assessment of Floodplain Development
- Water Quality Sampling



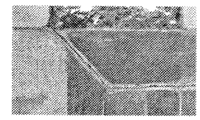
Problem Analysis

Riparian Corridor

Protects Water Quality and Preserves Stream's Natural Characteristics



Forested Riparian Buffer along Cool Creek East of S. R. 431



No Riparian Buffer – Cool Creek South of 191st Street

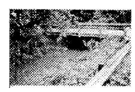
Problem Analysis

Floodplain Development

Prohibit development in floodplain to help preserve existing buffers and natural flood storage

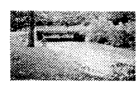
Problem Analysis

Water Quality Sampling Locations



- 186th Street

- 146th Street



- 116th Street

Problem Analysis

Water Quality Sampling Conclusions

- Pollutant constituents and concentrations in Cool Creek – generally comparable to other urban streams across country
- Nutrients levels somewhat high, possibly from excess fertilizer
- Bacteria levels exceed standards for recreational contact during wet weather *(problem is common to nearly all urban watersheds)*
- Stormwater Best Management Practices will help improve water quality

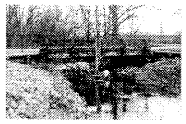
Solution Development

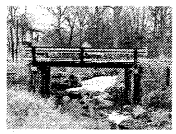
- Stream Flooding/Road Overtopping Solutions
- Neighborhood Problem Solutions
- Stream Bank Erosion Solutions
- Regional Stormwater Detention
- Future Land Use & Planning Recommendations

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace 171st Street Bridge and Regrade Roadway
- Regrade Roadway at 151st Street bridge
- Replace Gurley Street bridge (Anna Kendall Drain)
- Replace Cherry Street bridge (Anna Kendall Drain)

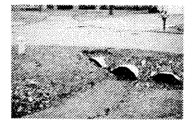




Solution Development

Streambank Flooding/Road Topping Solutions

- Replace SR 32 Culvert (J.M. Thompson Drain)
- Replace Culvert Downstream of US 31 (Highway Run)
- Add Culvert to US 31 (Highway Run)
- Replace Walter Street and Walter Court Culverts (Highway Run)
- Replace Private Drive Culvert between Walter Street and Walter Court (Highway Run)
- Replace Thornberry Drive Culvert (Highway Run)



Solution Development

Neighborhood Problem Solutions

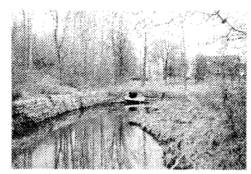
- Replace Carmel Drive Culvert (Hot Lick Creek)

Solution Development

Streambank Erosion Solutions

Restoration Projects at:

- Highway Run –
  - Downstream of Stonehedge Drive
- H.G. Kenyon Drain –
  - Downstream of Rolling Court
- Cool Creek –
  - Upstream of confluence with the White River,
  - Downstream of Gray Road (at bend),
  - Upstream and downstream of Hot Lick Creek
  - Upstream of 131st Street (Main Street) and
  - Upstream of Keystone Avenue



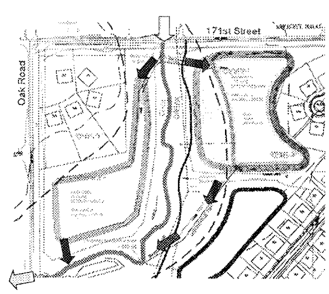
Solution Development

Regional Stormwater Detention

- **Two (2) off-line Regional Detention Basins to Control the Magnitude of Stormwater Flows and Reduce downstream channel erosion**
  - Immediately Downstream of 171st Street
  - West of Grassy Branch Road
- **Retrofit existing regional on-line detention provided by RR embankment on Anna Kendall Drain**

Solution Development

Regional Stormwater Detention



Solution Development

Land Use Planning Recommendations

- **Detention Requirements**
  Improve control of smaller storms (first flush)
- **Stream Buffer Ordinance**
  Grass filter strips, preservation
- **Floodplain Protection**
  Prohibit fill in the floodplain
- **Other Best Management Practices**
  Coordinate with Rule 13 Requirements

Recommendations

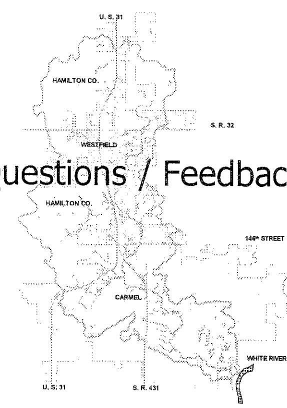
Cost of Improvements

Stream Flooding/ Roadway Overtopping Solutions -	$2,720,000
Neighborhood Solutions -	$100,000
Streambank Erosion Solutions -	$570,000
Regional Detention Solutions -	$5,100,000
Total of All Solutions -	**$8,490,000**

Recommendations

Implementation

- **Coordinate water quality recommendations with NPDES / Rule 13 program**
- **Implement bridge/culvert improvements projects in conjunction with planned roadway projects**
- **Implement neighborhood projects as local funding allows**
- **Coordinate streambank stabilization projects with local property owners**
- **Coordinate regional detention solutions with planned development projects**
- ***Obtain additional input on improvements and funding options (this project – Section 319)***



Questions / Feedback?

Cool Creek Watershed Management Plan

March 15, 2005

The meeting was called to order Tuesday, March 15, 2005 at 1:38 PM.

Those present were as follows: Mr. Kenton Ward, Hamilton County Surveyor's Office; Mr. Robert Thompson, Hamilton County Surveyor's Office; Mr. Hans Peterson, Clark Dietz; Mr. Eric Oliver, IDEM; Mr. Andy Cook, Citizen; Ms. Amanda Foley, City of Carmel; Ms. Lora Shrake, CEES (IUPUI); Ms. Amanda Smith, Hamilton County Parks Department; Ms. Sarah Baxter, Williams Creek Consulting; Ms. Jhani Laupus, Veolia Water Company; and Mike Deboy, Deboy Land Development Services.

Introduction and Sign-in

Mr. Ward stated that this is the first meeting of the Stakeholder Group Meeting for the Cool Creek Watershed Management Plan.

Mr. Oliver stated that the Steering Committee is the voice of how the direction of the plan would go. Each of you will have an input into this. However the Steering Committee chooses to operate, whether it's on consensus or some other way, but that is what they recommend. The Steering Committee could include all the towns and cities in Hamilton County and the Parks, business interests to regular citizens to try to get input from different aspects of the community. The Steering Committee would make the final decision on the plan versus the public input, but the Committee would take in affect what they have said and come up with a consensus on what the Steering Committee could come up with the Watershed Management Plan. The Committee would be responsible for having Mr. Peterson craft a policy with input from the Committee and any other groups that are interested in implementing the Cool Creek Watershed Plan in the future.

Mr. Thompson stated that they will have quarterly meetings and exchange information. If anyone has questions in between meetings or would like to call a special meeting contact Mr. Thompson, he will be inseminating meeting minutes. The minutes and agenda will be posted on the website.

Mr. Peterson stated that Mr. Oliver's presentation is about what a Watershed Management Plan is. Clark Dietz has been doing a lot of watershed planning on Cool Creek and will be modifying the plan based on input and IDEM; acceptable Watershed Management Plan which will allow projects and policies that we identify and implement in the future with potential grant funding.

IDEM Section 319 Watershed Management Plan Components

Mr. Oliver gave his presentation at this time.

Mr. Cook stated that it looked like Cool Creek had been study to death. How is this different from what you have been doing in the past?

Mr. Ward stated that most of the studies we have been doing is more on the hydraulics of the stream itself. Where this is more on water quality. There are a couple of places that was established in the first study for basins that will be open water system plus wetlands, to help clean the water in the existing storm 100-year flood plain.

Mr. Peterson stated that we are not starting from scratch on this watershed. We have some ideas on where we are heading. This is a focus on Storm water flooding quantity.

Mr. Cook asked if this goes on with other watersheds in the County? Is Cool Creek one going because the population is growing?

Mr. Ward stated we have one other 319 Grant for the little Cicero Creek also, which is in the northern portion of the County. There is a water study on Stony Creek that is going on and we are weaving water quality and quantity issues together. This office had a water quantity study on Mud Creek and revised the whole floodplain map on that. We found out that the floodplain maps were wrong as much as three (3) feet in elevation for the 100-year flood plain. We are looking at the broad water quantity issues and found the flood plain mapping issue, so we started concentrating on that. We extended the study to do some water quality studies. For the next study we would like to get Westfield and Carmel involved with Williams Creek.

Mr. Peterson asked about asset mapping. Is there any interesting groups or citizens that they should be thinking about?

Ms. Smith stated there are a lot of dedicated patrons to Cool Creek Park. Nothing is organized, but there are a lot of special interest groups, a lot of recreation programs that go on like bird watching for instance. There are a very large group of bird watchers that meet Wednesday, Saturdays and Sundays. They would be highly interested in what is going on. There is an adopt a River Program. A section of Cool Creek could be adopted by Girls Scouts or Boys Scouts; and they could have an acre that they would clean.

Mr. Thompson stated that you see a lot of stream bank erosion on Cool Creek that we can help with.

Ms. Smith stated John South did a project on Cool Creek doing different types of stream banks erosion examples.

Mr. Peterson asked if there were any other uses in the Park, such as people wading in the creek.

Ms. Smith stated that they do program creek stomps through the Park. Everything they do centers around the creek or around the riparian.

The Park has the National Gardener's Master Naturalist class that we are associated with. There will be a lot of people to rally around the project, there are people who are ready to help.

Previous Cool Creek Watershed Planning Efforts
Mr. Peterson gave his presentation on Watershed Planning Efforts.

Closing and Follow Up Action Items
Mr. Peterson stated they are going to have a public meeting at Cool Creek, April 3rd from 7:00 to 9:00 P.M.

Mr. Thompson stated that prior to the public meeting they could look at some demonstrations of erosion control projects. Anyone who is interested could meet at Cool Creek around 6:00 P.M. and anything else the Park would like to show case. The next meeting will be two or three months from now. We will be looking at priorities and setting goals.

Mr. Ward asked how we're getting the word out?

Mr. Thompson stated that one (1) press release has been made in the local papers. They could also put signs in the park.

Meeting adjourned at 2:54 P.M.

STAKEHOLDER MEETING 2

SIGN IN SHEET

Cool Creek Stakeholder Meeting

Cool Creek Watershed Management Plan
Hamilton County, Indiana

October 4, 2005
1:30 p.m. – 3:00 p.m.

Name	Department/Area of Responsibility	Telephone	E-mail
Bob Thompson	HCSO Program MGR	on File	on File
Sam Robertson	Clark-Dietz	(317) 582-0300	samuelr@clark-dietz.com
Sky Schelle	IDEM	317 234-4094	sschelle@idem.in.gov
Carrie Cason	Westfield	317-896-5577	ccason@westfield.in.gov
Amanda Foley	Carmel	317-571-2441	afoley@carmel.in.gov
Greg Hoyes	HCSO Plan Reviewer	776-8495	grh@co.hamilton.in.us
Jill Hoffmann	Williams Creek Consulting	423-0690	jhoffmann@williamscreek.net

AGENDA

Stakeholders Committee Meeting
Cool Creek Watershed Management Plan
Hamilton County, Indiana

October 4, 2005 – 1:30 p.m.

Conference Room 1-A
Hamilton County Government & Judicial Center (see map)

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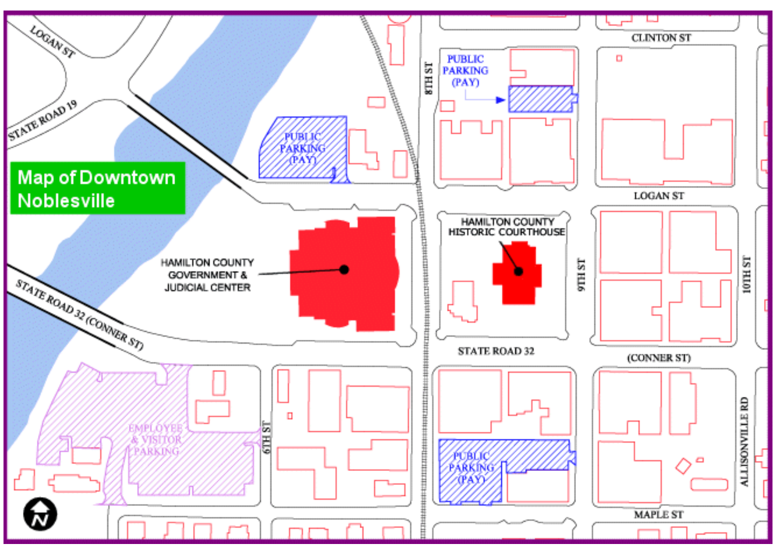
1. Introductions and Sign-in

2. Summary of Input Obtained at First Public Meeting and Interviews with Carmel and Westfield

3. Review Proposed Updates to the Plan to meet the IDEM 319 Checklist. Obtain additional ideas and feedback.

4. Closing and Follow Up Action Items



STAKEHOLDER MEETING SUMMARY

Project:	Cool Creek Watershed Management Plan
Date:	October 4, 2005
Time:	1:30 p.m.
Location:	Hamilton County Surveyor's Office
Attendees:	Bob Thompson – Hamilton County Hans Peterson – Clark Dietz Sam Robertson – Clark Dietz Sky Schelle – IDEM Carrie Cason – Westfield Amanda Foley – Carmel Greg Hoyes – Hamilton County Jill Hoffman – Williams Creek Consulting

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On October 4th, 2005, a Stakeholder meeting was held at the Hamilton County Surveyor's Office. Hans Peterson made a presentation to update stakeholders as to where the Cool Creek Watershed Management Plan (319 update) was at. The presentation agenda was as follows:

- Introductions/Sign-In
- Overall Project Update
- Summary of Input Received at Public Meetings and Interviews
- Overview of Updates of the Cool Creek Plan (319 checklist)
- Follow-Up Items

The discussion/feedback obtained during and after the presentation is summarized as folows:

- Carmel, Westfield, and Hamilton County are all in the process of updating their stormwater ordinances to address the requirements of Rule 13. Plans are to have the ordinances in place by the end of the year. We discussed that it would be desirable for these entities to have the same floodplain requirements as Hamilton County (no fill in the floodplain unless a variance is obtained requiring 10:1 mitigation for lost storage). Amanda thought Carmel was just beginning the ordinance update process and would mention this. Carrie Cason will also bring this feedback back to Westfield. Hans noted that a goal of the study was to have unified, consistent floodplain (and other stormwater) policies in the watershed.

- Carrie Carson noted that the planned recreational trail along Cool Creek near Washington Woods Elementary School is still about five years away. The potential park at the site of the current Public Works facility is not planned for anytime in the near future. Hans Peterson noted the linkage opportunities that would be available if the Oak Manor Regional Stormwater Quality Facility, along with the trail and park facilities, were constructed. Bob Thompson noted that we have submitted a 319 grant application for implementation of the Oak Manor facility.

- Hans Peterson noted that during the Westfield Interview, the only major new development being planned in the upper watershed is Sycamore. Carrie indicated that is still true. Hans Peterson asked if any special BMPs were planned for this development. Greg Hoyes noted that Sycamore is only at the platting stage (no detailed plans yet). The proposed development is located at 191st Street and Tomlinson Road (southwest quadrant).

- It was noted that during the interviews this past summer, Carmel Director of Parks and Recreation, Mark Westermeier, expressed interest in streambank erosion control measures in Flowing Well Park. There are some stream reaches with severe erosion in this park. Bob Thompson indicated this might be another possible pilot streambank restoration project with the Hamilton County SWCD.

- A follow-up should be made concerning the CEES/Cool Creek Park Partnership and their upcoming workday to remove invasive species in Cool Creek Park.

- Bob Thompson noted that the recent sanitary sewer overflow (SSO) occurred at the Hamilton Square Apartments (west of Cool Creek at 169th Street). This appears to have been a private property problem (grease build-up) that has been taken care of. Bob noted the new IDEM website that posts information on SSOs.

- Concerning the recent fish kill in Cool Creek, Bob Thompson said that Cool Creek may have to be restocked. The case is in IDEM and IDNR's hands for potential enforcement action. Bob also noted that even though the publicity was negative, it does raise awareness on the potential for creeks to become polluted by spills.

- Carrie Carson said that the Westfield Comprehensive Plan, currently in the process of being updated, would not be completed until at least June 2006.

- It was noted that we should continue to review volunteer (Hoosier River Watch) monitoring data being collected in Cool Creek (coordinate with Amanda Smith, Chief Naturalist - Hamilton County Park and Recreation/Cool Creek Nature Center).

- The next Upper White River Watershed Alliance Technical Committee Meeting is Nov. 2. We should plan on using this as another opportunity for Stakeholder involvement. Bob Thompson will get us on the agenda.

- Bob Thompson said we should discuss the impact of the Rule 13 requirements on the Cool Creek Watershed and how they could be a positive for the Cool Creek Watershed Management Plan. He said erosion control in the future should be better because there will be more inspectors since the SWCD is turning over duties to the County (for areas in their jurisdiction). Carmel and Westfield will also be taking over the Erosion and Sediment Control programs in their communities as well.

- Hans said Clark Dietz will try and meet with John South of the SWCD to review agricultural practices in the watershed.

- Hans Peterson asked the group if there were any key issues, problems, goals, etc. that were missing from the plan. Carmel and Westfield indicated they thought everything was covered. Sky Schelle indicated the only glaring thing he saw that was missing was addressing critical areas and load reductions. Sam Robertson indicated that we are working on these areas of the report.

Cool Creek Watershed Management Plan

Stakeholder Meeting

October 4, 2005

Agenda

- Introductions / Sign-In
- Overall Project Update
- Summary of Input received at Public Meeting and Interviews
- Overview of Updates of the Cool Creek Plan (319 checklist)
- Follow-Up Items

Overall Project Update

- Activities Since First Stakeholder Meeting
  - Public Meeting - April 13th
  - Interviews with Carmel and Westfield – June 20th
  - Newspaper Articles
  - 2nd Quarter Report
  - IDEM Progress Meetings
  - Working on Plan Updates

Public Meeting Feedback

- Interest, Concern, Questions regarding:
  - Stream impairment, types of contaminants, impact of golf courses
  - Funding, where is money coming from for improvements, regulated drain status
  - Invasive species, loss of native species
  - Beaver problems
  - Impact of U.S. 31 project in Hamilton County
  - Using wetlands for retention
- Specific areas noted for future BMPs:
  - 161st and Westfield Blvd (owned by Westfield?) – constructed wetland
  - Washington Woods Elementary School (Grassy Branch)

Interview Feedback

- Would like to adopt a floodplain ordinance similar to Hamilton County (no fill w/o 10:1 compensation)
- Plans for recreational trail along Cool Creek near new school (Washington Elementary)
- Lots of Beaver activity along Grassy Branch
- No major developments planned except for Sycamore (pending annexation)
- Potential for nitrate being discharged by holding ponds on Heartland Growers property
- Four neighborhoods still on septic systems, some with failure problems. Would like to get on Westfield sewers.

Interview Feedback

- Interested in constructing recreational trails along Cool Creek and its Tributaries
- Priorities for Potential Improvements
  - Replace bridges and upgrade roads to reduce overtopping during floods
  - Replace undersized culverts
  - Construct regional detention facilities to reduce downstream erosion and improve water quality
  - Provide sewers to the few neighborhoods still on septic systems

Interview Feedback

- Rules (regulations) for doing streambank stabilization work
- Interested in Hamilton County floodplain ordinance, would like something similar for Carmel
- Very few homes on septic systems
- Concern (staffing, resources, etc.) over taking over erosion and sediment control from SWCD
- Most complaints in Cool Creek are flooding/drainage. Second is streambank erosion
- Carmel has been requiring stream mitigation to compensate for impacts from road projects
- Severe streambank erosion problem at Flowing Well Park (high priority to address)

Other "Goings-On" in the Watershed

(**the good**, the bad, and the ugly!)

April 2005

September 2005

Streambank Restoration – Cool Creek Park
by Hamilton County SWCD

Other "Goings-On" in the Watershed

(**the good**, the bad, and the ugly!)

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Other "Goings-On" in the Watershed

(**the good**, the bad, and the ugly!)

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Other "Goings-On" in the Watershed

(**the good**, the bad, and the ugly!)

April 2005

September 2005

Streambank Restoration – Cool Creek Park
by Hamilton County SWCD

Other "Goings-On" in the Watershed

(**the good**, the bad, and the ugly!)

CEES/Cool Creek Park Partnership

Removal of Invasive Species (Brush Honeysuckle) in Cool Creek Park

Other “Goings-On” in the Watershed

(the good, **the bad**, and the ugly!)

PERMIT #	FACILITY NAME	COUNTY	BYPASS DATE	DURATION	GALLONS	LOCATION	RECEIVING AREA	REASON	ACTIONS
	WESTFIELD PUBLIC UTILITIES	HAMILTON	9/18/2005	7:30P - 1:30A	2000	MANHOLE APARTMENT COMPLEX PRIVATE SEWER	TRIB TO COOL CREEK	GREASE BACKUP IN PRIVATE SANITARY SEWER	NOTIFIED APARTMENT TO CONDUCT MAINTENANCE

Other “Goings-On” in the Watershed

(the good, the bad, and **the ugly**!)

Noblesville Daily Times
One of the Nation's Fastest-Growing Daily Newspapers

Cool Creek polluted

By Bob Hansen | Editor

WESTFIELD — Rainwater mixed with crop residue apparently created a toxic substance that killed fish in Cool Creek Wednesday.

About 70 to 100 fish were killed, and the water for about three miles was discolored. According to Barry Sneed, a public information officer at the Indiana Department of Natural Resources, water laden with ammonium nitrate flowed into a storm sewer outlet at Watt Elevator, located at 1131 State Road 32 East in Westfield. Workers from that agency were called to the scene after local officials found the source of the spill. They were still investigating Thursday.

"At this time, we don't believe there are any continuing effects," Sneed said Thursday afternoon.

An area resident called the Town of Westfield's public works department complaining that a creek had turned black and smelled like petroleum, said Kurt Wanninger, operations manager for the Department of Public Works.

The public works department located the source of the problem and called the state agency.

LEDGER.COM

Fish kill toll grows

534 fish dead; fines expected

Cool Creek Watershed Management Plan Updates

- Adding New Chapter 9.0 – Section 319 Watershed Management Plan Updates
- Adding New Appendix H – Section 319 Exhibits
- Keeps the integrity/history of the original 2003 document
- References applicable sections of 2003 document
- Includes new information to meet 319 Checklist

Chapter 9.0 Contents

9.1 Introduction
9.2 Watershed Description
9.3 Water Quality Evaluation and Benchmarks
9.4 Problem Statements and Goals
9.5 Implementation Measures
9.6 Evaluating, Monitoring, and Adapting the Plan

9.1 Introduction

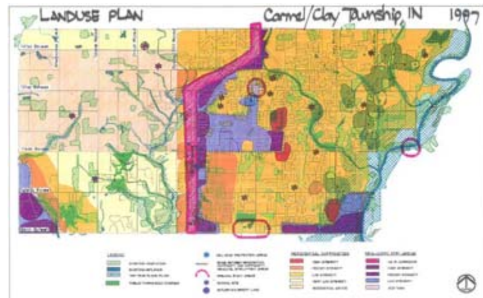
- Mission Statement
  - Preserve and improve the overall health of the Cool Creek Watershed by addressing existing stormwater quantity and quality concerns and by proactively guiding future stormwater management practices and decisions
- Partnerships
  - Hamilton County, Westfield, Carmel, developers, general public, other members of Stakeholder Committee

9.2 Watershed Description

- Generally adequately described in 2003 Plan
- Additional information included:
  - Land Use Breakdown
  - New Land Use Mapping (Westfield)
  - Population Trends

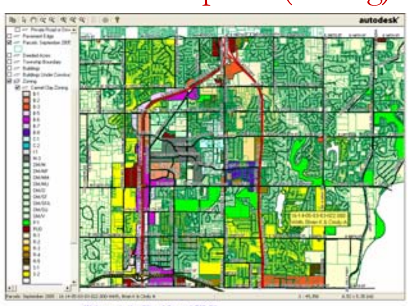
9.3 Watershed Description (land use)

9.3 Watershed Description (land use)

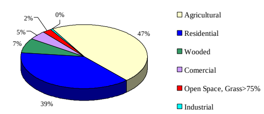


9.3 Watershed Description (zoning)

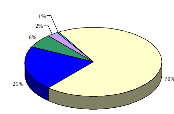
Zoning Map
City of
Carmel



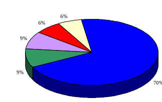
9.2 Watershed Description (land use)



Overall Watershed



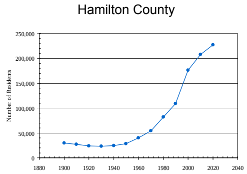
Upper Watershed
(above 146th St.)



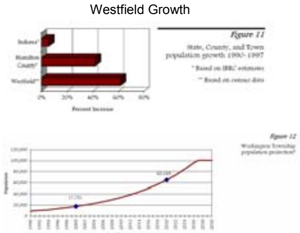
Lower Watershed
(below 146th St.)

9.3 Watershed Description (population)

Hamilton County



Westfield Growth



9.3 Water Quality Evaluation and Benchmarks

- Utilized sampling data from 2003 Cool Creek Plan
  - Cool Creek – 3 locations in watershed, dry and wet weather
  - Visual (Stream Inventory Maps)
- IDEM Assessment Branch Data
  - 1992, 1996, and 2001 data
  - Data collected in lower watershed (Hazeldell or Gray Road)
  - Lab data, field data, macroinvertebrate
- Volunteer Monitoring (Hoosier River Watch)
  - 2001, 2002, 2004, 2005
  - 136th Street, 146th Street
  - Streamflow, Chemical, Biological, Habitat

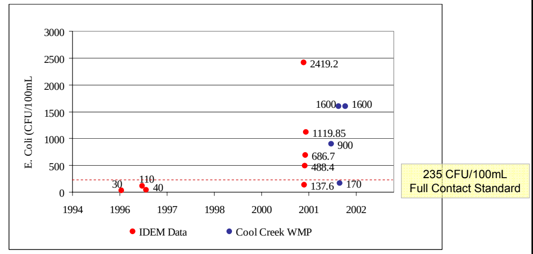
9.3 Water Quality Evaluation and Benchmarks (2003 Cool Creek Plan)

Parameter		Typical Wet Weather Values Reported in Literature	116th Street Crossing				146th Street Crossing				186th Street Crossing			
			Dry Weather		Wet Weather		Dry Weather		Wet Weather		Dry Weather		Wet Weather	
			06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02
BOD	mg/L	12 (1)	<5	<5	5.1	5.5	<5	<5	5	6.9	<5	<5	5	5.4
COD	mg/L	91 (1)	<10	<10	10	59	<10	9.8	10	81	<10	11	10	32
Nitrogen, Kjelhdahl	mg/L	2.35 (1)	0.56	0.3	2.3	3.0	0.84	0.54	2.1	3.6	0.73	0.69	1.1	2.1
Nitrogen, Nitrate	mg/L	0.96 (1)	0.65	0.47	0.9	0.69	0.85	0.16	1.2	0.81	1.8	0.65	2.2	1.2
Nitrogen, Ammonia	mg/L	0.26 - 1.1 (2)	<0.10	<0.10	0.88	0.14	<0.10	<0.10	5.1	0.16	<0.10	<0.10	4.3	0.29
Nitrogen, Total	mg/L	3.31 (1)	1.2	0.77	3.2	3.7	1.7	0.7	3.3	4.4	2.5	1.3	3.3	3.3
Nitrogen, Organic	mg/L	1.25 (3)	0.56	0.3	1.4	2.9	0.84	0.49	<0.10	3.4	0.73	0.66	<0.10	1.8
Phosphorus, Dissolved	mg/L	0.16 (1)	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.21	0.067	0.07	<0.05	0.28
Suspended Solids	mg/L	100 (4)	<5	<5	120	490	<5	<5	61	580	<5	10	11	160
Dissolved Solids	mg/L	N/R	440	530	280	120	390	430	290	210	360	490	390	140
E coli	/100 mL	11,000 (5)	170	>1600	900	1600	220	>1600	300	1600	170	>1600	900	>1600
Fecal Streptococcus	/100 mL	35,000 (5)	13	3	120	920	12	<1	240	960	5	4	<10	1700
Chromium, Hex	mg/L	0.007 (6)	0.01	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Phenol	mg/L	0.008 - 0.115 (6)	0.012	0.022	<0.01	0.025	<0.01	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	0.018
Copper	mg/L	0.047 (1)	<0.02	<0.02	<0.02	0.033	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02	<0.02
Nickel	mg/L	0.012 (6)	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.176 (1)	<0.05	<0.05	<0.05	0.095	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

N/R = Not Reported

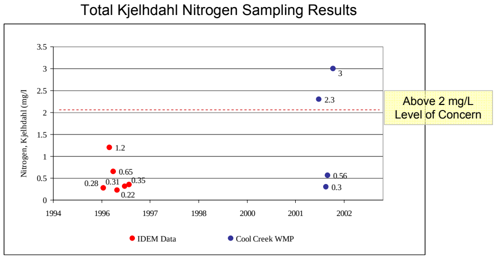
9.3 Water Quality Evaluation and Benchmarks (IDEM Assessment Branch Data)

Bacteria Sampling Results



9.3 Water Quality Evaluation and Benchmarks (IDEM Assessment Branch Data)

Total Kjelhdahl Nitrogen Sampling Results

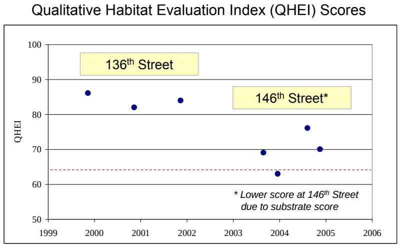


9.3 Water Quality Evaluation and Benchmarks (IDEM Assessment Branch Data)

- Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI)
  - Sampling conducted in 1992
  - Cool Creek at 116th Street
- Resultant Score: 4
- Interpretation
  - Fully Supporting: mIBI ≥ 4
  - Partially Supporting: mIBI < 4 and ≥ 2
  - Not Supporting: mIBI < 2

9.3 Water Quality Evaluation and Benchmarks (Volunteer Monitoring – Habitat Data)

Qualitative Habitat Evaluation Index (QHEI) Scores

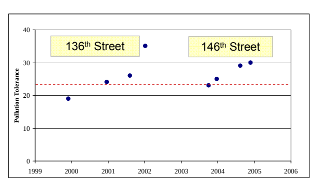


Scoring Factors
- Substrate
- In-stream cover
- Channel morphology
- Riparian zone & bank erosion
- Pool/glide and riffle/run
- Stream gradient

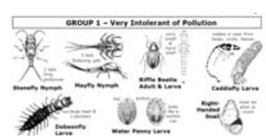
Scoring Criteria
>64 Fully Supporting
51-64 Partially Supporting
<51 Not Supporting

9.3 Water Quality Evaluation and Benchmarks (Volunteer Monitoring – Biological Data)

Pollution Tolerance Score



23 or More	Excellent
17 - 22	Good
11 - 16	Fair
10 or Less	Poor



9.4 Problem Statements and Goals (Stressors and Sources)

- Streambank Erosion
  - Urbanization (increase in impervious areas)
  - Impacts of detention basins (longer bank full flow conditions)
  - Encroachments
- Sedimentation
  - Inadequate erosion control on construction sites
  - Limited agricultural buffers in upper watershed
- Elevated nutrients in wet weather runoff
  - Fertilizers (agricultural and lawn)
  - Pond overflow from major plant growing facility

9.4 Problem Statements and Goals (Stressors and Sources)

- Bacteria (now listed as non-supportive for primary contact on 305(b) report, on 303(d) list for E.Coli)
  - Wildlife, pet waste
  - Leaky septic systems
  - SSOs, spills, general urbanization
- Flooding problems
  - Inadequate bridges, culverts
  - Undersized local drainage systems
  - Floodplain development
- Loss of Ecological Diversity in Riparian Areas (Cool Creek Park)
  - Influx of invasive species (Bush Honeysuckle)

9.4 Problem Statements and Goals

- Problem Statements:
  - Continued urbanization in the upper Cool Creek Watershed is increasing streambank erosion, degrading aquatic habitat, and increasing the stormwater pollutants in runoff
  - Lack of riparian buffers in the agricultural areas on the upper Cool Creek Watershed increase downstream sediment loads and provide limited aquatic habitat
  - Inadequate construction site erosion and sediment controls threaten downstream aquatic habitat
  - High nutrient levels (particularly ammonia) caused by both urban and agricultural runoff threaten aquatic life

9.4 Problem Statements and Goals

- Problem Statements:
  - Increased bacterial levels caused by urbanization and other sources have impaired full contact recreation use of Cool Creek
  - The influx of invasive species such as the Bush Honeysuckle has resulted in reduced ecological diversity in forested areas of Cool Creek such as Cool Creek Park
  - Inconsistent floodplain regulations has resulted in loss of floodplain storage and riparian habitat
  - Undersized bridges and culverts cause result in roadway overtopping and threaten public safety

9.4 Problem Statements and Goals

- Goals:
  - Reduce impact of urbanization by modifying stormwater detention policy to control smaller storms and treat the first flush of runoff
  - Implement consistent floodplain development restrictions by adopting necessary legal authority (ordinances)
  - Develop comprehensive erosion and sediment control program in Carmel and Westfield (ordinance, plan review, inspection, enforcement)
  - Provide public education and outreach to residents and business in Cool Creek Watershed to promote good watershed behavior (disposal of pet waste, proper lawn chemical use, illicit discharges, etc.)
  - Construct the bridge and culvert conveyance improvement projects to reduce flood hazards and protection public safety
  - Continue program (CEES, Cool Creek Park) to remove invasive species and protect ecological diversity in forested areas

9.4 Problem Statements and Goals

- Goals:
  - Implement the Oak Manor Regional Stormwater Quality Facility to reduce downstream channel erosion and reduce non-point source pollutant levels (nutrients, metals, bacteria)
  - Repair/restore severe channel erosion in the lower reaches of Cool Creek to improve aquatic habitat, reduce sedimentation, and protect public and private facilities
  - Provide additional agricultural BMPs (buffer strips, conservation tillage) in the upper watershed to reduce downstream sediment and nutrient loads)
  - Improve the riparian habitat in the upper watershed by establishing stream buffers and vegetation as agricultural areas are developed
  - Provide sanitary sewer service to the limited neighborhood areas in Westfield still on septic systems

9.5 Implementation Measures

- Prioritize projects (critical areas, load reductions)
- Capital improvement projects (Oak Manor regional stormwater quality facility, streambank stabilization, bridge/culvert replacements, septic elimination, etc.)
- Policy/ordinance updates (floodplains, erosion and sediment control, detention policy, buffer strips, other post-construction BMPs)
- Review and modify agricultural practices
- Public education/outreach programs and materials
- Developer agreements

9.6 Evaluating, Monitoring Plan

- Ongoing, periodic Stakeholder Meetings (after 319 project is over)
- Use of water quality monitoring data
- Visual inspection
- Reviewing progress on implementation of recommended improvements
- Adjust, update the plan as needed
- Achieve the Mission:
  - *Preserve and improve the overall health of the Cool Creek Watershed by addressing existing stormwater quantity and quality concerns and by proactively guiding future stormwater management practices and decisions*

Follow Up, Action Items

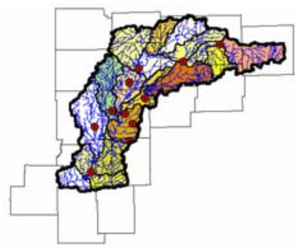
- Complete draft Section 319 Cool Creek Watershed Management Plan by end of October
- Additional stakeholder involvement
  - Upper White River Watershed Alliance?
  - Stakeholder meeting(s) to review draft, finalize plan
- Public Meeting
  - In conjunction with Hamilton County Drainage Board
- Newspaper Article
  - Streambank stabilization project in Cool Creek Park
  - Update on the Plan

STAKEHOLDER MEETING 3

UPPER WHITE RIVER WATERSHED ALLIANCE/COOL CREEK
STAKHOLDER
Meeting
November 2, 2005
Please Print

NAME & Co./Dept.:	E-MAIL:
Summer O'Brien/Williams Creek	sobrien@williamscreek.net
Bob Thompson	
Hans Peterson	hansp@clark-dietz.com
WALTER EVANS	wre@co.hamilton.in.us
Sam Robertson	samuelr@clark-dietz.com
Rob Shumowsky	rjshum@mccog.net
MEG ANDERSON	manderson@cbbel-in.com
LARRY STOUT	
William (Bill) SAVAGE/city of Elwood	savagewd@hotmail.com
Kent Ward / Ham Co. Surveyor	
Chris Meador / American Consulting	cmeador@amercons.com
Bob Meyer	robert.meyer@comcast.net
John Buechler	John Buechler

FAX TO:
HANS
PETERSON



UPPER WHITE RIVER WATERSHED ALLIANCE, INC.
Technical Committee Meeting
Wednesday, November 2, 2005 @ 2:00 PM
Commissioners Conference Room 1-A
Judicial Building
One Hamilton County Square, Noblesville, IN.

AGENDA

Welcome and Introductions: Kent Ward, Technical Committee Chair

Review minutes of Sept 1, 2005

UWRWA GIS Project Update John Buechler-Polis Center
a. Project oversight committee report-
b. Old web site information transfer to new site.

Guide Lamp Trustee Projects update-Carl Wodrich

UWRWA Golf Outing-Recap

Cool Creek 319 Project Summary-Hans Peterson-Clark-Dietz

Other Business

Next Meeting Date

STAKEHOLDER MEETING SUMMARY

Project:	Cool Creek Watershed Management Plan
Date:	November 3, 2005
Time:	2:00 p.m.
Location:	Hamilton County Surveyor's Office
Attendees:	Kent Ward – Hamilton County Surveyor's Office Walter Evans – Hamilton County Surveyor's Office Bob Thompson – Hamilton County Surveyor's Office Larry Stout – Hamilton County ISSD Bill Savage – City of Elwood Hans Peterson – Clark Dietz Sam Robertson – Clark Dietz Chris Meador – American Consulting Summer O'Brien – Williams Creek Consulting Rob Schumowsky – MCCOG Meg Anderson – Christopher B. Burke Engineering Bob Meyer – Upper White River Board of Trustees John Buechler – Polis Center

On November 2nd, 2005, the Technical Committee of the Upper White River Watershed Alliance (UWRWA) met at the Hamilton County Surveyor's Office. A portion of the meeting was dedicated to obtaining additional stakeholder input for the Cool Creek Watershed Management Plan. Cool Creek is a tributary to the Upper White River. The meeting agenda was as follows:

- Welcomes and Introductions
- Review Minutes
- UWRWA GIS Project Update
- Guide Lamp Trustee Projects
- Cool Creek 319 Project Summary
- Other Business
- Next Meeting Date

Hans Peterson made a presentation to attendees detailing the Cool Creek Watershed Management Plan (319 update). The agenda for his presentation was as follows:

- Cool Creek Watershed Overview
- IDEM Section 319 Update Requirements
- Recent Watershed Activities
- Overview of Updates of the Cool Creek Plan (319 checklist)
- Input/Feedback/Questions

The discussion/feedback obtained during and after the Cool Creek presentation is summarized as follows:

- During the presentation Mr. Peterson mentioned that part of our project is to submit articles to the local newspapers. We've had mixed success with getting them published. An article was recently submitted concerning the pilot stream bank restoration project in Cool Creek Park completed by the Hamilton County SWCD. The local newspapers declined to publish it. Bill Savage, with the City of Elwood, said that they had similar problems in getting the newspaper to publish news releases about their Little Duck Creek/Lilly Creek watershed project.

- Mr. Pratt asked if there was a program for promotion of low or no phosphorous fertilizers in the Cool Creek Watershed Management Plan. He stated that IDEM has a brochure on the subject that you can request in bulk and get from their website. Mr. Pratt passed out copies of the brochure at the meeting. Mr. Peterson and Mr. Thompson noted that the communities in the Cool Creek watershed have their own brochures on lawn chemical application practices; however, phosphorous free fertilizers are not specifically mentioned as a recommended practice. Mr. Pratt also mentioned that one way to help promote no phosphorous fertilizers is to let homeowners know that it helps reduce algae in neighborhood detention ponds and the associated odors that can be caused by algae.

- A question was posed as to who would own and maintain the proposed regional stormwater quality facilities, such as the proposed Oak Manor facility. Mr. Ward noted that this is yet to be worked out, but that it could possibly be the parks department or a homeowners association with deed restrictions that would require proper maintenance and usages. An additional question asked how maintenance of these facilities would be funded. Mr. Ward said that this would be a good reason for the parks department to be responsible. More meetings will be required to finalize this issue.

- It was noted that the Central Indiana Land Trust (CILT) is buying riparian lands. In the past, these riparian lands were being sold for approximately $3000 per acre. The last one was sold for $8000 per acre. The market place may be seeing more value in riparian lands. Perhaps there is higher demand for these lands by developers looking to use them as a development amenity rather than liability. A large tract of riparian land at Eller Road and 116th Street was recently purchased by CILT. It includes 78 acres that will be converted to hardwoods or tall grass prairie.

- The issue of septic systems was briefly discussed as Mr. Peterson noted that the Town of Westfield has a few neighborhoods still on septic systems. Mr. Pratt noted that IDEM is giving credit to combined sewer communities that have programs to eliminate septic systems (Indianapolis was discussed as an example). Mr. Pratt noted that the West Nile virus thrives in slow moving wet areas with high nutrients such as failing septic fields and wanted to encourage the communities to seek out these areas and build sewers to eliminate the septic systems. Mr. Ward said that Noblesville is currently addressing areas that are on septic systems and are looking to sewer these communities.

Cool Creek Watershed Management Plan

Upper White River Watershed Alliance Technical Committee

Stakeholder Meeting

November 2, 2005

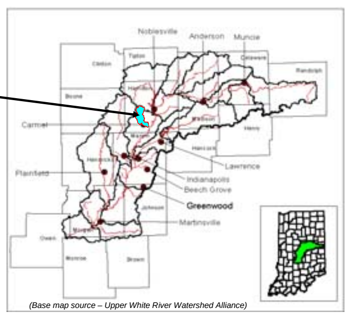
Agenda

- Cool Creek Watershed Overview
- IDEM Section 319 Update Requirements
- Recent Watershed Activities
- Overview of Updates of the Cool Creek Plan (319 checklist)
- Input/Feedback/Questions

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Cool Creek Watershed

- HUC Name
  - Cool Creek-Grassy Branch/Little Cool Creek
- HUC 14-digit
  - 051201090030

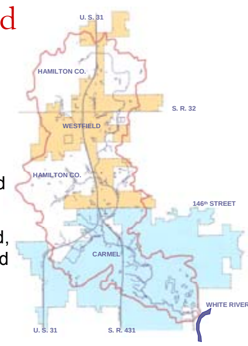


(Base map source – Upper White River Watershed Alliance)

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Cool Creek Watershed

- Drainage Area ~ 23.7 mi.2
- From 199th Street to White River, near 116th Street
- Large Portions of Westfield and Carmel and parts of unincorporated Hamilton County
- Lower watershed mostly developed, upper watershed experiencing rapid growth



Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Cool Creek Watershed

- Approximately 15 miles of watercourse
- Approximately 50 to 60 percent urbanized
- Impervious area estimate:
  - Urbanized Areas 40 – 50 %
  - Overall watershed 20 – 30 %

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Project Overview

- Section 319 Contract
  - Term January 1, 2005 – December 31, 2005
- Contract Tasks
  - Produce a Watershed Management Plan (Update to November 2003 Plan)
  - Stakeholder Committee Meetings (4)
  - Interviews (Hamilton County, Westfield, Carmel)
  - Public Meetings (2)
  - Newspaper Articles (4)

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities


April 2005 *September 2005*

Streambank Restoration – Cool Creek Park
by Hamilton County SWCD

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities


April 2005 *September 2005*

Streambank Restoration – Cool Creek Park
by Hamilton County SWCD

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities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Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities


April 2005 *September 2005*

Streambank Restoration – Cool Creek Park
by Hamilton County SWCD

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities

CEES/Cool Creek Park Partnership

Removal of Invasive Species (Brush Honeysuckle) in Cool Creek Park

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities

PERMIT #	FACILITY NAME	COUNTY	BYPASS DATE	DURATION	GALLONS	LOCATION	RECEIVING AREA	REASON	ACTIONS
	WESTFIELD PUBLIC UTILITIES	HAMILTON	9/18/2005	7:30P - 1:30A	2000	MANHOLE APARTMENT COMPLEX PRIVATE SEWER	TRIB TO COOL CREEK	GREASE BACKUP IN PRIVATE SANITARY SEWER	NOTIFIED APARTMENT TO CONDUCT MAINTENANCE

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Recent Watershed Activities

Noblesville Daily Times
ONE OF THE NATION'S FASTEST-GROWING DAILY NEWSPAPERS

Cool Creek polluted

By Bob Hansen | Editor

WESTFIELD — Rainwater mixed with crop residue apparently created a toxic substance that killed fish in Cool Creek Wednesday.

About 70 to 100 fish were killed, and the water for about three miles was discolored. According to Barry Sneed, a public information officer at the Indiana Department of Natural Resources, water laden with ammonium nitrate flowed into a storm sewer outlet at Watt Elevator, located at 1131 State Road 32 East in Westfield. Workers from that agency were called to the scene after local officials found the source of the spill. They were still investigating Thursday.

"At this time, we don't believe there are any continuing effects," Sneed said Thursday afternoon.

An area resident called the Town of Westfield's public works department complaining that a creek had turned black and smelled like petroleum, said Kurt Wanninger, operations manager for the Department of Public Works.

The public works department located the source of the problem and called the state agency.

LEDGER.COM

Fish kill toll grows

534 fish dead; fines expected

Cool Creek Watershed Management Plan Updates

- Adding New Chapter 9.0 – Section 319 Watershed Management Plan Updates
- Adding New Appendix H – Section 319 Exhibits
- Keeps the integrity/history of the original 2003 document
- References applicable sections of 2003 document
- Includes new information to meet 319 Checklist

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Chapter 9.0 Contents

9.1 Introduction
9.2 Watershed Description
9.3 Water Quality Evaluation and ***Benchmarks***
9.4 ***Problem Statements and Goals***
9.5 Critical Area Identification
9.6 ***Implementation Measures***
9.6 Evaluating, Monitoring, and Adapting the Plan

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Water Quality Benchmarks

- Utilized sampling data from 2003 Cool Creek Plan
  - Cool Creek – 3 locations in watershed, dry and wet weather
  - Visual (Stream Inventory Maps)
- IDEM Assessment Branch Data
  - 1992, 1996, and 2001 data
  - Data collected in lower watershed (Hazeldell or Gray Road)
  - Lab data, field data, macroinvertebrate
- Volunteer Monitoring (Hoosier River Watch)
  - 2001, 2002, 2004, 2005
  - 136th Street, 146th Street
  - Streamflow, Chemical, Biological, Habitat

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

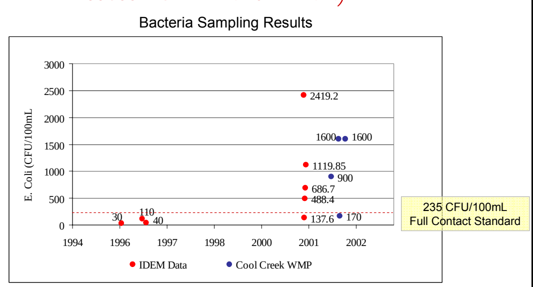
Water Quality Benchmarks (2003 Cool Creek Plan)

Parameter		Typical Wet Weather Values Reported in Literature	116th Street Crossing				146th Street Crossing				186th Street Crossing			
			Dry Weather		Wet Weather		Dry Weather		Wet Weather		Dry Weather		Wet Weather	
			06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02	06/21/02	09/09/02	03/25/02	08/19/02
BOD	mg/L	12 (1)	<5	<5	5.1	5.5	<5	<5	5	6.9	<5	<5	5	5.4
COD	mg/L	91 (1)	<10	<10	10	59	<10	9.8	10	81	<10	11	10	32
Nitrogen, Kjelhdahl	mg/L	2.35 (1)	0.56	0.3	2.3	3.0	0.84	0.54	2.1	3.6	0.73	0.69	1.1	2.1
Nitrogen, Nitrate	mg/L	0.96 (1)	0.65	0.47	0.9	0.69	0.85	0.16	1.2	0.81	**1.8**	0.65	**2.2**	1.2
Nitrogen, Ammonia	mg/L	0.26 - 1.1 (2)	<0.10	<0.10	0.88	0.14	<0.10	<0.10	**5.1**	0.16	<0.10	<0.10	**4.3**	0.29
Nitrogen, Total	mg/L	3.31 (1)	1.2	0.77	3.2	3.7	1.7	0.7	3.3	4.4	2.5	1.3	3.3	3.3
Nitrogen, Organic	mg/L	1.25 (3)	0.56	0.3	1.4	2.9	0.84	0.49	<0.10	3.4	0.73	0.66	<0.10	1.8
Phosphorus, Dissolved	mg/L	0.16 (1)	<0.05	<0.05	<0.05	0.15	<0.05	<0.05	<0.05	0.21	0.067	0.07	<0.05	0.28
Suspended Solids	mg/L	100 (4)	<5	<5	120	**490**	<5	<5	61	**580**	<5	10	11	160
Dissolved Solids	mg/L	N/R	440	530	280	120	390	430	290	210	360	490	390	140
E coli	/100 mL	11,000 (5)	170	>1600	900	1600	220	>1600	300	1600	170	>1600	900	>1600
Fecal Streptococcus	/100 mL	35,000 (5)	13	3	120	920	12	<1	240	960	5	4	<10	1700
Chromium, Hex	mg/L	0.007 (6)	0.01	<0.01	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Phenol	mg/L	0.008 - 0.115 (6)	0.012	0.022	<0.01	0.025	<0.01	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	0.018
Copper	mg/L	0.047 (1)	<0.02	<0.02	<0.02	0.033	<0.02	<0.02	<0.02	0.025	<0.02	<0.02	<0.02	<0.02
Nickel	mg/L	0.012 (6)	<0.01	<0.01	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.176 (1)	<0.05	<0.05	<0.05	0.095	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

N/R = Not Reported

Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

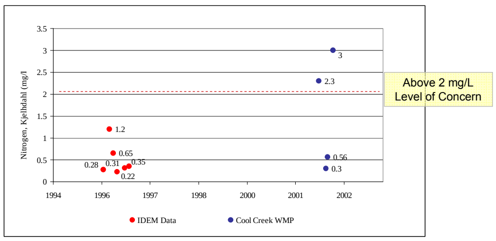
Water Quality Benchmarks (IDEM Assessment Branch Data)



Stakeholder Meeting – UWRWA Technical Committee
Cool Creek Watershed Management Plan Update
November 2, 2005

Water Quality Benchmarks (IDEM Assessment Branch Data)

Total Kjelhdahl Nitrogen Sampling Results

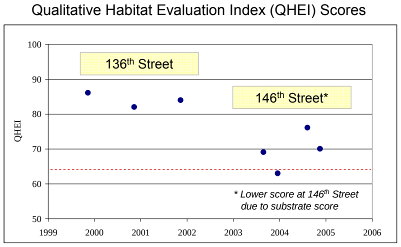


Water Quality Benchmarks (IDEM Assessment Branch Data)

- Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI)
  - Sampling conducted in 1992
  - Cool Creek at 116th Street
- Resultant Score: 4
- Interpretation
  - Fully Supporting: mIBI ≥ 4
  - Partially Supporting: mIBI < 4 and ≥ 2
  - Not Supporting: mIBI < 2

Water Quality Benchmarks (Volunteer Monitoring – Habitat Data)

Qualitative Habitat Evaluation Index (QHEI) Scores

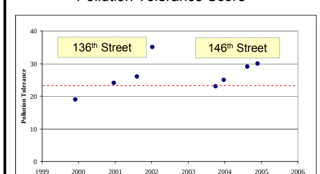


Scoring Factors
- Substrate
- In-stream cover
- Channel morphology
- Riparian zone & bank erosion
- Pool/glide and riffle/run
- Stream gradient

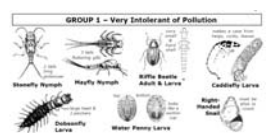
Scoring Criteria
>64 Fully Supporting
51-64 Partially Supporting
<51 Not Supporting

Water Quality Benchmarks (Volunteer Monitoring – Biological Data)

Pollution Tolerance Score



23 or More	Excellent
17 - 22	Good
11 - 16	Fair
10 or Less	Poor



Problem Statements and Goals

- Key Problems
  - Streambank Erosion
  - Sedimentation
  - Elevated nutrients in wet weather runoff
  - Bacteria (now listed as non-supportive for primary contact on 305(b) report, on 303(d) list for E.Coli)
  - Flooding problems
  - Loss of Ecological Diversity in Riparian Areas

Goals and Implementation Measures

- 1. Reduce impact of urbanization by modifying stormwater detention policy to control smaller storms and treat the first flush of runoff
  - Updating of ordinances and design standards (currently underway)
- 2. Implement consistent floodplain development restrictions by adopting necessary legal authority
  - County has restrictive floodplain ordinance, Carmel and Westfield are considering
- 3. Develop comprehensive erosion and sediment control program in Carmel and Westfield (ordinance, plan review, inspection, enforcement)
  - All three entities currently developing programs, will be responsible on January 1, 2006

Goals and Implementation Measures

- 4. Provide public education and outreach to residents and business in Cool Creek Watershed to promote good watershed behavior (disposal of pet waste, proper lawn chemical use, illicit discharges, etc.)
  - All three entities are already doing as part of Rule 13
- 5. Construct the bridge and culvert conveyance improvement projects to reduce flood hazards and protection public safety
  - Being implemented as funds allow
- 6. Continue program (CEES, Cool Creek Park) to remove invasive species and protect ecological diversity in forested areas
  - Recent Service Learning Project, Hamilton County will continue to support CEES in this activity

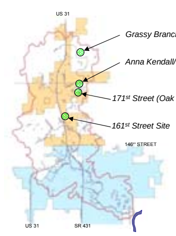
Goals and Implementation Measures

- 7. Implement the Oak Manor Regional Stormwater Quality Facility to reduce downstream channel erosion and reduce non-point source pollutant levels (nutrients, metals, bacteria)
  - Project currently in design, have applied for Section 319 Implementation Grant
- 8. Repair/restore severe channel erosion in the lower reaches of Cool Creek to improve aquatic habitat, reduce sedimentation, and protect public and private facilities
  - Demonstration project in Cool Creek Park, target additional high priority areas, promote SWCD cost share programs
- 9. Provide additional agricultural BMPs in the upper watershed to reduce downstream sediment and nutrient loads)

Goals and Implementation Measures

- 10. Improve the riparian habitat in the upper watershed by establishing stream buffers and vegetation as agricultural areas are developed
  - Consider buffer ordinance, work with developers to establish additional stream side vegetation
- 11. Provide sanitary sewer service to the limited neighborhood areas in Westfield still on septic systems
  - Five neighborhoods in Westfield, have plans to sewer areas as funds allow

Regional Water Quality Facilities



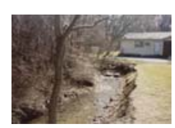
Oak Manor Stormwater Quality Facility

Regional Water Quality Facilities

High Priority Streambank Erosion Areas





Input, Feedback, Questions?

STAKEHOLDER MEETING 4

SIGN IN SHEET

Cool Creek Stakeholder Meeting

Cool Creek Watershed Management Plan
Hamilton County, Indiana

November 30, 2005
10:00 a.m.

Name	Department/Area of Responsibility	Telephone	E-mail	In-Kind Time (including travel)
Bob Thompson	HCSO	770-8833	RCT@co.Hamilton.in.us	
Sky Schelle	IDEM	234-4094	sschelle@idem.in.gov	
Bonny Elifritz	IDEM	234-0922	belifritz@idem.in.gov	
Summer O'Brien	Williams Creek Consulting	423-0690	sobrien@williamscreek.net	3.5 hrs
Hans Peterson	Clark Dietz, Inc.	582-0300	hansp@clark-dietz.com	
Sam Robertson	Clark Dietz, Inc.	582-0300	samuelr@clark-dietz.com	
Amanda Foley	City of Carmel	571-2441	afoley@carmel.in.gov	3 hr.
Amanda Smith	Ham. Co. Parks	848-0576	ads@co.hamilton.in.us	3 hours min

AGENDA

Stakeholders Committee Meeting
Cool Creek Watershed Management Plan
Hamilton County, Indiana

November 30, 2005 – 10:00 a.m.

Conference Room 1-A
Hamilton County Government & Judicial Center

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1. Introductions and Sign-in

2. Summary of Input Obtained at UWRWA Technical Committee Meeting (11-02-05)

3. Review/Discuss Stakeholder Questions/Comments on "November 2005 Draft Section 319 Updates to the Cool Creek Watershed Management Plan" (i.e. Chapter 9.0 of the plan)

4. Review IDEM Comments on Draft Chapter 9.0 (and other elements of the plan)

5. Closing and Follow Up Action Items

STAKEHOLDER MEETING SUMMARY

Project: Cool Creek Watershed Management Plan
Date: November 30, 2005
Time: 10:00 a.m.
Location: Hamilton County Surveyor's Office
Attendees: Bob Thompson – Hamilton County Surveyor's Office
Hans Peterson – Clark Dietz
Sam Robertson – Clark Dietz
Sky Schelle – IDEM
Bonny Elifritz – IDEM
Amanda Foley – City of Carmel
Amanda Smith – Hamilton County Parks & Recreation Dept.
Summer O'Brien – Williams Creek Consulting

On November 30th, 2005, a Stakeholder meeting was held at the Hamilton County Surveyor's Office. Hans Peterson went through the following agenda during the meeting:

- Introductions and Sign-in
- Summary of Input Obtained at UWRWA Technical Committee Meeting (11-02-05)
- Review/Discuss Stakeholder Questions/Comments on "November 2005 Draft Section 319 Updates to the Cool Creek Watershed Management Plan" (i.e. Chapter 9.0 of the plan)
- Review IDEM Comments on Draft Chapter 9.0 (and other elements of the plan)
- Closing and Follow Up Action Items

The following discussion/feedback is organized by agenda item.

Summary of UWRWA Technical Committee Meeting (11-02-05)

After introductions and sign-ins Hans Peterson went over the UWRWA Technical Committee Meeting held on November 5th, 2005. Some of the feedback obtained from the UWRWA included:

- Newspaper articles – we noted that we've had mixed success in getting newspaper articles published. Our article on the pilot stream bank restoration project in Cool Creek Park (by the Hamilton County SWCD) was not published. Bill Savage, with the City of Elwood, said that they had similar problems in getting the newspaper to publish news releases about their Little Duck Creek/Lilly Creek watershed project.

- Questions were asked regarding maintenance responsibilities for the proposed regional stormwater quality facilities, such as the proposed Oak Manor facility. Ideally, the County would like to have the parks department handle maintenance rather than a homeowners association.

- Septic systems were discussed. One of the stakeholders noted that CSO communities can take credit for eliminating septic systems in neighborhoods by providing sanitary sewers. Fortunately, there are only a few small neighborhoods in Westfield that are still on septic systems. Westfield has plans to service these areas with sanitary sewers.

- Mr. Peterson noted full meeting minutes would be available in the final 319 quarterly report.

Review/Discuss Stakeholder Questions/Comments on Draft Cool Creek Watershed Management Plan (i.e. Chapter 9.0 of the plan)

- Mr. Peterson said Kent Ward (Hamilton County Surveyor) had reviewed the report and his main comments were focused on future stream buffers. He would prefer limiting them to grass buffer strips in regulated drains in order to minimize the amount of maintenance required.

- Ms. Smith noted the Red Shouldered Hawk, mentioned in section 9.2.4, has been spotted recently in Cool Creek Park (the report reference indicates that observations may be 13 to 45 years old). She also noted that she has not seen the American Badger in the park, but it may be found in other parts of the watershed.

- Ms. Smith provided a Field Checklist for the Birds of Cool Creek Park pamphlet that is provided to visitors of Cool Creek Park. The pamphlet lists birds that have been spotted in the park. She noted that many of these birds are rare, endangered, or threatened.

- Ms. Smith noted that IDNR usually wants birds to nest in an area before they are listed as being observed in an area. She noted they have observed the Black and White Warbler nesting in the area.

- Ms. Smith mentioned that she could provide more detailed information concerning section 9.2.3 and more specifically the native vegetation and habitat in the area.

- Ms. Smith indicated that the parks department has had their application approved by IDNR for the "Adopt-A-River" program. The Parks Department has adopted Cool Creek within Cool Creek Park. A sign will be placed on U.S. 31 at the Cool Creek crossing. Mr. Thompson said they might want to consider adding report a polluter telephone numbers on these signs.

- Ms. Smith also noted that the CEES quote on page 9-15 came from Hamilton County Parks and Recreation Department and that the County has been the lead agency in the program to remove invasive species in the Cool Creek Watershed. Ms. Smith can provide more information regarding this program that can be added to Goal #6 in Chapter 9. The Parks Department typically has 2 to 4 service days per year.

- Ms. Smith said that the pilot stream bank erosion control project in Cool Creek Park may be useful to be included in the plan. She stated that signage is supposed to be added to this area along the creek to educate the public of the project.

- Ms. Smith mentioned that the Hamilton County Parks and Recreation Department is always looking for land to expand the park system. Currently they are attempting to purchase land adjacent to the park at 151st Street & Oak Road.

- Ms. O'Brien stated they have been working with a developer to construct a wetland facility at 161st Street and Westfield Blvd. The facility is mitigation for a nearby development that involved filling of an existing wetland. She stated the pond is approximately 2 acres. Construction will probably start this spring. Ms. O'Brien said she would provide Mr. Peterson with more information.

Review IDEM Comments on Draft Chapter 9.0

Mr. Schelle and Mr. Peterson went over IDEM comments on the 319 Update to the Cool Creek Watershed Management Plan (Chapter 9.0). Discussion by the group was added. Topics were generally address focusing on issues additional discussion would benefit. The following items were discussed:

- Figure 3-1 should be able to be modified as requested. Mr. Peterson said Clark Dietz would try to hatch the problem areas in order to make them show up better on black and white copies. Mr. Thompson said the figure would be available on the Hamilton County's website. Mr. Peterson confirmed that all copies produced by Clark Dietz would be color copies.

- The land use calculations were estimates from aerial photos. A land use map was not created. However, Carmel and Westfield have some land use mapping that we could put in an appendix to Chapter 9.

- Even though E. Coli has not been listed as a stakeholder concern, it has been discussed at public and stakeholder meetings. Mr. Thompson provided a summary of a stormwater quality awareness questionnaire that Hamilton County distributed as part of their Rule 13 program. One of the questions noted bacteria as being a pollutant of concern.

- It was noted that high metal levels were mentioned early in the report and not fully addressed later in the report. This possibly could be from a point source and should be reviewed again and addressed in Chapter 9.

- In general pollutants of concern (TSS, nutrients, and bacteria) should have existing load calculations. Implementation measures should have load reduction calculations.

- The nutrient critical area section should have more detail. If point sources have not been identified, potentially sources should be pointed out (i.e. golf courses, non-buffered areas, nurseries).

- Mr. Thompson noted that all areas within Cool Creek are in MS4 communities, therefore are required to follow Rule 13 guidelines. This includes public education which overlaps many items in the watershed management plan checklist.

- If agricultural land is diminishing in the watershed why focus on additional agricultural BMPs? Preserving buffer areas around the streams is more of a development issue. As this land is developed it would be desirable that buffer areas be provided along the streams. This may be accomplished through no construction in the floodplain ordinances. Goal #9 and #10 may need to be reworked to emphasize education of developers as agricultural land is developed.

- In general section 9.6 should have more detail about how the plan would be measured in the future. This would detail water quality monitoring procedures in the future. Hamilton County Parks and Recreation Department are planning on assisting individuals who would like to help with sampling of Cool Creek by providing equipment needed for sampling. These individuals have to be trained on sampling procedures. Ms. Elifritz mentioned that this section is not just for measuring by sampling of water quality but can also include other programmatic measures.

- Mr. Peterson said a revised copy of the draft report should be available by the end of next week.

- Copies of the report will be needed for IDEM, Hamilton County, Carmel, Westfield, Cool Creek Park, and the SWCD. Mr. Thompson noted a final copy would be put on the Hamilton County website.

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APPENDIX H.3

INTERVIEW EXHIBITS

WESTFIELD INTERVIEWS

AGENDA

Westfield Interview Workshop

Cool Creek Watershed Management Plan
Hamilton County, Indiana

June 20, 2005 – 9:30 a.m. - Noon

---

1. Introductions and Sign-in
2. Cool Creek Watershed Overview
3. Previous Cool Creek Watershed Planning Efforts
4. IDEM Section 319 Watershed Management Plan Components
5. Discussion of Problem Areas
6. Discussion of Implementation Priorities
7. Closing and Follow Up Action Items

SIGN IN SHEET

Westfield Interview Workshop

Cool Creek Watershed Management Plan
Hamilton County, Indiana

June 20, 2005
9:30 p.m. – Noon

Name	Department/Area of Responsibility	Telephone	E-mail
Hans Peterson	Clark Dietz, Proj. Mgr	(317) 582-0300	hansp@clark-dietz.com
Doug Valmore	Clark Dietz, Proj. Engr.	(317) 582-0300	hansp@clark-dietz.com
Carrie Cason	Westfield	317 896-5577	ccason@westfield.in.gov
MATT MCCOSTLIN	WESTFIELD	317 896-5452	mmccostlin@westfield.in.gov
Renee Goff	Westfield	317-896-5452	rgoff@westfield.in.gov
ANDY KERN	WESTFIELD PUBLIC WORKS	317.896-5452	AKERN@WESTFIELD.IN.GOV
Eric Watts	Westfield	317-896-5452	EWATTS@westfield.IN.GOV
Al Salzman	Westfield	317-896-5577	ASALZMAN@WESTFIELD.IN.GOV
KURT WANNINGER	WPWD	317-896-5452	KWANNINGER@WESTFIEL.IN.GOV
KEVIN BUCHHEIT	COMMUNITY DEVELOPMENT	317.896.5577	Kbuchheit@westfield.in.gov

Clark Dietz

MEETING SUMMARY
WESTFIELD STAFF INTERVIEWS

Project:	Cool Creek Watershed Management Plan
Date:	June 20, 2005
Time:	9:30 a.m.
Location:	Westfield Town Hall
Staff Attendees:	Sign In Sheet Attached

A staff interview session was held to introduce the update of the Cool Creek Watershed Management Plan to the Town of Westfield and to solicit input and answer questions. Ten people attended the meeting. The following is a summary of this interview session.

Hans Peterson initiated the session by conducting informal introductions, and then proceeded with a 20-minute PowerPoint presentation summarizing the background and purpose of the Cool Creek Watershed Management Plan. The presentation included a summary of the findings, alternatives, and recommended solutions. Following the presentation the interview was opened for general discussion and questions/answers. The following summarizes the key points that were discussed:

- Kurt Wanninger (Public Works) addressed the issue of construction in the floodplain. Does Hamilton County have a regulation regarding this? Hans Peterson stated that Hamilton County has adopted a very restrictive ordinance for construction in the floodplain, with the intent of discouraging floodplain construction whenever possible. Construction in the floodplain is not allowed, unless a variance is granted. Any variance will come with the requirement that floodplain area must be replaced at a 10:1 compensatory ratio.

- Mr. Wanninger noted that Westfield will likely adopt a similar floodplain ordinance.

- Mr. Wanninger noted that the County plans to replace the 186th Street culvert at Grassy Branch, but that this may be delayed due to funding.

- Westfield has plans for recreational trails along Cool Creek near the new school.

- Mr. Wanninger stated that there is a lot of Beaver activity along Grassy Branch. They have been working with the County to eradicate this problem.

- Mr. Peterson asked if there are any major developments pending. Mr. Wanninger stated that the only major development pending at this time is the Sycamore Development.

- Mr. Wanninger questioned whether the elevated nutrient levels found during the Cool Creek stream sampling program could possibly be caused by overflow from the holding basins on the Heartland Growers property.

- Mr. Wanninger stated that there are four neighborhoods that are still on septic systems, and that some systems in each of these areas are failing. They are Far Hills (161st and U.S. 31), Buena Vista (156th Street and U.S. 31), Ridgewood (161st Street and Oakridge Road), Bokeelia (191st Street and Tomlinson Road), and Brookview Place (191st Street and Flippins Road). Westfield intends to connect these homes to the public sewer system as soon as feasible. Barrett Law funding may be utilized.

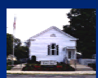
- The Town is interested in constructing recreational trails along Cool Creek and its tributaries. Mr. Wanninger asked if this is something that may be fundable through a Section 319 grant. Mr. Peterson stated that it is unlikely that this activity would be eligible unless it could somehow be tied to nonpoint source stormwater pollution reduction efforts.

- In summary, Mr. Wanninger stated that the Town has the following priorities regarding potential improvements in the Cool Creek Watershed:

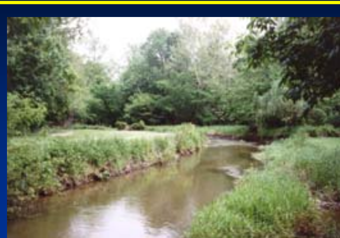
    1) Replace bridges and upgrade roads to reduce floodwater overtopping.
    2) Replace undersized culverts
    3) Construct regional detention facilities to reduce peak downstream flows and to improve water quality
    4) Replace failing septic systems

Interview Workshop
Town of Westfield

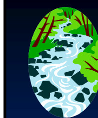

City of Carmel


Town of Westfield


Hamilton County



Cool Creek Watershed Management Plan
Section 319 Grant
June 20, 2005

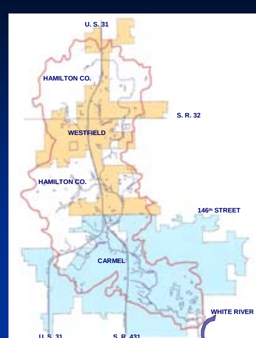


Agenda

- Introductions
- Cool Creek Watershed Overview
- Previous Planning Efforts
- IDEM Section 319 Grant Components
- Discussion of Problem Areas
- Discussion of Implementation Priorities
- Closing / Follow Up

Cool Creek Watershed Overview

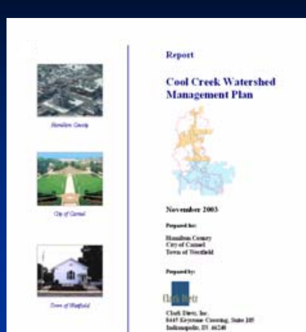
- Drainage Area ~ 23.7 mi.^{2}
- From 199th Street to White River, near 116th Street
- Large Portions of Westfield and Carmel and parts of unincorporated Hamilton County
- Lower watershed mostly developed, upper watershed experiencing rapid growth



Cool Creek Watershed Overview

- Approximately 15 miles of watercourse
- Approximately 50 to 60 percent urbanized
- Impervious area estimate:
  - Urbanized Areas
    40 – 50 %
  - Overall watershed
    20 – 30 %

Previous Cool Creek Planning Efforts


Report

Cool Creek Watershed Management Plan

November 2003

Prepared for:

Hamilton County
City of Carmel
Town of Westfield

Prepared by:

Clark Dietz, Inc.

Purpose of Previous Planning Efforts (2003 Plan)

- Address Existing Stormwater Flooding Problems
- Prevent Future Problems as the Watershed Continues to Develop
- Compliance with New Federal Regulations Governing Stormwater Quality

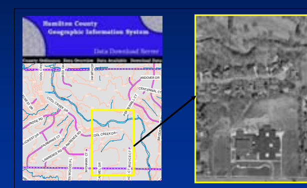
Scope of the Previous Study

- Inventory and Problem Identification
- Problem Analysis
- Solution Development
- Recommendations

Inventory & Problem Identification

Map & Plans

- GIS
- USGS
- National Wetland Inventory
- Flood Insurance Rate
- Zoning Maps
- Aerial Photographs



http://www.co.hamilton.in.us/gis/start.html

Inventory & Problem Identification

Previous Reports & Studies

- IDNR Memorandum – Grassy Branch
- Hydraulic Report for Village Farms Wilfong
- Countryside Overall System Drainage Report
- Soil Survey of Hamilton County, Indiana
- FEMA Flood Insurance Study
- US 31 Improvement Project documents

Inventory & Problem Identification

Ordinances & Standards

- Consistent Stormwater Management Controls.
- Detention Facility Requirements.
- Downstream Channel Protection.
- Water Quality Enhancement.
- Prohibition on Development in Floodplains.

Inventory & Problem Identification

Public Input

- Public Meetings
- Developer Input
- Interviews with:
  - Local Staff
  - Citizens

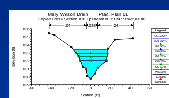
Problem Analysis

- Water Quantity Evaluation
  - Hydrologic/hydraulic modeling
  - Impacts of future development
- Water Quality Evaluation
  - Sampling
  - Existing conditions
  - Policies impacting future conditions

Problem Analysis

Hydrologic/Hydraulic Analysis

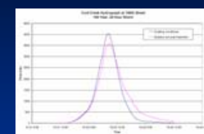
- Assess the volume and rate of runoff for various storm events
- Evaluate existing stormwater conveyance and storage facilities
- Evaluate stormwater runoff impacts from future development
- Determine appropriate control measures



Problem Analysis

Effects of Urbanization

- Higher peak flows as a result of urbanization
- County detention policy is effective in controlling peak flows
- Longer flow durations
- More frequent "bank-full" conditions tend to exacerbate erosion

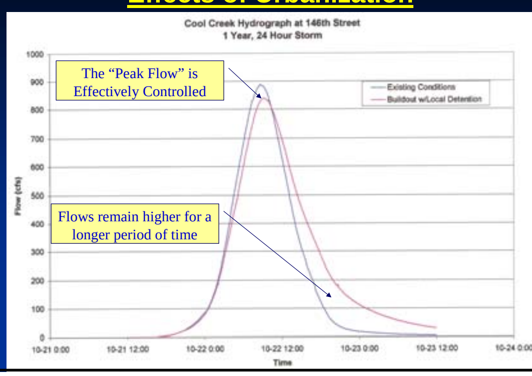


Cool Creek Upstream of White River confluence

Cool Creek Upstream of 116th Street in Golf Course

Problem Analysis

Effects of Urbanization



Problem Analysis

Hydraulic Evaluation

Conveyance Problems in the Upper Reaches of Cool Creek and its Immediate Tributaries

Examples

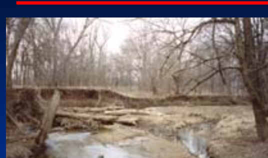
Inadequate bridge – 171st St. over Cool Creek

Culverts filled with sediment - Walter Street and Walter Court

Inadequate culverts – Carmel Drive over Hot Lick Creek

Problem Analysis

Stream Channel Evaluation



Severe erosion along lower reach of Cool Creek

Stream Information Compiled on Inventory Maps

Floodplain encroachments constrict flow and increases downstream erosion

Problem Analysis

Water Quality Evaluation

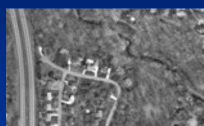
Entailed:

- Review of the Riparian Corridor
- Assessment of Floodplain Development
- Water Quality Sampling

Problem Analysis

Riparian Corridor

Protects Water Quality and Preserves Stream's Natural Characteristics



Forested Riparian Buffer along Cool Creek East of S. R. 431

No Riparian Buffer – Cool Creek South of 191st Street

Problem Analysis

Floodplain Development

Prohibit development in floodplain to help preserve existing buffers and natural flood storage

Problem Analysis

Water Quality Sampling Locations

- 186th Street

- 146th Street

- 116th Street

Problem Analysis

Water Quality Sampling Conclusions

- Pollutant constituents and concentrations in Cool Creek – generally comparable to other urban streams across country
- Nutrients levels somewhat high, possibly from excess fertilizer
- Bacteria levels exceed standards for recreational contact during wet weather *(problem is common to nearly all urban watersheds)*
- Stormwater Best Management Practices will help improve water quality

Solution Development

- Stream Flooding/Road Overtopping Solutions
- Neighborhood Problem Solutions
- Stream Bank Erosion Solutions
- Regional Stormwater Detention
- Future Land Use & Planning Recommendations

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace 171st Street Bridge and Regrade Roadway
- Regrade Roadway at 151st Street bridge
- Replace Gurley Street bridge (Anna Kendall Drain)
- Replace Cherry Street bridge (Anna Kendall Drain)

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace SR 32 Culvert (J.M. Thompson Drain)
- Replace Culvert Downstream of US 31 (Highway Run)
- Add Culvert to US 31 (Highway Run)
- Replace Walter Street and Walter Court Culverts (Highway Run)
- Replace Private Drive Culvert between Walter Street and Walter Court (Highway Run)
- Replace Thornberry Drive Culvert (Highway Run)
- Replace Carmel Drive Culvert (Hot Lick Creek)

Solution Development

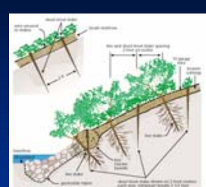
Streambank Erosion Solutions

Restoration Projects at:

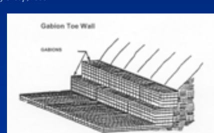
- Highway Run –
  - Downstream of Stonehedge Drive
- H.G. Kenyon Drain –
  - Downstream of Rolling Court
- Cool Creek –
  - Upstream of confluence with the White River,
  - Downstream of Gray Road (at bend),
  - Upstream and downstream of Hot Lick Creek
  - Upstream of 131st Street (Main Street) and
  - Upstream of Keystone Avenue

Streambank Stabilization Techniques

Riprap and Live Stakes (Joint Plantings)
Source: Federal Interagency Stream Restoration Working Group, 1998

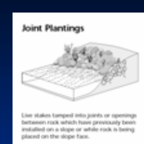


Brushmattress Technique (Source: USDA-NRCS 1996)



Source: Chattanooga Public Works Department

Streambank Stabilization Techniques



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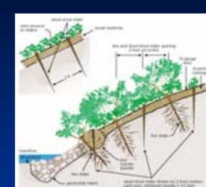


Brushmattress Technique (Source: USDA-NRCS 1996)

Source: Chattanooga Public Works Department

Cool Creek Demonstration Project (Hamilton County SWCD)

Cool Creek Demonstration Project (Hamilton County SWCD)

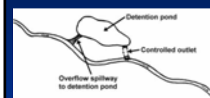
Solution Development

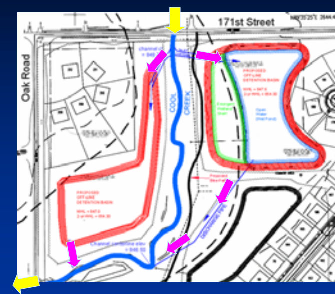
Regional Stormwater Detention

- Two (2) off-line Regional Detention Basins to Control the Magnitude of Stormwater Flows and Reduce downstream channel erosion
  - Immediately Downstream of 171st Street
  - West of Grassy Branch Road
- Retrofit existing regional on-line detention provided by RR embankment on Anna Kendall Drain

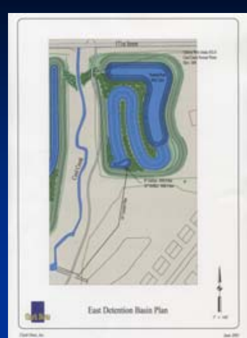
Solution Development

Regional Stormwater Detention





171st Street Regional Detention



Solution Development

Land Use Planning Recommendations

- Detention Requirements
  Improve control of smaller storms (first flush)
- Stream Buffer Ordinance
  Grass filter strips, preservation
- Floodplain Protection
  Prohibit fill in the floodplain
- Other Best Management Practices
  Improve water quality

Recommendations

Cost of Improvements

Stream Flooding/ Roadway Overtopping Solutions -	$2,720,000
Neighborhood Solutions -	$100,000
Streambank Erosion Solutions -	$570,000
Regional Detention Solutions -	$5,100,000
Total of All Solutions -	**$8,490,000**

IDEM 319 Plan Updates

- Two Public Hearings
- Quarterly Steering Committee Meetings
- Carmel, Westfield, and Hamilton County Interviews
- Quarterly Newspaper Articles
- Written Plan (updates to current Cool Creek Report)

Additional Problems/Concerns

- Critical Areas to Protect
- Agricultural Impacts
- Additional Streambank Erosion Areas
- Specific Development Concerns
- Flooding Concerns
- Ordinance deficiencies
- Opportunities for other regional solutions

Implementation Priorities

High	Med	Low	Improvement
			Repair Eroded Streambanks
			Solve flooding problems
			Construction Regional Off-Line Water Quality Pond(s)
			Implement Stream Buffer and/or Prohibit Floodplain Fill Ordinance
			Improve controls on new development
			Preserve Open Space/Sensitive Areas
			Improve Agricultural BMPs

CARMEL INTERVIEWS

AGENDA

Carmel Interview Workshop

Cool Creek Watershed Management Plan
Hamilton County, Indiana

June 20, 2005 – 2:00 p.m. – 4:00 p.m.

---

1. Introductions and Sign-in
2. Cool Creek Watershed Overview
3. Previous Cool Creek Watershed Planning Efforts
4. IDEM Section 319 Watershed Management Plan Components
5. Discussion of Problem Areas
6. Discussion of Implementation Priorities
7. Closing and Follow Up Action Items

SIGN IN SHEET

Carmel Interview Workshop

Cool Creek Watershed Management Plan
Hamilton County, Indiana

June 20, 2005
2:00 p.m. – 4:00 p.m.

Name	Department/Area of Responsibility	Telephone	E-mail
Hans Peterson	Clark Dietz, Inc., Proj. Mgr	(317) 582-0300	hansp@clark-dietz.com
Doug Valmore	Clark Dietz Proj Engr	(317) 582-0300	dougv@clark-dietz.com
Mark Westermeier	Parks	317 571 2485	mwestermeier@carmel.in.gov ~~ci.carmel.gov~~
David Loveall	Street	317) 733-2001	DLoveall@ci.carmel.gov
David Huffman	Street	317) 733-2001	DHUFFMAN@ ~~ci.~~ carmel. ~~gov~~ in.gov
Amanda Foley	Eng.	317-571-2441	afoley@carmel.in.gov
Adrienne Keeling	DOCS	317-571-2417	akeeling@carmel.in.gov
Jeff Kendall	Building & Code	317-571-2435	Jkendall@carmel.in.gov
Mike McBride	Engineering	317-571-2441	MMCBRIDE@CARMEL.IN.GOV
Scott Brewer	DOCS · Urban Forestry	317 · 571-2478	SBrewer@CARMEL.IN.GOV

Clark Dietz

MEETING SUMMARY
CARMEL STAFF INTERVIEWS

Project:	Cool Creek Watershed Management Plan
Date:	June 20, 2005
Time:	2:00 p.m.
Location:	Carmel Town Hall
Staff Attendees:	Sign In Sheet Attached

A staff interview session was held to introduce the update of the Cool Creek Watershed Management Plan to the City of Carmel and to solicit input and answer questions. Ten people attended the meeting. The following is a summary of this interview session.

Hans Peterson initiated the session by conducting presenting a 20-minute PowerPoint summary of the Cool Creek Watershed Management Plan. The presentation included a summary of the findings, alternatives, and recommended solutions. Following the presentation the interview was opened for general discussion and questions/answers. The following summarizes the key points that were discussed:

- Mr. Westermeier (Parks Department) asked what the regulatory requirements or construction guidance is applicable for streambank stabilization. Mr. Peterson stated that the Indiana Erosion Control Handbook is a valuable source of information regarding approved methods of stabilization. He also stated that the Indiana Department of Natural Resources has regulatory authority over any projects that occur along a waterway with a square mile or greater drainage area upstream of the improvement location. We also discussed the pilot streambank stabilization projects constructed in Cool Creek by the Hamilton County SWCD. They would also be a good resource on streambank stabilization techniques.

- Mr. McBride (Carmel City Engineer) asked how new the Hamilton County floodplain restrictions are. Mr. Peterson stated that they have been implemented for approximately one or two years.

- Carmel is interested in adopting a similar floodplain ordinance.

- Carmel has initiated Rule 13 activities (ordinances, staffing, etc.). They are not complete at this time.

- Mr. Peterson asked if there are any septic systems within the community. Mr. McBride stated that there are very few, and the ones that remain are scattered. There is no initiative to remove the remaining isolated septic systems at this time as they are not believed to be a source of pollution.

- Carmel plans to take over erosion and sediment control responsibilities form the Hamilton County SWCD. However, at this time the program is not very effective, due to lack of available staff and lack of enforcement authority.

- Mr. McBride stated that most of the City's stormwater complaints are related to local flooding. The next most frequent complaint is for streambank erosion.

- Mr. Mcbride stated that the City has been increasingly required to perform stream mitigation to compensate for impacts from road projects.

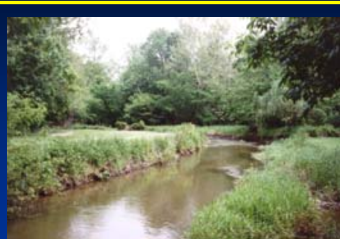
- Mr. Westermeier stated that the most severe streambank erosion problem in the City occurs along Cool Creek at Flowing Well Park (north of 116th Street). He stated that the streambank has been eroding in this area as much as two feet per year. This is a high priority for the City.

Interview Workshop
City of Carmel


City of Carmel


Town of Westfield


Hamilton County



Cool Creek Watershed Management Plan
Section 319 Grant
June 20, 2005

Agenda

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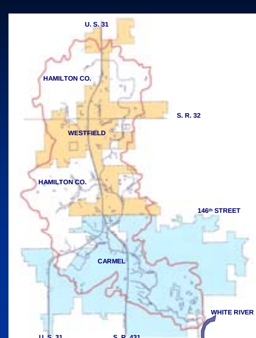

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- Impervious area estimate:
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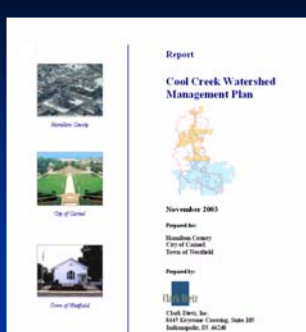
Previous Cool Creek Planning Efforts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Prepared for:
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City of Carmel
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- Prevent Future Problems as the Watershed Continues to Develop
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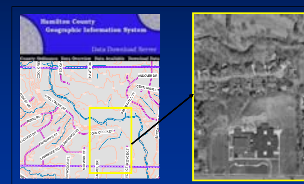

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  - Hydrologic/hydraulic modeling
  - Impacts of future development
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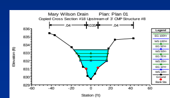
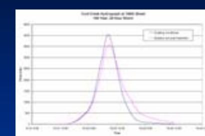


Problem Analysis

Effects of Urbanization

- Higher peak flows as a result of urbanization
- County detention policy is effective in controlling peak flows
- Longer flow durations
- More frequent "bank-full" conditions tend to exacerbate erosion

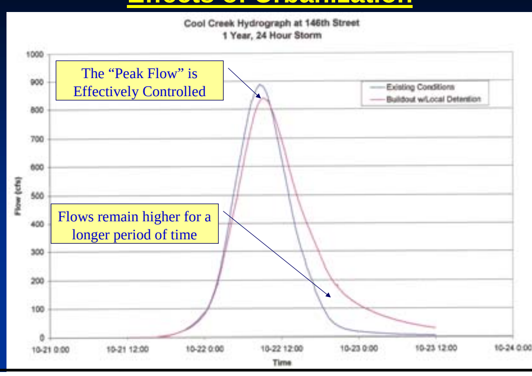


Cool Creek Upstream of White River confluence

Cool Creek Upstream of 116th Street in Golf Course

Problem Analysis

Effects of Urbanization



Problem Analysis

Hydraulic Evaluation

Conveyance Problems in the Upper Reaches of Cool Creek and its Immediate Tributaries

Examples

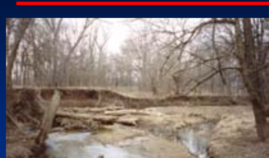
Inadequate bridge – 171st St. over Cool Creek

Culverts filled with sediment - Walter Street and Walter Court

Inadequate culverts – Carmel Drive over Hot Lick Creek

Problem Analysis

Stream Channel Evaluation



Severe erosion along lower reach of Cool Creek

Floodplain encroachments constrict flow and increases downstream erosion

Stream Information Compiled on Inventory Maps

Problem Analysis

Water Quality Evaluation

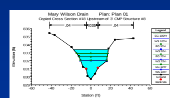
Entailed:

- Review of the Riparian Corridor
- Assessment of Floodplain Development
- Water Quality Sampling

Problem Analysis

Hydrologic/Hydraulic Analysis

- Assess the volume and rate of runoff for various storm events
- Evaluate existing stormwater conveyance and storage facilities
- Evaluate stormwater runoff impacts from future development
- Determine appropriate control measures



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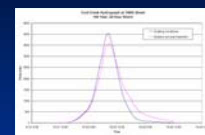

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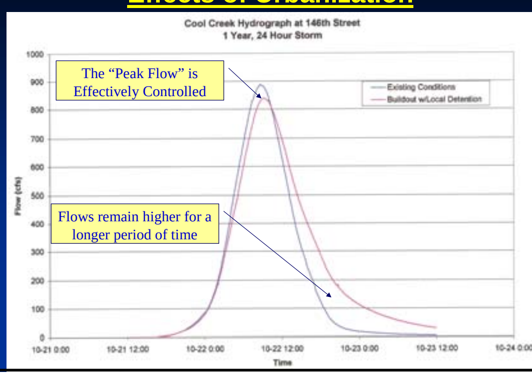
Cool Creek Upstream of 116th Street in Golf Course

Problem Analysis

Effects of Urbanization



Problem Analysis

Hydraulic Evaluation

Conveyance Problems in the Upper Reaches of Cool Creek and its Immediate Tributaries

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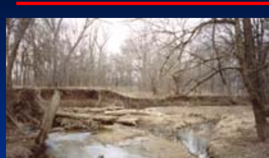


Severe erosion along lower reach of Cool Creek

Stream Information Compiled on Inventory Maps

Floodplain encroachments constrict flow and increases downstream erosion

Problem Analysis

Water Quality Evaluation

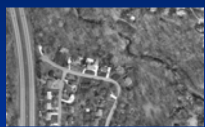
Entailed:

- Review of the Riparian Corridor
- Assessment of Floodplain Development
- Water Quality Sampling

Problem Analysis

Riparian Corridor

Protects Water Quality and Preserves Stream's Natural Characteristics



Forested Riparian Buffer along Cool Creek East of S. R. 431

No Riparian Buffer – Cool Creek South of 191st Street

Problem Analysis

Floodplain Development

Prohibit development in floodplain to help preserve existing buffers and natural flood storage

Problem Analysis

Water Quality Sampling Locations

- 186th Street

- 146th Street

- 116th Street

Problem Analysis

Water Quality Sampling Conclusions

- Pollutant constituents and concentrations in Cool Creek – generally comparable to other urban streams across country
- Nutrients levels somewhat high, possibly from excess fertilizer
- Bacteria levels exceed standards for recreational contact during wet weather *(problem is common to nearly all urban watersheds)*
- Stormwater Best Management Practices will help improve water quality

Solution Development

- Stream Flooding/Road Overtopping Solutions
- Neighborhood Problem Solutions
- Stream Bank Erosion Solutions
- Regional Stormwater Detention
- Future Land Use & Planning Recommendations

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace 171st Street Bridge and Regrade Roadway
- Regrade Roadway at 151st Street bridge
- Replace Gurley Street bridge (Anna Kendall Drain)
- Replace Cherry Street bridge (Anna Kendall Drain)

Solution Development

Streambank Flooding/Road Topping Solutions

- Replace SR 32 Culvert (J.M. Thompson Drain)
- Replace Culvert Downstream of US 31 (Highway Run)
- Add Culvert to US 31 (Highway Run)
- Replace Walter Street and Walter Court Culverts (Highway Run)
- Replace Private Drive Culvert between Walter Street and Walter Court (Highway Run)
- Replace Thornberry Drive Culvert (Highway Run)
- Replace Carmel Drive Culvert (Hot Lick Creek)

Solution Development

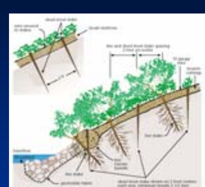
Streambank Erosion Solutions

Restoration Projects at:

- Highway Run –
  - Downstream of Stonehedge Drive
- H.G. Kenyon Drain –
  - Downstream of Rolling Court
- Cool Creek –
  - Upstream of confluence with the White River,
  - Downstream of Gray Road (at bend),
  - Upstream and downstream of Hot Lick Creek
  - Upstream of 131st Street (Main Street) and
  - Upstream of Keystone Avenue

Streambank Stabilization Techniques

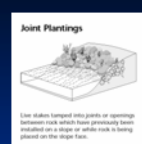
Riprap and Live Stakes (Joint Plantings) Source: Federal Interagency Stream Restoration Working Group, 1998



Brushmattress Technique (Source: USDA-NRCS 1996)

Source: Chattanooga Public Works Department

Streambank Stabilization Techniques



Riprap and Live Stakes (Joint Plantings) Source: Federal Interagency Stream Restoration Working Group, 1998

Brushmattress Technique (Source: USDA-NRCS 1996)

Source: Chattanooga Public Works Department

Cool Creek Demonstration Project (Hamilton County SWCD)

Cool Creek Demonstration Project (Hamilton County SWCD)

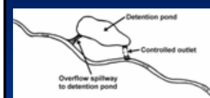
Solution Development

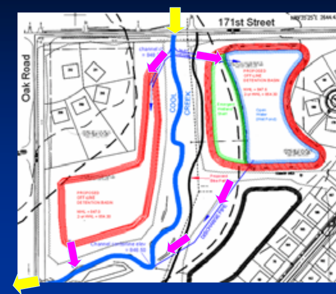
Regional Stormwater Detention

- Two (2) off-line Regional Detention Basins to Control the Magnitude of Stormwater Flows and Reduce downstream channel erosion
  - Immediately Downstream of 171st Street
  - West of Grassy Branch Road
- Retrofit existing regional on-line detention provided by RR embankment on Anna Kendall Drain

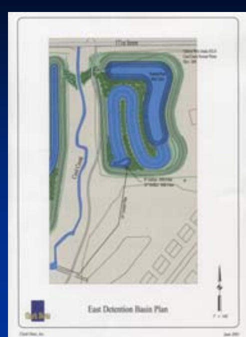
Solution Development

Regional Stormwater Detention





171st Street Regional Detention



Solution Development

Land Use Planning Recommendations

- Detention Requirements
  Improve control of smaller storms (first flush)
- Stream Buffer Ordinance
  Grass filter strips, preservation
- Floodplain Protection
  Prohibit fill in the floodplain
- Other Best Management Practices
  Improve water quality

Recommendations

Cost of Improvements

Stream Flooding/ Roadway Overtopping Solutions -	$2,720,000
Neighborhood Solutions -	$100,000
Streambank Erosion Solutions -	$570,000
Regional Detention Solutions -	$5,100,000
Total of All Solutions -	**$8,490,000**

IDEM 319 Plan Updates

- Two Public Hearings
- Quarterly Steering Committee Meetings
- Carmel, Westfield, and Hamilton County Interviews
- Quarterly Newspaper Articles
- Written Plan (updates to current Cool Creek Report)

Additional Problems/Concerns

- Critical Areas to Protect
- Agricultural Impacts
- Additional Streambank Erosion Areas
- Specific Development Concerns
- Flooding Concerns
- Ordinance deficiencies
- Opportunities for other regional solutions

Implementation Priorities

High	Med	Low	Improvement
			Repair Eroded Streambanks
			Solve flooding problems
			Construction Regional Off-Line Water Quality Pond(s)
			Implement Stream Buffer and/or Prohibit Floodplain Fill Ordinance
			Improve controls on new development
			Preserve Open Space/Sensitive Areas
			Improve Agricultural BMPs

APPENDIX H.4

NEWSPAPER ARTICLES

HAMILTON COUNTY SURVEYOR'S OFFICE

One Hamilton County Square, Suite 188
Noblesville, Indiana 46060
Phone (317) 776-8495
Fax (317) 776-9628

Press Release

Contact: Robert Thompson, RLA
Phone: (317) 776-8495

FOR IMMEDIATE RELEASE

COUNTY SURVEYOR RECEIVES WATERSHED GRANT

The Hamilton County Surveyor's office is about to expand the existing Cool Creek Watershed Management Plan to meet the Indiana Department of Environmental Management's (IDEM) requirements for a Watershed Management Plan.. The previous Cool Creek Watershed Study done by a local environmental firm, Clark-Dietz, Inc, in cooperation with the Town of Westfield and the City of Carmel, included some analysis of nonpoint source pollution issues; however, the main focus of the study was on flooding problems and development concerns in the watershed. The scope of the study will now be expanded to address IDEM's requirements for a Watershed Management Plan. On January 1st, the Surveyor's Office obtained a Section 319 grant to work with Clark-Dietz to modify the original study which will identify nonpoint source pollution management strategies so that additional grants may be obtained to implement some or all of the water quality best Management Practices (BMPs) in the future.

The Surveyor's Office is organizing a Steering Committee to direct the project. The Steering Committee will include representatives from government and the general public as well as business interests. The Steering Committee will meet quarterly throughout the one year project term. Steering Committee meetings will be open to the public and advertised as such in the local newspaper. The Steering Committee will identify the public's priorities as they pertain to water quality, develop strategies for addressing the public's concerns, and ultimately implement the plan.

If you are interested in participating in this Steering Committee please call the Surveyor's Office at 776-8495.

Hans J. Peterson

From: Robert Thompson [rct@co.hamilton.in.us]
Sent: Wednesday, April 06, 2005 11:31 AM
To: hansp@clark-dietz.com
Cc: afoley@ci.carmel.in.us; mmcbride@ci.carmel.in.us; dalet@clark-dietz.com; Amanda Smith; Jeanette Gartner; miked@deboyland.com; acook@hoosiertradewinds.com; BELIFRIT@idem.in.gov; EOLIVER@idem.in.gov; PBROWN@idem.in.gov; lshrake@iupui.edu; msweat@washingtontownship-hc.us; bhauk@westfieldtown.org; nmyers@williamscreek.net; sbaxter@williamscreek.net
Subject: Cool Creek Meeting

Waterway study looks to clean up creek

By Rebecca L. Sandlin | Staff writer

Residents who attend an April 13 meeting to discuss stormwater management issues in the Cool Creek Watershed are likely to learn some information they don't want to hear.

The watershed is on the Environmental Protection Agency's list of impaired water bodies, and to help take it off that list, the Hamilton County Surveyor's Office received a grant of nearly $31,000 to study pollution in the creek and watershed.

The first public meeting will seek input from the community on key issues regarding Cool Creek. Included in the discussion will be existing stormwater problems in the watershed such as flooding and erosion, the effect of urbanization on the quality of water and the best ways to reduce pollution.

Robert Thompson, program manager at the Hamilton County Surveyor's Office, said he hopes to have many people attend the public meeting, which will take place at the Cool Creek Nature Center auditorium, 2000 E. 151st St. in Westfield.

"We want to find out what their thoughts are, what they believe are the significant sources of pollution and what they can recommend to do about it," Thompson said. "Also, we want to educate them about the watershed and why it is impaired."

The grant will fund a one-year study of the Cool Creek watershed. Thompson said there has been an ongoing study of problems associated with the watershed, beginning about three years ago.

"It was originally studied for flooding issues," he said. "This second one is for the water quality issues, the pollution issues that have occurred in the watershed. That study has been completed and now we're wanting to address the reasons why it is so impaired."

Some of those problems include E-coli bacteria that was discovered in Cool Creek. There are signs posted to warn against swimming, drinking or fishing from the water.

Noblesville Daily Times™

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Much of the cause can be attributed to run-off of storm water from farms, developed areas, failing septic systems and illegal connections where people dump untreated sewage into the stream.

"There are several causes and one of the things the city will do is try to pinpoint the causes more specifically and develop strategies to improve the water quality," Thompson said.

A separate EPA grant for nearly $93,000 also was awarded for a two-year study to begin on the Little Cicero Creek watershed, another body of water on the agency's impaired list.

A future study is planned for Stony Creek.

A consultant will be brought on board to help with the studies.

Know more:

- The first public meeting of the study and cleaning of the Cool Creek Watershed will take place at 7 p.m. April 13 at the Cool Creek Nature Center auditorium, 2000 E. 151st St. in Westfield.

Robert Thompson, RLA, CLARB
Program Manager, Phase II Stormwater
Surveyor's Office
One Hamilton Co. Square
Suite 188
Noblesville, IN 46060
ph: 317-770-8833
fax: 317-776-9628
email: rct@co.hamilton.in.us
Watch over your watershed - you drink what runs off

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Public invited to participate in water-quality committee

Daily Times

The Hamilton County Surveyor's office is looking for volunteers to help expand the Cool Creek Watershed Management Plan.

The surveyor's office is going to expand the Cool Creek Watershed Management Plan to meet the Indiana Department of Environmental Management's requirements for a Watershed Management Plan. The surveyor's office will modify the original study to identify nonpoint source pollution management strategies.

The steering committee will direct the project. It will include representatives from government and the general public as well as business interests. The committee will meet quarterly throughout the one-year project term. Steering committee meetings will be open to the public. The committee will identify the public's priorities about water quality, develop strategies for addressing the public's concerns and implement the plan.

People interested in participating on this steering committee may call the surveyor's office at 776-8495.

THE NOBLESVILLE LEDGER.COM

Posted 8:37 PM February 10, 2005

Residents needed to study water quality

February 11, 2005

NOBLESVILLE -- Residents are needed to serve on a steering committee for the Hamilton County Surveyor's Office to identify priorities for water quality, develop strategies to address concerns and implement a plan to address them.

The one-year project will expand the Cool Creek Watershed Management Plan to meet Indiana Department of Environmental Management requirements.

The steering committee also will include government and business representatives. The committee meets quarterly throughout the year. Persons interested in serving on the steering committee may call the Surveyor's Office at (317) 776-8495.

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ADDRESS: 152 S. 9TH ST. NOBLESVILLE, IN 46060 PHONE: 317-773-9960 FAX: 317-770-5770

Cool Creek polluted

By Bob Hansen | Editor

WESTFIELD — Rainwater mixed with crop residue apparently created a toxic substance that killed fish in Cool Creek Wednesday.

About 70 to 100 fish were killed, and the water for about three miles was discolored. According to Barry Sneed, a public information officer at the Indiana Department of Natural Resources, water laden with ammonium nitrate flowed into a storm sewer outlet at Waitt Elevator, located at 1131 State Road 32 East in Westfield. Workers from that agency were called to the scene after local officials found the source of the spill. They were still investigating Thursday.

"At this time, we don't believe there are any continuing effects," Sneed said Thursday afternoon.

An area resident called the Town of Westfield's public works department complaining that a creek had turned black and smelled like petroleum, said Kurt Wanninger, operations manager for the Department of Public Works.

The public works department located the source of the problem and called the state agency.

"The water was black for 3.1 miles downstream" from Waitt Elevator, Wanninger said. "Fish were found dead in Cool Creek and tributaries, including bass, shad and bluegill."

Most of the fish were fairly small.

Sneed and Wanninger said that apparently what happened is that Waitt Elevator was pumping out a pit under an old silo the company planned to tear down. Grain had been left in the pit, and rainwater had mixed with it over a period of time.

The company pumped out the mixture to a location next to a storm sewer outlet starting at about 11:30 a.m. Wanninger said the toxic substance then entered the storm sewer and flowed into the Goodrich Brothers Regulated Drain and then the Anna Kendall Regulated Drain. It then flowed into Cool Creek, which also is called the Wheeler and Bills Regulated Drain.

The water and crop residue mixture created ammonium nitrate, a substance that robs oxygen from the water. That explains why the fish died, Wanninger said.

The public works department received a call about the problem at 2:57 p.m. Wednesday. At about 4:30 he located the source of the substance at Waitt Elevator.

Sneed confirmed that the discolored water had a high concentration of ammonia and low oxygen levels.

The Indiana Department of Environmental Management was continuing its investigation Thursday. As a precaution, the state agency was sampling the ground near the dumped material and near the polluted waterways, Sneed said. IDEM also was sampling the water in Cool Creek to find how far toxic concentrations of the pollution traveled.

Waitt Elevator will have to pump out the remaining water and residue and contain it so that waste will not flow into the drainage system, Sneed said. He did not know how much material was left in the pit.

Additionally, IDEM officials will be reviewing the situation to decide whether to levy a fine or take other action against the elevator company.

A phone call to Waitt Elevator owner Robert Drayer seeking comment was not returned before publication.

Besides the town public works department and IDEM, other agencies that assisted at the site included the Westfield police and fire departments, Hamilton County Surveyor's office and Hamilton County Emergency Management Agency.

Westfield grain spill kills fish

Workers raze old elevator, pump contents onto ground

By Diana Lamirand
Diana.Lamirand@TheNoblesvilleLedger.com

WESTFIELD — A black, smelly sludge entered a storm drain Wednesday afternoon and resulted in a fish kill in a tributary leading to Cool Creek.

According to a preliminary count Thursday afternoon, 100-150 fish were killed as a result of the toxic substance being released, said Russ Grunden, a spokesman for the Indiana Department of Natural Resources (DNR).

"There were shad, bluegill and at least one bass," said Kurt Wanninger, operations manager for the Westfield Public Works Department.

Employees tearing down an old grain elevator at Waitt Elevator, 1131 E. Indiana 32, had pumped about 2-3 feet of dirty water from the bottom of the elevator onto the ground.

The water, which contained old, fermented corn, soybeans and wheat, flowed into a nearby storm drain and eventually made its way to Cool Creek.

"It was nasty smelling stuff," Wanninger said.

Though the fish kill was minor when compared to the massive one in December 1999 that wiped out fish along a 50-mile stretch of the White River, Grunden said, it's still a loss of resources.

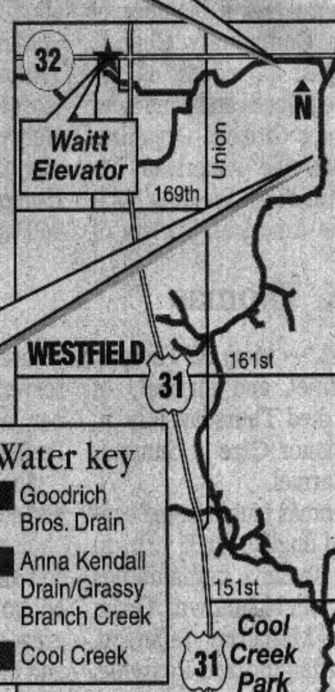
"We take any fish kill seriously," he explained. "These are resources that are part of the state of Indiana and something that all Hoosiers are responsible for."

An Indiana Department of Environmental Management (IDEM) field officer found high ammonia nitrate readings in the

See FISH, Page A22

Fish were found floating dead Wednesday afternoon in a tributary under Timberbrook bridge in the Timberbrook Run subdivision south of Indiana 32. Between 100-150 fish were killed, officials said, as a result of a toxic-substance released from Waitt Elevator Co. in Westfield.

Residents reported seeing this black sludge flowing downstream Wednesday afternoon in a Westfield tributary that leads to Cool Creek near Indiana 32.



Marilyn.Cooley@TheNoblesvilleLedger.com

At least one bass, a popular sporting fish, was found dead Wednesday afternoon in the Anna Kendall Drain or tributary under Timberbrook bridge in the Timberbrook Run subdivision.

No fines for Waitt Elevator yet

FISH/From A1

tributary and creek.

The ammonia nitrate decreased oxygen levels and suffocated the fish, said public information officer Amy Hartsock.

Emergency response officials from Westfield, Hamilton County and IDEM tracked the toxic substance spill for about 3.19 miles from Waitt Elevator to near 161st Street, Wanninger said. The rain that fell Wednesday night and early Thursday flushed the substance further.

"It's probably down to White River by now," Wanninger said Thursday morning.

Residents called Westfield officials about 3 p.m. to report a "black smelly substance" in the Anna Kendall drain or tributary that flows into Cool Creek, Wanninger said, and investigators tracked it for about one mile upstream before they found the contamination source at Waitt Elevator.

When told of the situation, Wanninger said, the company's owners "didn't think it was a big deal. We told them we thought it was a serious situation."

Roger Drayer, who owns the grain elevator business with Gary Fulton, said his employees did not know that they shouldn't pump the contaminated water onto the ground.

"I'm not really sure" what happened, Drayer said. "It's not a huge fish kill... I think Kurt (Wanninger) is trying to make a mountain out of a molehill."

Drayer also pointed out that most of the fish were shad or "junk fish."

Gizzard shad, while sometimes overabundant, provide an important ecological niche in the fishing community, said Tom Flatt, an aquatic habitat coordinator for DNR. They are a plankton feeder, he said, and serve as food for bass fish.

Grunden said the toxic dumping is an ongoing investigation that will probably take a few days. Once the damages are assessed, he said, the responsible party will be notified how much it will cost to reimburse the state for the loss of life.

"We witnessed live fish downstream at some of the access points so it was not a long-running spill," Grunden said.

Hartsock said IDEM officials returned to Waitt Elevator Thur[sday] to further discuss ways to r[e]move the toxic materials in an e[n]vironmentally friendly manner.

The investigation will be r[e]viewed internally before a dec[i]sion is made to assess Wait[t] owners any fines.

"Right now, we don't know," she said.

Call staff writer Diana Lamirand at (317) 444-5545.

"I'm not really sure" what happened. "It's not a huge fish kill. . . . I think Kurt (Wanninger) is trying to make a mountain out of a molehill."

Roger Drayer,
Waitt Elevator co-owner

Owners to restock fish, pay fine

Waitt Elevator wants to 'make it right,' after fish kill in creek.

By Diana Lamirand
Diana.Lamirand@TheNoblesvilleLedger.com

NOBLESVILLE — The owners of Waitt Elevator have agreed to work with the White River Rescue group to restock more than 500 fish killed July 20 after employees dumped sludge down a storm drain.

"We will do some restocking" in addition to any fines that may be assessed by state agencies, said Roger Drayer, who owns the elevator with Gary Fulton. "We will work with Steve (Schwartz) to get that done."

Schwartz, who along with John Bundy formed White River Rescue 2000 after a massive fish kill in December 1999, approached Drayer.

He and Fulton are "trying to make it right," said Schwartz, who's also on the Hamilton County Council.

Schwartz and Bundy have been frustrated throughout the years, Schwartz said, that the Indiana Department of Natural Resources (DNR) assesses fines for fish kills but the agency doesn't use the money to restock the fish that were killed.

"They're (DNR) not putting fish back into that resource," he said. "We'd really like to have it done right."

Bill James, DNR's chief of fisheries, explained that the fines collected from fish kills go into a special account but could be spent on equipment to investigate fish kills or other related items. On a small fish kill like the one that occurred in Westfield, restocking is "not a real practical thing to do," James said. Oftentimes, James said, Mother Nature takes its course and fish replenish themselves long before the state can find hatcheries with the type of fish killed. Other fish may move upstream or downstream and fill the void, too.

The fines are "a powerful fish-management tool but we try to use it discreetly instead of restocking whether it's needed or not," James said.

The fines may be used to buy fish-kill investigation equipment, educational materials for investigators, technical training, streamside rehabilitation projects or buying conservation easement rights to protect key habitats from development.

"That's great," Schwartz said after learning how the funds could be used. "But we really need to restock these little streams.

Instead of waiting for nature to run its course, he said, adult fish need to be put back in as soon as possible. He also thinks DNR should charge stiffer fines so more funds are available to restock every lost resource.

The DNR said about 534 bluegill, green sunfish, minnows, white suckers, sculpins, yellow bullheads, smallmouth bass, largemouth bass and darters were killed in the upstream portion of Cool Creek.

Employees tearing down an old grain elevator pumped about 1,500-2,000 gallons of dirty water from the bottom of the elevator. The water, which contained fermented corn, soybeans and wheat, flowed into a nearby storm drain and eventually made its way to Cool Creek.

Call staff writer Diana Lamirand at (317) 444-5545.

THE NOBLESVILLE LEDGER.COM

Posted 1:07 AM July 26, 2005

Fish kill toll grows

534 fish dead; fines expected

By Diana Lamirand
Diana.Lamirand@TheNoblesvilleLedger.com
July 26, 2005

WESTFIELD -- The number of fish killed Wednesday after Waitt Elevator employees dumped a black, smelly sludge down a storm drain has increased to more than 500 fish, according to a state conservation officer.

John Gano of the Indiana Department of Natural Resources (DNR) said Monday afternoon that he counted 534 bluegill, green sunfish, minnows, white suckers, sculpins, yellow bullheads, smallmouth bass, largemouth bass and darters in an upstream portion of Cool Creek.

"It's a significant number of fish," Gano said, but still small when compared to the 5 million fish killed in December 1999 when a toxic chemical spill from Guide Corp. wiped out everything in the White River between Anderson and Indianapolis.

"It would have been a lot worse if it hadn't rained like it did," Gano said, explaining how the Wednesday night rain diluted the toxic substance as it flowed downstream. "We would have had a more sizeable fish kill . . . we're very fortunate that it rained."

Employees tearing down an old grain elevator at Waitt Elevator, 1131 E. Indiana 32, pumped about 1,500-2,000 gallons of dirty water from the bottom of the elevator. The water, which contained old, fermented corn, soybeans and wheat, flowed into a nearby storm drain and eventually made its way to Cool Creek.

"They didn't have intent to kill fish in the creek . . . there is no criminal intent," Gano said of the workers. But DNR officials will place a monetary value on the loss of fish -- some costing more than others based on their recreational value to local fishermen. "I'd be surprised if it's over $1,000 . . . probably between $500 and $1,000."

The company may also face fines from the Indiana Department of Environmental Management (IDEM) after the state agency reviews investigating officers' reports, IDEM public information officer Barry Sneed said.

"Our goal is to work with the owner to educate him so, hopefully, we will not have any more accidents," Sneed said.

The majority of the fish killed, Gano said, were game fish like bluegill and the green sunfish. There were also 20-30 bass and about 20 bullheads or catfish. There were no gizzard shad, Gano said, despite initial reports.

All fish died within the first mile of the dumping, the conservation officer said, but some fish were still alive further downstream.

Besides being illegal, dumping anything but water into a storm drain is harmful to the environment, said Robert Thompson, program manager with the Hamilton County Surveyor's Office.

"What many people fail to realize is that they are polluting our drinking water supply," he said. "Less that 0.4 percent of the Earth's water supply is available to us by way of rivers, streams, lakes and ground water, and more that 99 percent is not readily drinkable.

"Public education . . . will go a long way to make people aware that storm sewers are for flood control and not for the disposal of wastes and contaminated surface water," he added.

After residents reported a black, smelly substance in the Anna Kendall drain or tributary that flows into Cool Creek, an IDEM field officer found high ammonia nitrate readings. The ammonia nitrate decreased oxygen levels and suffocated the fish, Gano said. Roger Drayer, who owns the grain elevator business with Gary Fulton, said his employees did not know that they shouldn't pump the contaminated water onto the ground.

THE NOBLESVILLE LEDGER.COM

Posted 11:31 PM November 23, 2005

Program aims to oust water pollution

Officials to educate about dumping harmful liquids into storm sewers.

By Leslie Collins
Correspondent
November 25, 2005

NOBLESVILLE -- Washing the family car in the driveway could result in a violation of local and state ordinances. A more blatant offense is changing the car's oil and dumping the drained product into the storm sewer.

Hamilton County officials want to educate the public about illegal residential and commercial dumping into storm drains, rivers, creeks and other bodies of water.

Noblesville, Westfield, Arcadia and Cicero, along with Carmel and Fishers, are included in the Pollution Prevention and Good Housekeeping program. The Hamilton County Commissioners signed the illicit discharge ordinance in July.

"Through ignorance or laziness, people dump oil and other substances (into storm sewers)," said Robert Thompson, storm-water program manager for the Hamilton County Surveyor's Office. "These (substances) are not treated and go directly into rivers and streams."

Citizens washing cars in driveways can use eco-friendly detergents, Thompson said, adding that sudsy runoff from commercial car washes is treated.

The county is also cracking down on illegal commercial dumping.

Amy Ballman of the Hamilton County Health Department has cited at least one Carmel carpet company for discharging what is known as gray water into the storm sewer.

Commercial carpet cleaners often dump cleaning refuse from homes where carpets have been cleaned directly into neighborhood storm sewers, Thompson said.

Carpet companies aren't the only offenders under scrutiny. Construction company crews have been seen rinsing tools and other items in the street after installing concrete, Thompson said.

"That material (cement) has a high pH, which wipes out anything living in a river or stream," Thompson said.

He suspects companies that dump substances down storm sewers don't want to take the time to properly dispose of the waste, but taking that time could save violators a possible $1,000-per-day fine.

David Cage of the Indiana Department of Environmental Management said companies have two options: Either haul the material and dispose of it according to state law or get written approval from the local wastewater treatment plant to discharge it into the sanitary sewer system.

The Carmel Utilities Department will allow businesses to discharge gray water directly into Carmel's sanitary sewers at a cost of $38 per 1,000 gallons, according to Amanda Foley, Carmel's storm-water coordinator.

Foley was out of town last week and unavailable for comment. However, in an e-mail to Thompson, she said carpet-cleaning companies are illegally discharging cleaning fluids into the storm sewers throughout the county.

"This is likely a widespread problem," she said.

Information will be available during a workshop Dec. 7 at the Hamilton County 4-H Grounds, 2003 E. Pleasant St., when the county's new storm-water standards will be unveiled.

REPORT STORM-WATER POLLUTERS

Citizens may report incidents of storm-water pollution or dumping of pollutants into storm drains by calling (317) 776-8495, or by completing a Report-a-Polluter form at www.co.hamilton.in.us

To report a storm drainage problem, call the Hamilton County Surveyor's Office at (317) 776-8495.

PITCH IT PROPERLY

Items such as solvents, pesticides and paint products can pose fire hazards and, if not disposed of properly, may threaten local waterways and groundwater.

The Hamilton County Household Hazardous Waste Center is at 1717 E. Pleasant St., Noblesville.

Hours are: 8 a.m.-4:30 p.m. Mondays-Wednesdays; 11:30 a.m.-8 p.m. Thursdays; 7 a.m.-3:30 p.m. Fridays; 8 a.m.-noon on the second and fourth Saturdays.

HAMILTON COUNTY SURVEYOR'S OFFICE

One Hamilton County Square, Suite 188
Noblesville, Indiana 46060
Phone (317) 776-8495
Fax (317) 776-9628

Press Release

Contact: Robert Thompson,RLA
Phone: (317) 776-8495

FOR IMMEDIATE RELEASE

HAMILTON COUNTY TO RELEASE RESULTS FROM THE COOL CREEK WATERSHED STUDY

The Hamilton County Surveyor's Office invites the public to attend a meeting to discuss findings and provide additional feedback on the Cool Creek Watershed Management Plan, which is scheduled for completion by the end of this year. On December 14th a public meeting will be held at 7 PM in the Cool Creek Nature Center Auditorium, 2000 E. 151st Street in Westfield.

On January 1st, 2005 the Surveyor's Office received a Section 319 Watershed grant from the State of Indiana to work with Clark Dietz, a local environmental firm as well as residents of Westfield and Carmel, to identify stormwater pollution reduction strategies in the Cool Creek Watershed. Since receiving the grant, representatives from Hamilton County, the City of Carmel, and the Town of Westfield, as well as interested individuals have met on several occasions to review water quality data from the Cool Creek Study and to make recommendations for improving the water quality in the watershed. Some of the issues investigated were:

- Existing stormwater problems in the watershed (stream bank erosion, flooding, etc.)
- The effect of urbanization on water quality (Cool Creek is on the State's list of impaired water bodies due to high bacteria levels)
- Best Management Practices (ways to reduce stormwater pollution)
- Reduction of invasive species

Hamilton County, the City of Carmel and the Town of Westfield believe that the residents of the Cool Creek Watershed have played and will continue to play an important role in improving water quality in the watershed. Identification of Best Management Practices to reduce pollution as well as potential stormwater quality improvement projects will be outlined in the meeting. For further information contact:

Robert Thompson, Program Manager, Hamilton County Surveyors Office

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Important Press Release

Contact: Robert Thompson, RLA
Phone: (317) 776-8495

FOR IMMEDIATE RELEASE

SURVEYOR HOLDS MEETINGS ADDRESSING WATER QUALITY IN HAMILTON COUNTY

On December 7th the Hamilton County Surveyor, the Hamilton County Phase II Public Education Committee along with the towns of Cicero, Fishers, Arcadia, the Cities of Carmel and Noblesville held a workshop to inform developers, builders, engineers and public officials about new water quality regulations in Hamilton County. Over 240 representatives attended the all day workshop that outlined new requirements that will help address water quality issues at construction sites as well as post-construction stormwater runoff pollution. New requirements include permits for commercial and residential construction on sites of 1 acre or more, installation of water quality BMP devices in new developments (Best Management Practices) that will help remove pollutants before they enter the streams, rivers and lakes as well as stiff penalties for developers that fail to meet the new requirements.

~ MORE ~

On December 14th, 2005 another meeting was held at the Cool Creek Nature Center to release the results of the Cool Creek Watershed Study. Representatives of Clark-Dietz, Inc. presented to representatives of the County, the City of Carmel, the Town of Westfield and interested individuals, According to Hamilton County Surveyor,

According to Kenton C. Ward, Hamilton County Surveyor, this study which was part of an EPA Watershed Management Grant began in the early spring of 2005, was aimed at identifying and analyzing stormwater management concerns as a result of the continuing development in the watershed and to provide specific plans to manage stormwater quality for Cool Creek which has been listed by IDEM as an impaired body of water for e-coli.

Among the recommendations of the study was to construct Regional Stormwater Quality facilities that would reduce streambank erosion and reduce non-point source pollutants like e-coli, heavy metals, and nutrients like nitrogen and phosphorous that result from excessive lawn fertilization and agricultural runoff. Other recommendations include public education, stream bank stabilization at several sites, elimination of failing septic systems, adopting a county wide policy of prohibiting construction in floodways, and requiring vegetated buffers along Cool Creek and its tributaries.

If you have any questions, please contact the Hamilton County Surveyor's Office at 317-776-8495.

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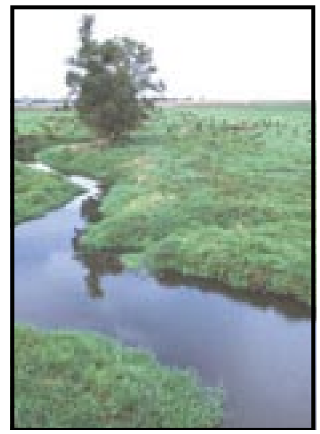
Town & Country

Hamilton County Soil & Water Conservation District

Winter 2005

Applications for Cost Share Now Being Accepted

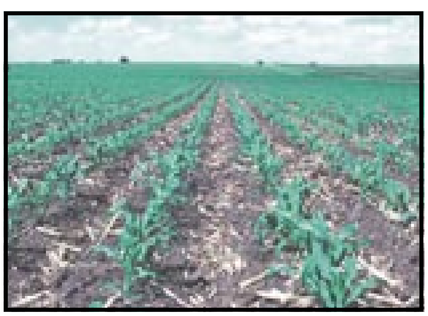


EQIP — Applications for the 2006 **E**nvironmental **Q**uality **I**ncentives **P**rogram (EQIP) are currently being accepted at the Natural Resources Conservation Service. The EQIP program is available to anyone qualifying as a farm. A wide variety of practices are available for cost sharing through the EQIP program. Applications must address environmental concerns determined at the local, state and national levels.

Cost share rates are typically 50% of the actual costs or are set as a flat rate incentive for those practices such as no-till, nutrient management and pest management. Practices must be applied on a planned schedule developed at the time of application. Once an application is accepted and a contract is signed, there is a penalty for not completing all of the planned practices or withdrawing from the contract.

All applications will be ranked on the environmental benefits derived from the contract. The more benefits are derived from the contract and the longer lasting the effects on the environment, the better an application will rank and the better chance for funding. In Indiana, all applications received by the initial cut off date will be ranked together.

Examples of eligible projects might include manure management, filter strips, tree planting, streambank erosion control, and wildlife habitat development. To make an application, contact the local Natural Resources Conservation Service office at 1108 St. 9th street, Noblesville, phone 317/773-2181 Ext. 101.



CREP — Applications are also being accepted for the **C**onservation **R**eserve **E**nhancement **P**rogram which can provide cost share, incentive, and annual rental payments to apply conservation practices on eligible cropland in Hamilton County. These practices include Warm Season Grass Establishment, Hardwood Tree Planting, Permanent Wildlife Habitat, Grass Filter Strips, Riparian Buffers, Wetland Restoration, Bottomland Timber Establishment.

Sign-up for the Indiana CREP went into effect August 1, 2005 and will continue until enrollment goals are attained or through December 31, 2007, whichever comes first. Contact the local Farm Service Agency at 317-773-2181 Ext. 100 for more details or to enroll in the program.

SWCD Cost Share Programs — The Hamilton County SWCD also has a variety of cost share programs available to local residents, including a **well capping program**. Funds are available to assist in the cost of properly capping abandoned wells. The picture shown at the right is of a recent project that utilized these funds. A complete list of the SWCD cost share programs can be found on our web site at www.hamiltonswcd.org, or by calling 317-773-2181 Ext. 101.

Do You Want To Attend The National No-Till Conference ?

The Hamilton County SWCD will pay half the cost of registration for individuals wishing to attend the National No-tillage Conference, which will be held in St. Louis, MO in January 2006. This conference is unparalleled in the U.S. in terms of no-till information and technology. Please call if interested 317-773-2181 Ext. 101.

HAMILTON COUNTY
Soil & Water
CONSERVATION DISTRICT

Town & Country

Published quarterly and distributed to landowners, farm operators, teachers, local agencies, public officials, conservation organizations and other interested individuals.

Personnel Changes — BUSH LEAVING OFFICE

(no not George…John)

John Bush has been the acting District Conservationist for Hamilton Co. since the beginning of August when Aaron Lauster was transferred. John has announced that he is retiring effective the end of 2005.

John has been the District Conservationist in Boone County since the fall of 1976. John started his career with the Soil Conservation Service in 1969 as a student trainee in Vermillion County. During his career he has served in various positions in Vermillion, Delaware, Henry, Hamilton, Parke, Putnam, Howard, Montgomery, Tippecanoe and Fountain counties in Indiana.

After retirement, John intends to do some traveling, continue his hobby of woodworking and working with the 4-H shooting sports program in Boone County as an instructor. He and his brother still have the home farm in Vermillion County which he intends to continue to farm.

The Hamilton County SWCD would like to express our appreciation for John's dedicated service in conservation. His years of experience and knowledge will be hard to replace. Thanks John.

Stream Bank Stabilization Project at Cool Creek Park

Streams and creeks can be a mixed blessing. They are absolutely needed to transport stormwater from our neighborhoods and farmlands to White River. They are also an important component for wildlife habitat and serve as corridors for wildlife movement. What we don't often comprehend is the force, power and persistence of flowing water.

A stream in a stable watershed (a watershed is the contributing land area that creates the water flow) may have little soil erosion for many years. However, large storm events like those experienced in Hamilton County in 2003 and 2004 can cause rapid soil erosion and significant damage to the stream. Major changes in the watershed (increased impervious surface resulting from development) can also cause increased erosion. The Cool Creek watershed is an example of a watershed that is experiencing degradation, and stream bank erosion has become a serious problem.

Hamilton County is hoping to mitigate this environmental damage by proactively addressing the issue through more stringent stormwater management practices and by repairing areas already experiencing degradation. Work is being done on the Cool Creek Watershed Management Plan, which will identify improvements needed to protect the overall health of this important community resource. With the help of Clean Water Indiana funds and the cooperation of the Hamilton County Park and Recreation Department, the Soil and Water Conservation District has already began the repair process by completing a stream bank stabilization project in Cool Creek Park.

The project demonstrates several new products that can be used for stream stabilization and erosion control of the banks. These practices include soil wrapped terraces, locking pavers, riprap, biologs, compost logs, A-jacks, and a concrete mattress.

Project may be viewed on site at Cool Creek Park, or on our web site at www.hamiltonswcd.org. For questions about the project call the SWCD at 773-1101 Ext. 106, and for questions or concerns about the Cool Creek watershed call the Surveyor's office at 776-8495.

APPENDIX H.5

CD WITH PDF FILES OF

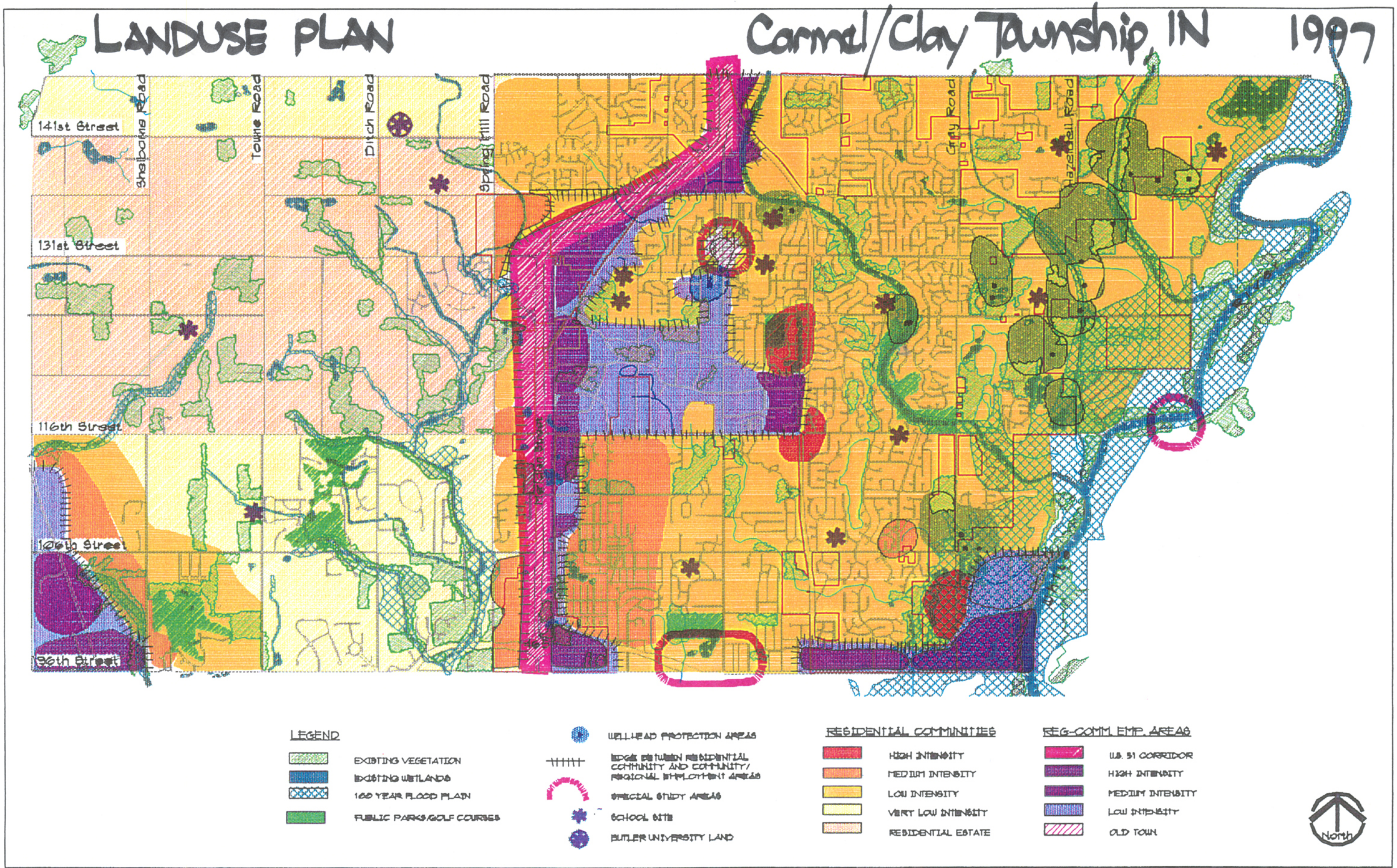
STREAM INVENTORY MAPS
NOVEMBER 2003

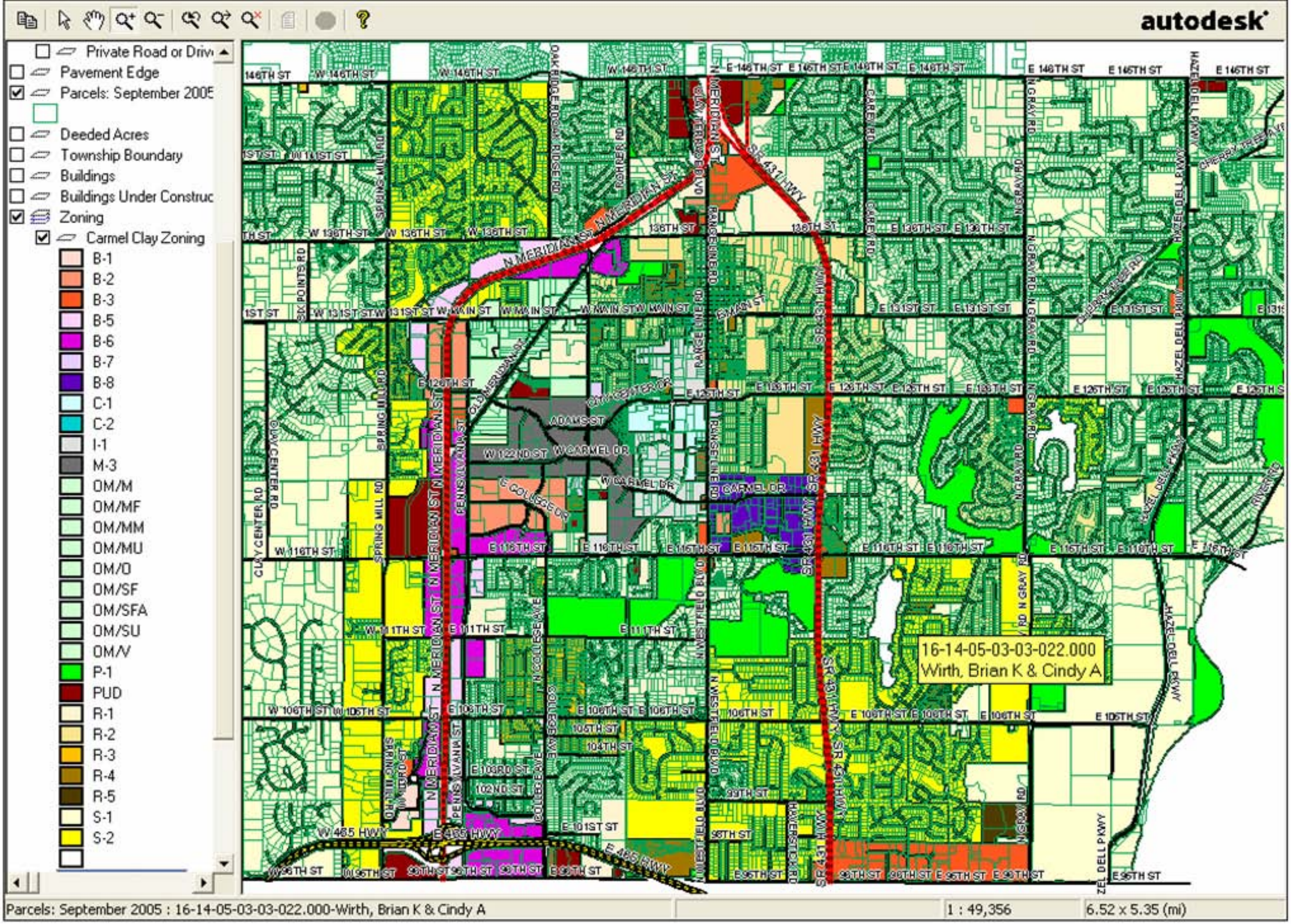
AND

COOL CREEK WATERSHED
MANAGEMENT PLAN

APPENDIX H.6

LAND USE AND ZONING MAPS FOR CARMEL AND WESTFIELD

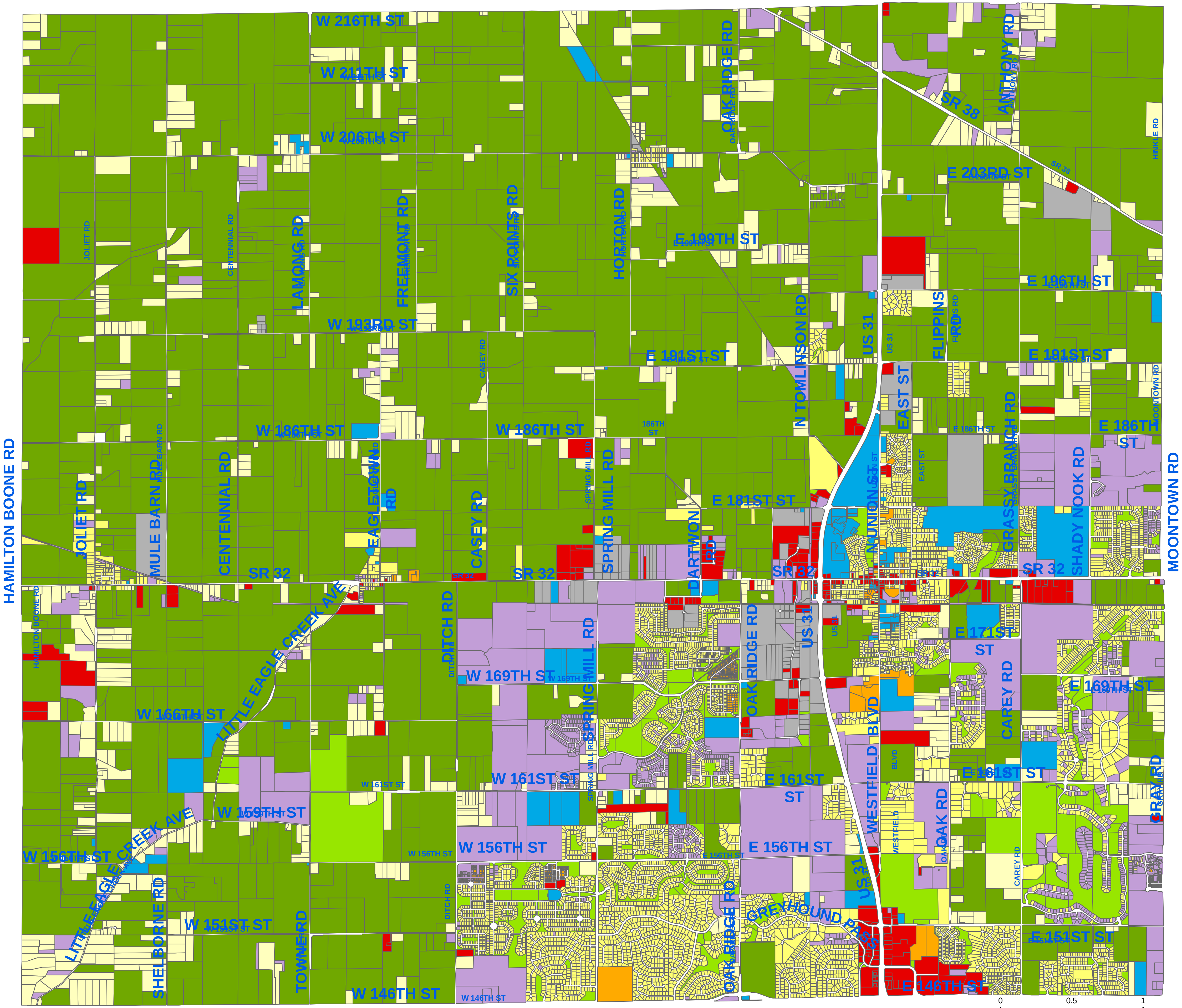

LANDUSE PLAN
Carmel/Clay Township, IN
1997
141st Street
131st Street
116th Street
106th Street
96th Street
Shelborne Road
Towne Road
Ditch Road
Spring Mill Road
Gray Road
Hazel Dell Road
LEGEND
EXISTING VEGETATION
EXISTING WETLANDS
100 YEAR FLOOD PLAIN
PUBLIC PARKS/GOLF COURSES
WELLHEAD PROTECTION AREAS
EDGE BETWEEN RESIDENTIAL COMMUNITY AND COMMUNITY/ REGIONAL EMPLOYMENT AREAS
SPECIAL STUDY AREAS
SCHOOL SITE
BUTLER UNIVERSITY LAND
RESIDENTIAL COMMUNITIES
HIGH INTENSITY
MEDIUM INTENSITY
LOW INTENSITY
VERY LOW INTENSITY
RESIDENTIAL ESTATE
REG-COMM. EMP. AREAS
U.S. 31 CORRIDOR
HIGH INTENSITY
MEDIUM INTENSITY
LOW INTENSITY
OLD TOWN
North



Welcome to the City of Carmel GIS Site

Washington Township Land Use Map

GIS



Legend

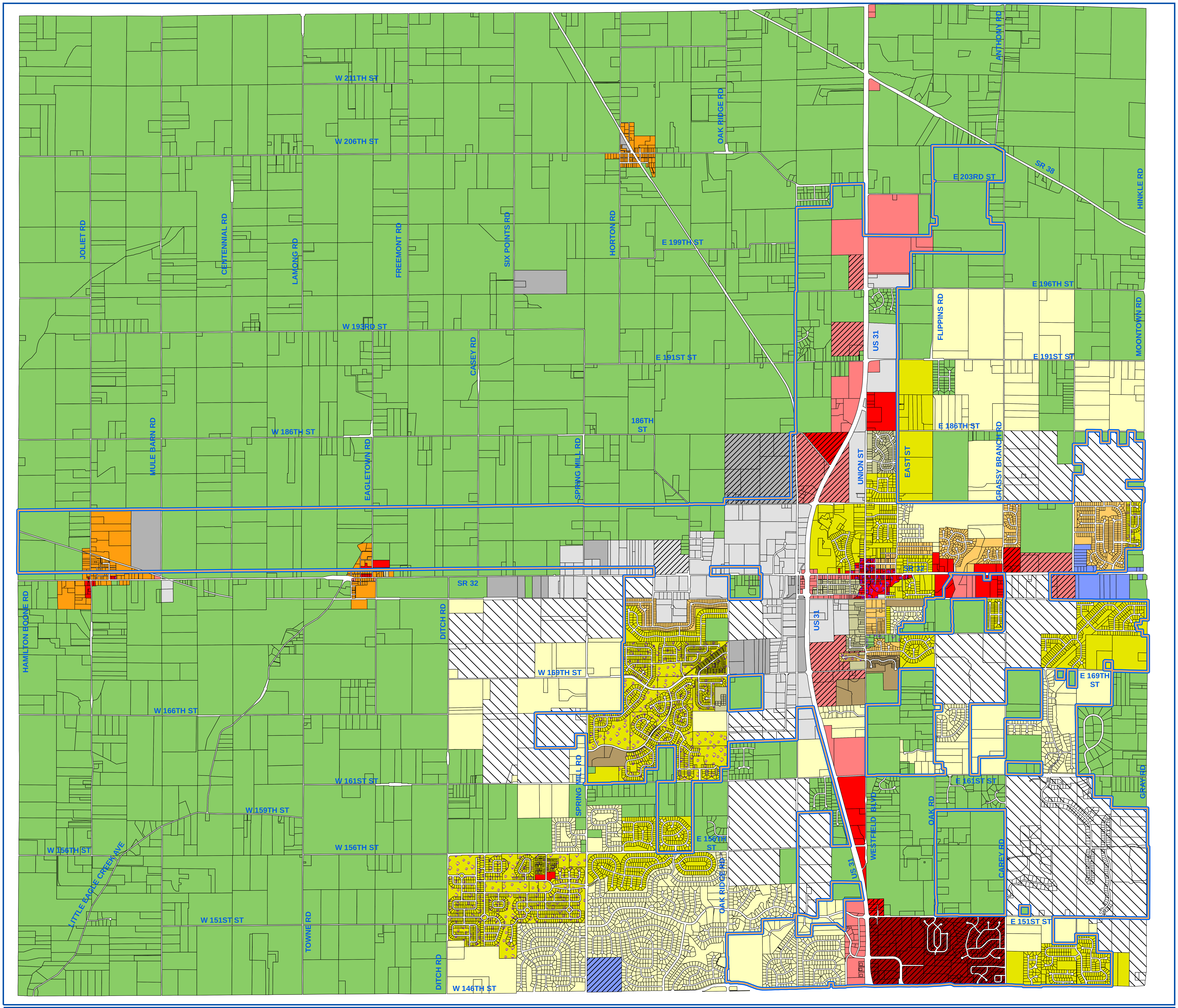
Land Use

Type

- AG
- COM
- IND
- INST
- REC
- RES
- RESA
- RESNU
- VAC

August 1, 2005

Town of Westfield and Washington Township Zoning Map



GIS

December 1, 2004

Westfield Town Council Members

President
Teresa Otis Skelton

Vice President
Jack Hart

David Mikesell

Bob Smith

Ron Thomas

Westfield Town Manager
Jerry Rosenberger

Legend

Zoning

AG-SF1I, AG-SF1, SF-3, SF-2, SF-3 (Cluster), SF-4, SF-4 (Pre-1994), SF-5, MF-1, MF-2, LB, LB-H, LB-PD, GB, GB-PD, SB-PD, GO, GO-PD, EI, EI-PD, OI, OI-PD, PUD, Westfield Town Limits

0 0.25 0.5 1
Miles