WASHINGTON COUNTY

MULTI JURISDICTION HAZARD MITIGATION PLAN

A Cooperative effort between Washington County, Jonesborough, Johnson City, and the Washington County Emergency Management Agency.

2010

TABLE OF CONTENTS

Section 1.0 Planning Process 1-1
1.1 Plan Introduction 1-1
1.1.1 Washington County Background 1-1
1.1.2 History 1-1
1.1.3 What is Hazard Mitigation 1-3
1.1.4 Disaster Mitigation Act of 2000 1-3
1.1.5 Parts of the Plan 1-4
1.1.6 The Planning Process 1-4
1.1.7 Public Participation Challenges 1-5
1.1.8 Public Participation Plan Overview 1-5
1.1.9 Review Process 1-9
1.1.10 Availability of Plans and Documents 1-10
1.1.11 Washington County Core Planning Team 1-11
Section 2.0 Planning Area 2-1
2.1 Planning Area 2-1
2.1.1 General Geography 2-1
2.2 General Land Use/Development Patterns 2-3
2.2.1 Forestry and Agriculture 2-3
2.2.2 Residential Development 2-3
2.2.3 Commercial and Industrial Development 2-3
2.2.4 Transportation 2-4
2.2.5 Surface Water 2-4
2.2.6 Floodplains 2-5
2.2.7 Wetlands 2-5
2.2.8 Emergency Services and Facilities 2-5
2.2.9 Parks 2-6
2.2.10 Critical Community Facilities 2-6
Section 3.0 Risk Assessment 3-1
3.1 Hazard Identification and Prioritization 3-1
3.2 Vulnerable Structures/Facilities 3-3
3.3 Vulnerability and Risk Assessment by Hazard 3-4
3.3.1 Severe Winter Storms 3-4
3.3.2 Severe Storms (Hail, Lightning and High Winds) 3-5
3.3.3 Fire 3-7
3.3.4 Flooding 3-9
3.3.5 Hazardous Materials Release 3-12
3.3.6 Earthquake 3-14
3.3.7 Washington County, Tennessee Repetitive Loss Assessment 3-17
Section 4.0 Mitigation Strategies 4-1
4.1 Purpose 4-1
4.2 Mitigation Strategies 4-2
4.3 All Hazards 4-2
4.4 Severe Winter Storms 4-3
4.5 Severe Storms (Hail, Lighting and High Winds) 4-4
4.6 Fire 4-5
4.7 Flooding 4-6

4.8 Hazardous Materials 4-8
4.9 Earthquake 4-9
4.9 Mitigation Matrix 4-10
Section 5.0 Plan Maintenance Process 5-1
5.1 Plan Evaluation and Maintenance 5-1
5.2 Plan Implementation 5-1
5.3 Plan Adoption 5-2
Appendix .....
Appendix A Mitigation Documents ..... A
Appendix B Planning Area Maps/Data ..... B
Appendix C Washington County Events/Data C
Appendix D Plan Adoption ..... D
Appendix E Washington County Flood Plain Studies ..... E
Appendix F Glossary ..... F

SECTION 1.0
PLANNING PROCESS

1.1 Plan Introduction

This plan presents a comprehensive strategy to reduce the impacts of natural hazards in Washington County. The rising costs associated with natural disasters and the apparent increase in the rate of their occurrence has led to the need to identify additional ways to reduce the county's vulnerability to natural hazards before the next disaster actually occurs. Disasters can have a heavy toll on individuals and local governments. In the past, natural hazards in Washington County have caused injury and loss of life, severe property damage, and interruption of the delivery of vital goods and services, disruption of local economies, and harm to the natural environment. Natural hazards are an inevitable fact. Human ingenuity can do nothing to stop a tornado or winter storm from occurring. Planning for natural hazards and implementing mitigation measures can reduce the impact of such events when they do occur. Monetary losses, personal injury, and loss of life can be reduced. The economic and social impact on the community as a whole can also be reduced. The purpose of this plan is to outline a strategy with specific programs and policies that can be implemented by Washington County and its two participating municipalities to reduce the impact of natural hazards on people, structures, and the natural environment. ***Please see Appendix F for glossary of terms.***

1.1.1 Washington County Background

Washington County is the 10th largest county in Tennessee with an estimated 2008 population of 118,639. The city of Johnson City (Incorporated) is the eighth largest city in the state with an estimated 2008 population of 61,990 . The county seat of Washington County is Jonesborough (Incorporated) with an estimated 2008 population of 5,221 .

Washington County is located in northeastern Tennessee and is bordered on the north by Sullivan County, Tennessee; on the east by Carter County, Tennessee; on the west by Greene and Hawkins Counties, Tennessee; and on the south by Unicoi County. The major city in the county is Johnson City, which serves as a manufacturing, retail, education and healthcare center in the region. The county covers approximately 330 square miles or 208,640 acres. Washington County is bordered by Boone Lake and the Holston River to the north, and the Nolichucky River and Cherokee National Forest at the county's southern edge. The county's total water area is 3 square miles.

Major transportation corridors include Interstates 26 and 81; U.S. Routes 11, 19, 23, 93 and 321; Primary State Routes 67 and 381; Secondary State Routes 34, 36, 75, 91, 354, 359 and 400 and the CSX and Norfolk Southern Railway.

1.1.2 History

Washington County
Washington County was established from the Washington District by an act of the North Carolina general assembly on December 18, 1777, and organized February 23, 1778.

Washington County's territory initially included most of present-day Tennessee excepting along the current Virginia State Line, including the Holston Settlements.

Johnson City

Johnson City, Tennessee, without question, was historically a railroad town. Three railroads crossing in the middle of the downtown area propelled Johnson City from a village of 600 people in 1880 to the fifth largest city in Tennessee with a population of over 25,000 in 1930. A test subject for nineteenth century railroad builders, Johnson City's physical layout is completely unique from almost any city in the nation. It was one of the early experiments in rapid industrialization and the full throttle development of railroad- related industries and trade area expansion. Development of the railroad system was the missing element in tapping the natural resources (primarily timber and minerals) of the Appalachian region. Lacking the advantages of rivers for transport, Washington County, Jonesborough, and Johnson City aggressively supported railroad expansion as a way to "level the playing field" and take full advantage of the new "iron horse" that was changing America.

Jonesborough

Founded in 1779, Jonesborough is Tennessee's oldest incorporated jurisdiction and is the County Seat of Washington County. Washington County was created in 1777 by an act of North Carolina as one of six counties on the western frontier. This frontier would later become the State of Tennessee. Frustrated with the lack of commitment from North Carolina to maintain and defend Jonesborough and other settlements, efforts were made to form a new state called the "State of Franklin" between 1784 and 1788. Jonesborough served as the State of Franklin's temporary capital until a decision was reached to remain part of North Carolina. When North Carolina ratified the new US Constitution in 1789, it ceded its western counties to the federal government and Jonesborough was placed under a territorial government. Finally statehood was achieved on June 1, 1796, when Tennessee was admitted as the sixteenth state of the Union following a close vote in Congress.

The town of Jonesborough and surrounding Washington County were home to Andrew Jackson and many founding fathers of the State of Tennessee. Outstanding historic preservation efforts have made this town one of the most authentic historic districts from the period of 1790 to 1870 in the nation. Jonesborough is home to the International Storytelling Center which features numerous special events and festivals annually.

1.1.3 What is Hazard Mitigation?

Mitigation refers to the policies and activities that will reduce the area's vulnerability to damage from future natural disasters in the long term. Generally, these measures are programs that can be put in place before a disaster occurs. There are a multitude of different types of mitigation programs that can be implemented. In general, these programs fall into two categories: structural and non-structural. *Structural mitigation* measures try to minimize the effect of hazards on people, buildings, and infrastructure. This includes actions such as building dams and levees, flood-proofing homes, constructing tornado shelters, and instituting building codes that require wind resistant construction.

> *Non-structural mitigation* measures typically concentrate on identifying hazard-prone areas and restricting their use. Examples include land use zoning, the selection of building sites, tax incentives, insurance programs, relocation of residents to remove them from the path of a hazard, the establishment of warning systems, and planning for at-risk populations.

1.1.4 Disaster Mitigation Act of 2000

This plan is designed to meet the requirements of the Federal Disaster Mitigation Act of 2000 (DMA 2000). The DMA 2000 established new hazard mitigation project funding mechanisms and new state and local planning requirements as conditions of project funding eligibility. The DMA 2000 also provides specific criteria for the preparation and adoption of multi-jurisdictional, "all-hazards" mitigation plans. The Washington County Multi Jurisdiction Hazard Mitigation Plan was prepared to support the requirements of a mitigation plan for all participating local governments in the county. DMA requirements specify that the following elements must be included in the plan:

- Adoption by the local governing body. The plan must include documentation that the local governing body has formally adopted the plan. In a multi-jurisdictional plan, all participating local units of government seeking plan approval must individually adopt the plan.
- All local units of government included in the plan must participate in the planning process.
- The plan must document how the plan was prepared and who was involved in the planning process. Public involvement is essential.
- A risk assessment section should include:
    - Identification of the hazards likely to affect the area, noting data limitations and providing an explanation for eliminating hazards from further consideration.
    - A discussion of past events and description of their severity and resulting effects.
    - A description of the vulnerability in terms of land use and development so that mitigation options can be considered in future land-use decisions.

- The plan must include a hazard mitigation strategy describing:
    - Goals to reduce or avoid long-term vulnerabilities to the identified hazards.
    - A range of specific mitigation actions and projects to be considered, with particular emphasis on new and existing buildings and infrastructure.
    - An action plan identifying how the actions will be prioritized, implemented, and administered by the local jurisdiction.
    - Emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.
    - For multi-jurisdictional plans, there must be identifiable actions items specific to the jurisdiction requesting FEMA approval of the plan.
    - Provisions for reviewing, monitoring, and evaluating progress of the plan's implementation. The plan must also be updated at least every five years and re-approved.

1.1.5 Parts of the Plan

The plan is divided into five sections to address FEMA requirements for a local mitigation plan. The five sections are:

- Section 1 – Planning Process
- Section 2 – Planning Area
- Section 3 – Risk Assessment
- Section 4 – Mitigation Strategy
- Section 5 – Plan Maintenance Procedures

1.1.6 The Planning Process

One of the key elements of any plan is participation. The Mitigation Plan for Washington County is no exception. This planning process not only included consultation with various government agencies, but also the public, specifically the citizens of Washington County, TN. The planning process is a continual cycle starting with public awareness for mitigation issues, plan development, adoption, implementation and back to public awareness for future updates of the plan.

The Mitigation Plan for Washington County has a five year planning horizon, however the planning process is ongoing. While plans are excellent tools they must continually be evaluated for effectiveness and modified as necessary. Throughout the lifecycle of the mitigation plan comments are continually accepted from the public in preparation for future plans. Shown below was the Planning Cycle that was used for the Washington County Mitigation Plan.

- Mitigation awareness and preliminary framework for Mitigation Plan was completed.
- Public input and consultation with jurisdictions and other agencies was conducted
- Rough Draft Developed

- Initial Review by EMA Staff, LEPC and Core Mitigation Planning Team. This also included guidance from TEMA and crosswalk.
- Additional public review and comment including a 30 day public comment period. Comments that were addressed are included in the final plan.
- Final draft submitted to TEMA for approval. TEMA submits plan to FEMA for approval and then it is returned to the local EMA office pending local approval.

1.1.7 Public Participation Challenges

Effective public involvement requires the use of various techniques to engage the public. Some of these tools include the use of the internet, direct involvement with neighborhood or citizen groups, public meetings, direct mailings, and other methods.

The public requires interest, active participation and time. Many people have great demands placed on their time by their jobs, families, and lifestyles with little time remaining or willingness to be involved with community affairs. Others may not show an interest in the planning process, but will become very vocal when disaster strikes.

Involving the public also brings together viewpoints from people with various backgrounds and motivations. This involvement can have positive results by bringing to light alternatives not considered, having the public "buy-in" or having the public take ownership of projects, thus becoming champions. However, there are cases where the opposite can happen. The general public can become divided on a project with no solution pleasing everyone. In extreme cases this division of opinions can delay or even halt projects.

In addition to these challenges, emergency management planning has the added issues of security and safety. The Washington County/Johnson City Emergency Management Agency often deals with sensitive data and information which is by law not available to the general public, however there are also charged with involving the public in the planning process.

1.1.8 Public Participation Plan Overview

In the development of the mitigation plan for Washington County, Tennessee public input and agency consolation was solicited early on in the development of the plan. A variety of techniques including public notices, comment periods, workshops, public hearings, newsletters, surveys, media relations, and committees/work groups were used to develop the framework of the mitigation plan.

Early Involvement – Early involvement with local community leaders helped to determine suitable meeting forums and information formats to foster valuable input, especially when soliciting input from target populations including the traditionally underserved populations. The WC/JC EMA solicited community leaders, including neighborhood associations that represented traditionally underserved populations for their input on emergency management planning activities. ***Please see Appendix A to view public comment information.***

Committees – The EMA has adopted the approach to establish partnerships with existing committees that have an interest in emergency management and security. One example of this is the partnership between the EMA and Regional Metropolitan Transportation Planning Organization which focuses on transportation safety and was directly responsible for establishing the emergency highway reference marker program for I-26 in Washington County, TN. This type of partnership is in addition to the standing Local Emergency Planning Committee which involves government, private industry and citizen leaders.

Websites – Solicitation for public input to the Mitigation Plan for Washington County, Tennessee occurred early in plan development and continues throughout the planning process. An electronic copy of this hazard mitigation plan has been placed on three websites for the public review and comment.

- http://www.johnsoncitytn.org – Emergency Management Section
- http://www.washingtoncountytn.com – Emergency Services Section
- http://www.jonesboroughtn.org – Main Webpage

Public Notices – Public notices and/or advertisements were placed in the regional newspaper notifying the general public of public hearings on the mitigation plan. While the public is engaged early on in the planning process an official notice will appear in the newspaper giving the general public an opportunity to comment on the Washington County Multi Jurisdictional Hazard Mitigation Plan. The comment period will be a minimum of 30 days. The following is a list of locations for public notices regarding the hazard mitigation plan.

- Johnson City Press http://www.johnsoncitypress.com
    - The Johnson City Press serves all jurisdictions in Washington County, TN.
- Johnson City Government Channel
    - Covers Washington County, Johnson City and Jonesborough
- Johnson City Municipal Building at 601 East Main Street, Johnson City, TN 37601
    - City of Johnson City Website http://www.johnsoncitypress.com
- WC/JC EMA Office 333 East Maple Street, Johnson City, TN 37601
- Jonesborough Town Hall 123 Boone Street, Jonesborough, TN 37659
- Washington County Website http://www.washingtoncountytn.com

Participation Activities/Awareness- WC/JC EMA was awarded one of the final "Project Impact" grants from FEMA. One aspect of the grant was to promote public awareness regarding natural and manmade hazards and mitigation efforts to reduce their impacts. Staff and elected officials received mitigation awareness training in Washington D.C. At the awareness training presentations were given on mitigation activities and the loss estimation software tool HAZUS MH. Copes of the software were given to participants to assist with education, planning and mitigation. This project greatly enhanced Washington County's public outreach and involvement process. Through the use of HAZUS MH, "what-if" scenarios are conducted on

select hazards. The results from these scenarios are integrated into presentations designed to stimulate public interest in mitigation and natural hazards.

As emergency management professionals know HAZUS MH only addresses flood, earthquake and hurricane winds along coastal states. With this realization, the WC/JC EMA did not try to present HAZUS MH as a complete solution to risk analysis, but merely one tool to assist in mitigation awareness and what potential losses might be expected from certain disasters.

Since HAZUS MH is based on GIS technology and produces excellent visualizations through maps, reports, and three dimensional maps (based on elevation) showing the impacts of floods, great interest was generated by the public and private organizations. The WC/JC EMA capitalized on this enthusiasm to effectively integrate awareness on other hazards.

Listed below are some of the initial major outreach and mitigation awareness activities that involved the WC/JC EMA.

- Johnson City Municipal Building March 4th, 2010 (Public Comment) Johnson City, TN
- Jonesborough Visitor's Center February 17th, 2010 (Public Comment) – Jonesborough, TN
- Mitigation Plan presentation at ETSU – April 20, 2009
- Mitigation Plan presentation at Johnson City 101 Citizens Government Academy – March, 24 2009
- Mitigation Plan presentation at the Washington County LEPC – April 22, 2009
- Public Safety Meetings – City of Johnson City – Weekly Meetings with management staff.
- Volunteer Fire Association – Washington County – May 6, 2009

These outreach meetings brought mitigation awareness to the public forefront for the region. Elected officials from all affected jurisdictions in the region including TEMA and FEMA attended at least one of these meetings. Over one hundred and twenty people attended the Regional Mitigation Conference that was held in Johnson City, TN and sponsored by WC/JC EMA. The meeting was advertised in the local paper and was open to the general public. Discussions were held on mitigation, natural hazards, and other related topics, which proved to be a stimulus for the public to be involved in the planning process.

Through these beginnings WC/JC EMA has developed an excellent track record of public involvement in the community. Today the WC/JC EMA continues to speak at schools, fire departments, hospitals, nursing homes, civic groups and other organizations. All meetings for Washington County include the Town of Jonesborough, City of Johnson City and Washington County.

Listed below are more recent outreach and public involvement activities conducted by staff to gather additional input in the development of the Mitigation Plan.

Consultation with other Agencies – With information gathered from outreach and public awareness, local jurisdictions in Washington County were contacted for their input. The Washington County Multi Jurisdictional Hazard Mitigation Plan is developed and maintained

with all jurisdictions in the county. These jurisdictions include the Town of Jonesborough, City of Johnson City and Washington County. Unincorporated areas of Washington County are represented by the Washington County, TN government.

In addition to the jurisdictions in Washington County, the WC/JC EMA regularly consults with:

- FEMA
- TEMA
- Town of Jonesborough, City of Johnson City and Washington County

The consultation process includes plan review, public work projects, transportation related projects and other mitigation projects independent of funding source. Once a draft mitigation plan is developed, agencies will be sent a copy of the plan for their review. Various departments and agencies throughout the region were consulted in the development of the mitigation plan. Listed in ***Table 1-1*** are the various agencies that were involved in the consultation process.

TABLE 1-1 ***WC*/JC EMA AGENCY CONSULATION LIST**	
Town of Jonesborough Bob Browning, Town Manager 123 Boone Street Jonesborough, TN 37659	City of Johnson City M.D.Peterson, City Manager 601 East Main Street Johnson City, TN 37601
Johnson City Metropolitan Transportation Planning Organization Glenn K. Berry 137 West Market Street Johnson City, TN 37601	Washington County LEPC Dan O'Brien, Chairman P.O. Box 70653 Johnson City, TN 37614
East Tennessee State University Dan O'Brien P.O. Box 70653 Johnson City, TN 37614	State of Tennessee Department of Health Regional Office: Northeast Shirley Hughes 1233 Southwest Avenue Extension Johnson City, TN 37604-6519
Washington County/Johnson City Health Department Tim Carson 415 State of Franklin Road Johnson City, TN 37604-6093	Washington County George Jaynes, County Mayor P.O. Box 219 Jonesborough, TN 37659
Washington County Highway Department Johnny Deakins, Superintendent 608 Depot Street Johnson City, TN 37659	Washington County Sold Waste Charlie Baines, Solid Waste Director P.O. Box 219 Jonesborough, TN 37659
East Tennessee Emergency Management Agencies	
Carter County EMA *Director Position Currently Open* 801 East Elk Avenue Elizabethton, TN 37643	Greene County EMA Bill Brown, Director 310 South Main Street, Suite 2 Greeneville, TN 37743

Hancock County EMA Jack Mullins, Director P.O. Box 402 Sneedville, TN 37869	Hawkins County EMA Gary Murrell, Director 160 Washington Street Rogersville, TN 37857
Johnson County EMA Jason Blevins, Director 211 North Church Street Mountain City, TN 37683	Sullivan County EMA Jerry Fleenor, Director 3425 Hwy 126 Suite 201 Blountville, TN 37617
Unicoi County EMA Ed Herndon, Director P.O. Box 728 Erwin, TN 37650	Tennessee Emergency Management Agency Bill Worth, Area Coordinator 803 North Concord Street Knoxville, TN 37919

The goal of this consultation process is to keep all agencies informed of existing planned projects, coordinate their implementation when necessary, and to assist the planning process by resolving issues before major investments of time and funds is involved.

The WC/JC EMA sponsors the Local Emergency Planning Committee. The LEPC in Washington County is a volunteer organization comprised of industry specialists, university professors, first responders, business leaders and concerned citizens. The LEPC serves to educate the community and officials on potential hazards, identify available resources, and possible mitigation activities. While the LEPC has no binding power they play an important role in public awareness and recommending mitigation activities to county officials. The Washington County LEPC meets quarterly. All meetings are open to the public.

1.1.9 Review Process

The WC/JC EMA shall review and update the Washington County Multi Jurisdictional Hazard Mitigation Plan yearly. During this review WC/JC EMA will ensure the plan is consistent and current with the need of the community. During the development of the plan, as well as updates, the WC/JC EMA staff will use the techniques described throughout this document to ensure public involvement which includes the traditionally underserved. Some possible activities to encourage involvement may be working directly with community leaders of the tradtionally underserved areas, attending community meetings, and conducting presentations on mitigation related issues.

Once a draft mitigation plan has been completed it will be open to public comment for 30 days. During this period of time comments will be taken from the general public. A public notice will appear in the regional newspaper stating comments on the Washington County Mule-Jurisdictional Hazard Mitigation Plan are being solicited.

The WC/JC EMA staff will then prepare a written response to the comments to be incorporated in the document or suggest amendments to the draft document as a means of summarizing, analyzing and reporting on the disposition of the comments.

While agencies listed in ***Table 1-1*** were involved with the consultation process, in-depth cooperation was received from the following departments in the development of this plan.

- Washington County Mayor's Office
- Washington County Highway Department
- Johnson City Planning Department
- Johnson City Metropolitan Transportation Planning Organization
- Town of Jonesborough Town Administrator's Office.
- Johnson City Public Works
    - Traffic Division
    - Engineering Division
    - Storm Water Division

1.1.10 Availability of Plans and Documents

Copies of the adopted Washington County Multi-Jurisdictional Hazard Mitigation Plan shall be available in the WC/JC EMA office, City of Johnson City Municipal Building, Town of Jonesborough Town Hall and the Washington County Mayor's Office.

Washington County/Johnson City EMA provided an opportunity for the public to comment on the plan prior to plan approval. Documentation for these public comment sessions can be found in Appendix A, pages A-2 – A14.

During the public review and comment period draft documents were available at the following locations along with comment forms for the general public.

Johnson City Locations
Washington County/Johnson City Emergency Management Office
333 East Maple Street
Johnson City, TN 37601

Johnson City Municipal Building
601 East Main Street
Johnson City, TN 37601

Johnson City Public Library
100 West Millard Street
Johnson City, TN 37601

Jonesborough Locations
Jonesborough Town Hall
123 Boone Street
Jonesborough, TN 37659

Washington County/Jonesborough Library
200 Sabin Drive
Jonesborough, TN 37659

Washington County Locations
Washington County Mayor's Office
103 West Main Street
Jonesborough, TN 37659

Washington County Library – Gray Branch
5026 Bobby Hicks Highway
Gray, TN 37615-3461

Websites
Johnson City Government Website – http://www.johnsoncitytn.org – EMA Link
Washington County Government Website – http://www.washingtoncountytn.com – Emergency Services Link
Town of Jonesborough Government Website – http://www.jonesboroughtn.org

1.1.11 Washington County Core Planning Team

TABLE 1-2 Core Regional Planning Team 2010

TEAM MEMBER	TITLE
WASHINGTON COUNTY	
JOHNNY DEAKINS	WASHINGTON COUNTY HIGHWAY SUPERINTENDENT
MIKE RUTHERFORD	WASHINGTON COUNTY ZONING
TOWN OF JONESBOROUGH	
CRAIG FORD	OPERATIONS MANAGER
PHIL FRITTS	FIRE MAJOR
TODD WOOD	TOWN ENGINEER (CONTRACT)
CITY OF JOHNSON CITY	
GLENN BERRY	MTPO
JIM DONNELLY	PLANNER
ANDY BEST	STORM WATER MANAGER
WC/JC EMA	
NES LEVOTCH	EMA DIRECTOR
CHAD BRUCKMAN	OPERATIONS/TRAINING OFFICER

The Washington County Core Regional Planning Team is comprised of planners from the three jurisdictions that the plan will serve. Also included on this planning team is the WC/JC EMA Director and Operations/Training Officer who will provide guidance in the planning process. ***Please see Appendix A page A-20 for Core Team Meeting Dates and attendees.***

The Washington County Core Regional Planning Team met on January 20th, 2010 at 10:00 a.m. at the WC/JC EMA Office. Each member was given a plan and assigned a section in the plan to review. Each member reviewed their assigned sections and forwarded all changes to the WC/JC EMA office. After receiving these changes either additions or deletions the plan draft was updated.

SECTION 2.0
PLANNING AREA

2.1 Planning Area

Section 2.0 of the Washington County Multi-Jurisdiction Hazard Mitigation Plan provides demographic and geographic information for Washington County. This information acts as a base for development of hazard mitigation strategies. ***Please see Appendix B to view data for this section.***

2.1.1 General Geography

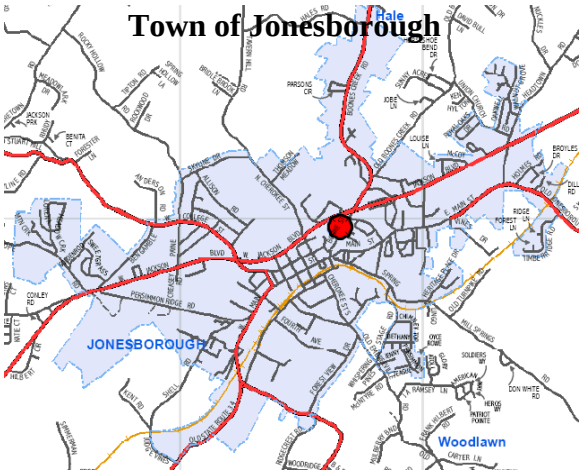
Washington County

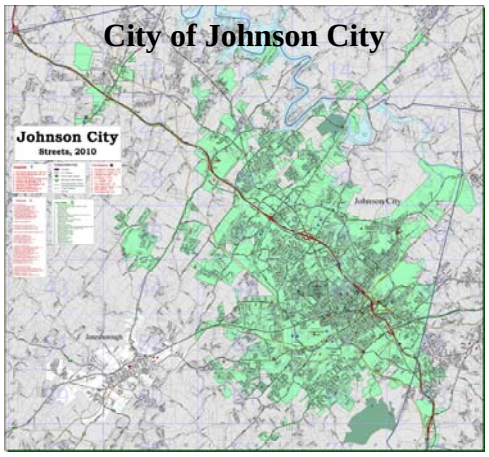
Washington County was established from the Washington District by an act of the North Carolina general assembly on December 18, 1777, and organized February 23, 1778. Washington County's territory initially included most of present-day Tennessee excepting along the current Virginia State Line, including the Holston Settlements.

Washington County's earliest settlers consisted primarily of pioneer families from North Carolina and Virginia, many of whom later created the Watauga Association. The hardy Wataugans helped win the Battle of Kings Mountain, and later were instrumental in the creation of the former State of Franklin.

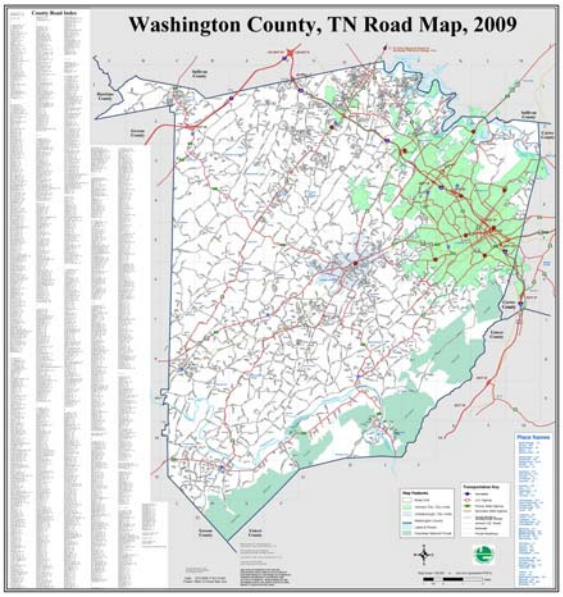
Washington County, TN is located in Upper East Tennessee. The estimated population for Washington County was obtained from the 2008 U.S. Census Estimate showing the estimated population to be 118,639.

The Town of Jonesborough is the county seat for Washington County, TN and has an estimated 2008 population of 5,221.





The City of Johnson City is the largest city within Washington County with the 2008 estimated population of 61,990.



Washington County, Tennessee's total land area is 330 square miles with 327 square miles in land and 3 square miles in water. Washington County's highest elevation is that of Buffalo Mountain. This ridge is 2,700 feet high and is the location of Buffalo Mountain Park located inside the city limits of Johnson City. The rest of Washington County is comprised of picturesque rolling hills to the north and mountain ridges to the south. The City of Johnson City is the largest incorporated city within Washington County and measures 39.3 square miles in land area and .3 square miles in water area.

Table 1 *illustrates population date from the 1980, 1990 and 2000 census*

Table 2 *illustrates recent population trends for Johnson City, Jonesborough, the unincorporated areas, and that of Washington County proper.*

Table 1: Washington County Population 1980 to 2000 by Jurisdiction

Jurisdiction	CENSUS 1980	% of County	CENSUS 1990	% of County	CENSUS 2000	% of County	Growth 1980 - 1990		Growth 1990 - 2000	
							Number	% Change	Number	% Change
Johnson City	39,738	44.8%	49,381	53.5%	55,469	51.7%	9,643	19.5%	6,088	11%
Jonesborough	2,829	3.1%	3,091	3.3%	4,168	3.9%	262	8.5%	1,077	26%
Unincorporated	46,188	52.1%	39,843	43.2%	47,561	44.4%	-6,345	-16%	7,718	16.2 %
County Totals	88,755	100%	92,315	100%	107,198	100%	3,560	3.9%	14,883	14%

Source: U.S. Census 1980, 1990, 2000.

Table 2: Annual Estimates of the Population for Areas in Washington County, TN: July 1, 2003 to July 1, 2008

Area	Resident Population Estimate (July 1)						Resident Population Census Estimates Base April 1, 2000	Census 2000 Population
	2008	2007	2006	2005	2004	2003		
Johnson City	61,990	60,990	60,333	58,718	57,658	57,251	55,485	55,469
Jonesborough	5,221	5,038	4,735	4,550	4,483	4,399	4,168	4,168
Unincorporated Washington Co.	51,428	50,442	49,568	49,239	48,786	48,339	47,545	47,561
County Totals	118,639	116,470	114,636	112,605	111,093	110,143	107,198	107,198

Source: Population Estimates Branch, U.S. Census Bureau

Civil Divisions

There are two municipalities within Washington County. The first is the City of Johnson City, which is the larger of the two municipalities. The second is the Town of Jonesborough which is the county seat. Washington County also contains numerous unincorporated areas which are represented by Washington County.

2.2 General Land Use/Development Patterns

To assess potential hazard risk, it is important to inventory and examine the County's current land uses and patterns of development. This helps identify areas that may be particularly vulnerable.

2.2.1 Forestry and Agriculture

The majority of Washington County, Tennessee is comprised of rural areas and farm land. The land within both incorporated cities is comprised of residential neighborhoods, business districts, school properties and community park properties.

2.2.2 Residential Development

Residential concentrations are scattered throughout the county. However, there are concentrated areas of residential development within the Town of Jonesborough and City of Johnson City. There are also numerous small concentrations of residential development taking place throughout Washington County, TN. ***Table 3*** *illustrates U.S. census projections from 2005 to 2025.*

Table 3: Washington County Census projections 2005 - 2025

	2005	2010	2015	2020	2025
Washington	112,764	120,236	127,230	133,790	140,467
Johnson City	57,329	61,224	64,887	68,340	71,848
Jonesborough	4,488	4,809	5,115	5,405	5,703
Unincorporated	50,868	54,118	57,126	59,938	62,803

Source: U.S. Census Projections 2005-2025

2.2.3 Commercial and Industrial Development

Industrial development is currently taking place in the Washington County Industrial Park which is located off of Hwy 11e in the unincorporated area of Washington County called the Telford Community. There are also industrial areas in both the Town of Jonesborough and the City of Johnson City.

Commercial Development is currently taking place along State of Franklin Road in North Johnson City and North Roan Street, where there is a large amount of newly constructed shopping areas. The Town of Jonesborough has also been experiencing a growth in commercial development along East/West Jackson Blvd which is also classified as Tennessee State Highway 11 E.

2.2.4 Transportation

Roadways

Interstate 81 North/South runs through Washington County on its north end. Interstate 26 intersects Interstate 81 near Kingsport and travels south through Johnson City to the North Carolina State line and the Virginia State line to the north. Interstate 26 serves as Johnson City's primary route to the Port of Charleston, South Carolina. There has been substantial growth along I-26. US Highway 11E runs through Washington County from the Greene County Line to the Sullivan County Line running West/East. Tennessee State Route 81 runs from Interstate 81 to the north to Interstate 26 to the South. State Route 107 runs from the Greene County State line through the Chuckey Community to 81 South.

The State of Franklin Road (State Route 381) forms a loop around the northwest and southern portions of Johnson City. It connects the downtown district with the ETSU/MED TECH COORIDOR complexes northward to intersect with I-26.

Transit

Washington County has a public school system and along with this they also maintain a public transportation system for school children. The City of Johnson City also maintains a transit system for school children along with a public transit system that has numerous stops throughout the city to promote the idea of public transportation throughout the City of Johnson City.

Airports

Washington County does not have a airport within it's jurisdiction but is serviced by the Tri-Cities Regional Airport which is located on 1,040 acres of land in Blountville, Tennessee.

Railroads

In addition to the major railroad transportation service provided by CSX and Norfolk Southern, Johnson City offers local offices for Clinchfield and East Tennessee Railway Corporation. There are two boxcar loading stations in Johnson City. CSX and Norfolk Southern rail transportation can also be found in the Town of Jonesborough and the unincorporated areas of Telford, Limestone, Gray and Boones Creek.

2.2.5 Surface Water

Washington County has a small amount of surface water that is within our jurisdiction. Washington County has 3.5 square miles of surface water which consist of Boone Lake and the Nolichuckey River.

2.2.6 Floodplains

The primary value of floodplains is their role in natural flood control. Floodplains represent areas where excess water can be accommodated or stored in a flood event. If uninterrupted by development, the areas shown on a map as floodplains should be able to handle the most severe flood., i.e. the 100 year storm that has a one percent chance of occurring in any given year. There are numerous floodplain areas that have been identified within Washington County.

2.2.7 Wetlands

Wetlands consist of transitional areas between uplands and open water. Wetlands perform important ecological functions, such as flood water storage and water treatment. In addition, they provide wildlife habitat and recreational opportunities. We have a few wetland areas in Washington County but only a few large areas of wetlands.

The largest area of wetlands is located in the Town of Jonesborough on both sides of Highway 11E at its intersection with New Hope Road and Persimmon Ridge Road. There are about 4.5 acres of wetlands on the north side of Highway 11E at this intersection and on the south side of this same intersection in another 6 acres of wetlands. The south side wetlands are adjacent to the Town of Jonesborough's Wetlands Water Park. On the south side of the water park is another couple of acres of wetlands.

2.2.8 Emergency Services and facilities

Public emergency services are an important resource to hazard mitigation planning because these services will have direct involvement in a hazard event. Washington County has one career fire department, **Johnson City Fire Department**, one combination career/volunteer fire department, **Jonesborough Fire Department** and 6 volunteer fire departments:

- Embreeville V.F.D.
- Gray V.F.D
- Fall Branch V.F.D.
- Limestone V.F.D.
- Nolichuckey V.F.D
- Watauga V.F.D.

Washington County has the following Law Enforcement agencies:

- Washington County Sheriff's Office
- Johnson City Police Department
- Jonesborough Department of Public Safety
- ETSU Public Safety
- Veterans Affairs Police
- Tennessee Highway Patrol Fall Branch Office
- Washington County Constables.

Washington County has the following E.M.S. service:

- Washington County/Johnson City E.M.S.

Hospitals

- Mountain States Health Alliance (Johnson City Medical Center & North Side Hospital)

There are a variety of Emergency Service Agencies within Washington County.

2.2.9 Parks

Parks are susceptible to high winds, heavy precipitation, ice and surface water contamination due to a variety of hazards. The City of Johnson City operates 17 parks.

Johnson City Parks

- Buffalo Mountain Park
- Cardinal Park
- Carnegie Park
- Carver Park & Recreation
- Civitan Park
- Kiwanis Park & Recreation
- Legion Recreation Center
- Lions Park
- Metro Kiwanis Park
- Optimist Park
- Paul Chrisman Park
- Powell Square Park
- Rotary Park
- Skate Park at Freedom Hall
- Veterans Park
- Willow Springs Park
- Winged Deer Park

The Town of Jonesborough operates 4 parks including their Wetlands Water Park complex which also has pavilions, baseball fields, and walking trails.

Town of Jonesborough Parks

- Mills Spring Park
- Wetlands Water Park Complex
- Depot Street Park
- Stage Road park

Washington County does not operate any specific parks and recreation areas. All play grounds and ball fields associated with the county are located on school grounds.

2.2.10 Critical Community Facilities

Critical community facilities are of particular importance in hazard mitigation planning for a number of reasons. These types of facilities can house large numbers of people and are also important to the day-to-day function of a community; therefore they are vulnerable to damages caused by hazards. Those same facilities may also be needed to provide shelter or medical care during a hazardous event. For example, hospitals are needed to treat people who have been injured in a hazardous event. Likewise if a hospital were to be hit by a tornado, patients and staff

would be in danger and millions of dollars worth of medical equipment could be lost or damaged. *Due to the size of Washington County and the number of incorporated and unincorporated jurisdictions, a table listing critical community facilities in the county can be found in* ***Appendix B****.*

SECTION 3.0
RISK ASSESSMENT

3.1 Hazard Identification and Prioritization

Risk assessment is the process of measuring the potential loss of life, personal and economic injury, and property damage resulting from natural or man-made hazards. The results of this risk assessment assisted Washington County and its incorporated municipalities in identifying and understanding their risk from natural and man made hazards. This information also serves as the foundation for the development of the mitigation plan as well as strategies to help minimize risks from hazardous events.

This risk assessment followed the methodology described in the FEMA publication 386-2 "Understanding Your Risk – Identifying Hazards and Establishing Losses" and was based on a four step process which includes:

1. Identify Hazards
2. Profile Hazard Events
3. Inventory Assets
4. Estimate Losses

Using FEMA guidance as well as Section 322 regulations for developing local hazard mitigation plans, a risk assessment that identifies the following was developed

- The hazards to which the county and its communities are susceptible.
- The impact of these hazards on physical, social, and economic assets.
- The areas within the county most vulnerable to these hazards.
- The potential costs of damages or costs avoided through future mitigation projects.

Hazard Identification

The first step in the risk assessment process was to identify each of the hazards that could occur within Washington County, Town of Jonesborough and the City of Johnson City. This hazard process began with researching previous hazard events based on historical data compiled by the National Climate Data Center of the National Oceanic Atmospheric Administration from 1950 to 2009. Additional data collection resulted from research of newspaper reports, personal experiences, public records, Emergency Management Records and the internet. From this information it was determined that the following natural hazards and man made hazards would be assessed. Washington County has been involved with three disaster declarations since 1998. The 1998 Declaration was in response to sever storms and flooding. The 2001 was due to severe flooding and the 2005 assistance was in response to receiving Hurricane Katrina victims. ***Please see Appendix C pages C-8 and C-9 to review Washington County Disaster Declarations.***

TABLE 3-1 EVALUATION RANKING PROCESS

Hazard (Natural)	Jurisdiction	Historical/Probability	Vulnerability	Severity of Impact	Score	Ranking
Flood	Washington County	12	12	12	36	4
	Jonesborough	12	12	12		4
	Johnson City	12	12	12		4
Severe Storm (Hail, Lighting & High Winds)	Washington County	18	12	12	42	2
	Jonesborough	18	12	12		2
	Johnson City	18	12	12		2
Severe Winter Storm (Snow, Ice, Hail)	Washington County	12	18	18	48	1
	Jonesborough	12	18	18		1
	Johnson City	12	18	18		1
Tornado	Washington County	6	12	12	30	7
	Jonesborough	6	12	12		7
	Johnson City	6	12	12		7
Earthquake	Washington County	6	12	12	30	6
	Jonesborough	6	12	12		6
	Johnson City	6	12	12		6
Extreme Temperatures	Washington County	6	12	6	18	10
	Jonesborough	6	6	6		10
	Johnson City	6	6	6		10
Drought (includes urban, agriculture)	Washington County	6	12	12	30	8
	Jonesborough	6	12	12		8
	Johnson City	6	12	12		8
Fire (Wildfire, Urban)	Washington County	12	12	18	42	3
	Jonesborough	12	12	18		3
	Johnson City	12	12	18		3
Geologic (Expansive Soils, Landslide, Land Subsidence)	Washington County	6	6	6	18	11
	Jonesborough	6	6	6		11
	Johnson City	6	6	6		11
Hazard (Man Made)	Jurisdiction	Historical/Probability	Vulnerability	Severity of Impact		
Dam Failure	Washington County	6	12	12	30	9
	Jonesborough	6	6	6		9
	Johnson City	6	12	12		9
Hazardous Materials	Washington County	12	12	12	36	5
	Jonesborough	12	12	12		5
	Johnson City	12	12	12		5

Source: National Climatic Data Center

Ranking System Explanation

1. Historical/Probability – Utilizes past occurrences as a guide to predicting the probability for future occurrences.

   - The average number of reportable/damage producing hazard events in a jurisdiction since 1950.

RISK LEVEL	NOMENCLATURE
LOW=6	0 TO 10 OCCURENCES SINCE 1950
MEDIUM =12	11 TO 50 OCCURENCES SINCE 1950
HIGH=18	MORE THAN 50 OCCURENCES SINCE 1950

2. Vulnerability – Identifies the affected populace based on proximity to the hazard.

- The percentage of people adversely affected by the hazard occurrence.

RISK LEVEL	NOMENCLATURE
LOW=6	LESS THAN 10% OF THE TOTAL POPULATION OF THE JURISDICTION
MEDIUM =12	10% TO 25% OF THE TOTAL POPULATION OF THE JURISDICTION
HIGH=18	MORE THAN 25% OF THE POPULATION OF THE JURISDICTION

3. Severity of Impact – Estimates the severity by considering people, property, environment and infrastructure.

- The worst conceivable impact to human life and property resulting form a hazard.

RISK LEVEL	NOMENCLATURE
LOW=6	MINOR INJURIES (UNDER 50) & PROPERTY DAMAGE (UNDER $1,000,000) OR LESS THAN 24 HOUR SHUTDOWN OF ESSENTIAL FACILITIES.
MEDIUM =12	SERIOUS INJURY (MORE THAN 50) & MAJOR PROPERTY DAMAGE (STRUCTURAL STABILITY), ($1,000,001 TO $15,000,000) OR 24-72 HOUR SHUTDOWN OF ESSENTIAL FACILITIES.
HIGH=18	MULTIPLE DEATHS (MORE THAN 5) & PROPERTY DESTROYED OR DAMAGED BEYOND REPAIR (MORE THAN $15,000,000) OR MORE THAN 3 DAYS OF SHUTDOWN FOR ESSENTIAL FACILITIES.

Evaluation Results
This evaluation process left six hazards to be addressed in the Hazard Mitigation Plan, in order of priority:

1. Severe Winter Storm (Snow, Ice, Hail)
2. Severe Storms (Hail, Lightning and High Winds)
3. Fire
4. Flooding
5. Hazardous Materials (Interstate 81, Interstate 26, Hwy 11 e)
6. Earthquake

Tornados, Extreme Temperature, Drought, Geologic incidents and Dam Failure were not included in this plan because they have a very low risk of occurrence in Washington County, Tennessee.

3.2 Vulnerable Structures/Facilities

Some specific vulnerabilities and estimated losses are documented in the following risk assessment, however there are a number of structures and areas within each jurisdiction that are vulnerable to different types of hazards. *Due to the large number of structures and multiple jurisdictions covered in this plan, a table listing these structures and facilities and their respective jurisdiction is included in* ***Appendix B*** *on page B-5.*

3.3 Vulnerability and Risk Assessment by Hazard

3.3.1 Severe Winter Storm

Hazard Analysis

Winter storms can vary in size and strength and include heavy snowfall, freezing rain, sleet, ice, and/or blowing and drifting snow. Extremely cold temperatures accompanied by strong winds can result in severe wind chills that result in frostbite, hypothermia and even death

A heavy snowstorm is considered to be an event where four or more inches of snow fall in 12 hours or less. An ice storm is defined as an event with ice accumulations of a quarter inch or more in 12 hours or less. A blizzard is the extreme end of a winter storm. A blizzard is defined as an event with sustained or frequent wind gusts of over 35 miles per hour, with falling or blowing snow causing visibilities near or less than a quarter-mile for three or more hours. *Please refer to* ***Appendix C Table 1*** *on page C-1*.

History in Washington County, Tennessee

According to the National Climatic Data Center Washington County in East Tennessee has experienced 30 recorded snow events from 12/20/1993 through 2/11/2006. The total estimated loss to the jurisdictions during these events is estimated by the NCDC at $2 million. Winter storms in Tennessee often include extreme cold and ice. These storms are especially hazardous in terms of closing emergency routes, creating power and utility failures, and immobilizing economic activity. Because of the state's general mild winters, major storms occur about once every five years. When they do occur, they typically affect as much as half of the state's population. The potential exists that a major storm could affect the entire state.

The landmark winters of the nineteenth century were in 1835 and 1898. February 5, 1835, was called "Cold Friday" because so many cattle and hogs froze to death that day. The most arduous blizzard seasons of the twentieth century were those of 1945, 1951, and 1993. In March of 1993 the "Storm of the Century" struck the eastern half of the state, killing 18 people and causing $18 million in damage. In 1994, a major ice storm created massive utility outages and road damage over two thirds of the state. The net result was over $100 million in damages and was the largest disaster in the state's history. Additionally, major snowstorms affected the citizens of Tennessee in 1996 and 1998, required both state and federal response. The total combined cost of these winter storms were approximately $25 million.

Vulnerability Assessment

Winters storms are a serious health risk to county residents and can also cause significant property damage. Heavy snow and Ice accumulation can cause roofs and power lines to collapse. Down power lines can cause widespread power outages leaving businesses, critical

facilities and residences without electricity. Perhaps most importantly, it can also isolate people from assistance or services due to icy conditions and downed trees and power lines blocking roadways.

Power outages resulting in loss of heat is of particular concern. As mentioned, the most serious health risks associated with winter storms and extremely cold temperatures are frostbite, hypothermia, and sometimes death resulting from these conditions. Elderly people and children under the age of one year are most susceptible to the negative health effects of cold temperatures.

Winter storm damage is often widespread and can affect numerous other resources. Other resources that may be affected by a winter storm include:

- Community facilities – access to healthcare/emergency services and schools
- Public service – Police and Fire Departments, Social service organizations/Shelters
- Utilities – power lines, telephone lines, radio and cell towers
- Transportation – icy roads, white out conditions, public transit not available
- Residential – trees, roofs
- Commercial – roofs, temporary closure of business, deliveries
- Agriculture – outbuildings, crops, livestock, equipment

Winter storms usually cover the entire region, and there are no specific areas in Washington County that would have more of a risk than other areas.

Future Probability and Potential Dollar Losses

According to the NCDC there have been 30 winter storm events from December 20th, 1993 through February 11th, 2006. Based on historical data, Washington County can expect on the average of 2 winters storm events each year. During the years referenced our area was affected by "El Nino". After 2006 this condition wasn't as prevalent but according to the National Weather Service the "El Nino" has resurfaced and we are starting to see the same patterns that we did in the early 1990's.

It is difficult to estimate potential future losses for winter storms. Typically, costs are minor and widespread and include minor auto accidents and additional time for workers to remove snow. As a result, these costs are not usually compelled or even tracked. However, winter storms can be potentially disastrous, especially in the event of a major ice storm. The NCDC estimates a total property loss for the data given at around $2 million dollars.

3.3.2 Severe Storms (Hail, Lightning and High Winds)

Hazard Analysis

According to FEMA, a thunderstorm is formed from a combination of moisture, rapidly rising warm air and a force capable of lifting air such as a warm and cold front, a sea breeze or a mountain. All thunderstorms contain lightning. Lighting is an electrical discharge that results

from the building up of positive and negative charges within a thunderstorm. When buildup becomes strong enough, lightning appears as a "bolt". This flash of light usually occurs within the clouds or between the clouds and the ground. A flash of lightning usually occurs within the clouds or between the clouds and the ground. A bolt of lighting reaches a temperature approaching 50,000 degrees Fahrenheit in a split second. The rapid heating and cooling of air near the lightning causes thunder. In the United States, between 75 and 100 Americans are hit and killed each year by lightning.

According to the National Weather Service, a typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Thunderstorms may occur singly, in clusters, or in lines. Thus, it is possible for several thunderstorms to affect one location in the course of a few hours. Some of the most severe weather occurs when a single thunderstorm affects one location for a more extended period of time. Thunderstorms can carry an arsenal of accompanying hazards. In addition to thunder and lighting, thunderstorms include heavy rain, high winds and hail. Hail is produced by many strong thunderstorms and can be smaller than a pea and as large as a softball. Heavy rains in short periods of time or steady rain for longer periods of time can also result in flooding and flash flooding.

Straight line winds can exceed 100 miles per hour and are responsible for most thunderstorm damage. One type of straight line wind, the down burst, can cause heavy damage equivalent to a tornado. Thunderstorms are associated with tornadoes and heavy rains that lead to floods.

Tropical Depressions are organized systems of clouds and thunderstorms with a defined circulation and maximum sustained winds of 38 mph or less. They almost always are connected with hurricane activity that forms over oceans. Tropical storms are associated with heavy rain, high wind, thunderstorms, and high intensity rainfall in short periods. These storms are medium to large in size and are capable of producing dangerous winds, torrential rains, and flooding, all of which may result in significant property damage and loss of life.

History in Washington County, Tennessee

Thunderstorms are common in East Tennessee and we find the most severe storms occur during the summer months and then again during November before finally tapering off before the cold of winter finally moves south. In the summer months of 2009 East Tennessee experienced an unusually seen round of severe weather move through the area over a two week period. Western Tennessee experienced worse weather with tornadoes. During June a funnel cloud move west to east over the northern part of Johnson City, Tennessee. Damages during this two week period for Washington County were estimated at around $250,000 dollars. *Please refer to **Appendix C Table 2, 3 & 4** on pages C-2, C-3, C-4, C-5 and C-6.*

Future Probability and Potential Dollar Losses

According to the NCDC Washington County has experienced a total of 153 reported events between 1950 and 2009. After analyzing the data received from the NCDC we came to the conclusion that the majority of the events were caused by thunderstorms, 119 events, being reported to the NCDC. The total damage estimated by the NCDC was over $4 million dollars.
Based on the $4 million dollar reported estimate Washington County can expect to experience on the average loss of $29,000 per severe storm. Washington County can also expect to experience on the average of three severe storms per year. Historically Washington County has experienced only two severe weather events that caused more than $1 million dollars in damages. The fist event was recorded as occurring on 4/11/1995 with over $1 million dollars in damages caused by High Winds and a second event occurring on 10/5/1995 that caused over $2 million dollars in damages specifically from High Winds.

3.3.3 Fire

Hazard Analysis

Fire refers to the natural phenomenon that occurs whenever a combustible fuel source comes into contact with oxygen at an extremely high temperature. A forest fire is an uncontrolled fire occurring in a forest or in woodlands outside the limits of incorporated villages or cities. A wildfire constitutes uncontrolled burning in brush, marshlands, grasslands or fields. Most fires are started by humans, the most common cause being careless burning of debris. Natural fires caused by lightning only account for one percent of all forest fires and wildfires. Natural fires are healthy and essential to a forest ecosystem. The USDA Fire Service indicates that the state is in an ecosystem zone in which natural fires occur approximately every 125 to 180 years.

Forest Fires and wildfires are most likely to occur in the spring and early summer from March to July and also in the fall from late August through October. The season length and peak months may vary greatly from year to year. Factors influencing season length or fire frequency can include land use, vegetation, and amount of combustible materials present. Weather conditions such as wind, low humidity and drought are also major factors. The Tennessee Division of Forestry requires that burn permits be issued October 15th – May 15th of each year. This is the identified time frame where most wild fires occur.

We also need to address Urban Fire Hazards. Areas of Downtown Johnson City and Downtown Jonesborough are prone to fires that occur in the historic buildings. The Town of Jonesborough has identified its downtown area as a “Historic District” and depends on this historic district as an attractor for tourism. The Town of Jonesborough has gone to great strides in developing their downtown district and depends on the downtown area economically. The threat of fire in the downtown area of the Jonesborough can have a huge economic impact on Jonesborough’s economy. The City of Johnson City has also been committed to a downtown revitalization project and any fires that can occur within the downtown area can be detrimental and have an economic impact.

History in Washington County

The wild fire threat is always present in Washington County because of the large amount of farm land and fields. During the dry summer months and fall fire season these areas are prone to fire because of local residents conducting controlled burns that become out of control.

Buffalo Mountain Park is a 725-acre natural resource area obtained in a land swap with the U.S. Forest Service in 1994. The park is located on the North Slope of Buffalo Mountain and consists of steep topography and densely forested land. The park functions as a nature preserve primarily for hiking, picnicking, and nature programs. In May 2008, during the drought that we experience in this area for about two years, a wildfire erupted on the top of Buffalo Mountain. The fire involved about 100 acres on top of Buffalo Mountain. The fire started in the National Forest and spread quickly to the park area run by the City of Johnson City. The fire lasted for days and was finally extinguish by the U.S. Forestry Service along with mutual aid agencies. The City of Johnson City's public safety communications towers are located on top of Buffalo Mountain and were also in danger of being damaged by the fire.

WATAUGA AVE FIRE
JOHNSN CITY PRESS

JOHN SEVIER CENTER
EMA ARCHIVES

Urban fires are also a threat to both the downtown areas of Johnson City and Jonesborough. A large fire destroyed close to a city block of apartments that were under renovation in Johnson City on April 13th, 2009. This fire was determined to be arson after investigation. Twenty years earlier on Christmas Eve the City of Johnson City experienced an even more deadly fire which occurred at the John Sevier Center. On this night a fire on the first floor caused smoke to billow throughout the building which killed 16 people. The firefighters worked all night to evacuate the building and recover the dead. This building had been converted from a hotel to a retirement home for those people who are on fixed incomes. The fire codes were improved as mitigation action to prevent further tragedies.

The Town of Jonesborough has also had some close calls with numerous minor fires in the historic buildings and has had one major fire in the past ten years in a business called the "Pig and Slipper". This fire was caused by a power surge after the power had been knocked out by storms the night before the fire occurred. When the shop owners realized that the power was not coming back on they left the building but did not shut the power off as they usually did every night. When the power came back on during the night the power surge caused the fire in this structure totally gutting the first floor of this business.

DOWNTOWN JONESBOROUGH
EMA ARCHIVES

Vulnerability Assessment

The data provided for the wildfire assessment was received from the Tennessee Division of Forestry. From 2004 – 2009 Washington County, Tennessee has seen 2,300 acres burned. 40% of the acreage burned was due to arson, 40% of the acreage burned was due to debris burns, and 20% of the acreage burned was due to miscellaneous causes.

- 34 Structures were saved at a cost savings of $3,528,300
- 4 Cell towers were saved at a cost savings of $2,500,0002 Structures loss at an estimated lost of $40,000The most recent urban fire that occurred was on April 13th, 2009 in Johnson City, Tennessee on West Watauga Avenue @ West Market Street. This fire was caused by an arsonist and caused a total loss to the structures involved. The fire wiped out a city block of buildings at an estimated loss of $1million dollars. *Please Refer to* ***Appendix C Table 6 Urban/Wild Fire Losses*** ***on page C-7.***

Future Probability and Potential Dollar Losses

According to the historical data provided by the Tennessee Division of Forestry, forest fires and wildfires are fairly common occurrences in Washington County, Tennessee. Washington County can expect on the average of 30 – 40 wildfires per fire season with most of these being minor. Washington County can expect one to two major wildfire/forest fires each decade. Such occurrences will also be the fires that cause the highest dollar amount in damages.

According to the historical data provided by the Johnson City Fire Department, Jonesborough Fire Department and Washington County Volunteer Fire Departments, Washington County or any of the jurisdictions within Washington County can expect to see one to two serious urban fires that will cause a large amount of life and dollar loss each decade.

3.3.4 Flooding

Hazard Analysis

Flooding is an overflowing of water onto normally dry land and is one of the most significant and costly natural disasters. The three principle types of floods discussed in this risk assessment are: Riverine Floods, Flash Floods, and Dam Break Floods.

- Riverine Floods – Result from precipitation over large areas and occur in river systems whose tributaries may drain large geographic areas.
- Flash Floods – Usually result s from a torrential rain event on a relatively small drainage area and produce localized floods of great volume and short duration.
- Dam Break Floods – Usually are the result of intense rainfall producing flooding larger dam design.

Flooding tends to occur during years of prolonged regional rainfall and is typified by increased humidity and high summer temperatures. Flash flooding is a critical natural hazard caused by excessive rain falling in a short amount of time, often a result of thunderstorms or the remnants of a tropical storm. Several factors contribute to flash flooding:

- Rainfall intensity and duration
- Topography
- Soil Conditions
- Ground Cover

Most flash flooding is caused by slow moving thunderstorms, thunderstorms repeatedly moving over the same area, or by multiple storm cells colliding. Flash Flooding can occur within a few minutes of excessive rainfall or from a quick release from dam or levee failure. Thunderstorms produce flash flooding, often far from the actual storm, and water may rise at night when natural warnings may not be noticed.

History in Washington County, Tennessee

Flooding occurs when abnormally high stream flow overtops the natural or artificial banks of water course. As mentioned previously, there are three principle types of floods which may affect Tennessee:

- Riverine Floods
- Flash Floods
- Dam Break Floods

General flooding occurs annually in Tennessee and is the most common and costly disaster in the state. From 1963 through 1998, flooding has resulted in 19 presidentially declared disasters across the state, with expenditures in excess of $60 million. Flooding presents significant problems for some 20% to 30% of the state's population annually. Slow rise and flash floods have been the most common recurrent disasters.

In Tennessee, the worst slow rise floods occurred in 1926-1927, 1936-1937, and 1973. The great Tennessee and Cumberland River floods of 1927 gave way to even greater floods in 1937. Moderate to heavy rainfall, ice, and snow in December 1936 continued through January 1937. Soils became saturated, and the Mississippi, Cumberland, and Tennessee Rivers and their tributaries overflowed into some of the most industrialized and populated sections of Tennessee. It was a record flood year for these river systems. Socially and economically, this was the worst single disaster in American history to that date, rivaling the combined effects of the floods of 1926-1927 and the "Dust Bowl" of 1930-1931. The National Weather Service reported that 21.24 inches of rain fell in January alone. January 24th was dubbed "Black Sunday" as rivers overflowed in Tennessee and eleven other states, inundating 12,700 square miles and affecting 75,000 homes. Almost 900 people were seriously injured and 250 died of flood related causes.

The National Weather Service conducted an analysis of flooding in East Tennessee based on the flood that occurred in Nashville, Tennessee in May of 2010. According to the National Weather Service study they estimated that the severity of flooding that may occur in the county is measured by inches of rainfall and by feet for flooding. Based on previous occurrences, in a worst case scenario it is possible for the extent of a flooding event to exceed 13-15 inches of rainfall and cause over 3 feet of localized flooding throughout Washington County in the span of twenty four hours. *Please refer to Appendix C pages* ***C-11, C12 & C13*** *for National Weather Service Data.*

Vulnerability Assessment

The National Climatic Data Center (NCDC) lists 20 major flooding events in Washington County since December 1993. These flooding events created over $23 million dollars worth of damage; however, there have also been many smaller events that have not been listed by NCDC. Of the 20 major flood events in Washington County, seven events were localized in Johnson City, responsible for approximately $75,000 in damage. Only one event was confined to Jonesborough with approximately $5,000 in damages reported. *Please refer to* ***Appendix C Table 5*** *on page C-7.*

The City of Johnson City's Downtown area experiences flooding yearly. Currently the City of Johnson City is working with AMEC Earth & Environmental, Inc. to come up with a plan to help with flooding issues in down town Johnson City. According to initial report from AMEC the flooding in downtown Johnson City is caused by overflow from Brush Creek and King Creek. Flow from these creeks enters the downtown area when the Brush Creek and King Creek culverts are overtopped. *(DOWNTOWN DRAINAGE STUDY Prepared by AMEC 10/20/2008). Please refer to* ***Appendix E AMEC's Drainage Study.***

The downtown area of Jonesborough also experiences flooding due to the construction of buildings over Little Limestone Creek. Also, there are numerous buildings including the Jonesborough Visitor's Center, Post Office, and Jonesborough Town Hall were constructed in a flood area but they are elevated above the drainage way. The Town of Jonesborough recently proceeded with a plan and construction by the Army Corps of Engineers to reduce flooding problem in this area of Jonesborough by conducting a study and working on abatement of this area. *Please refer to* ***Appendix E to review the Town of Jonesborough's Drainage Study.***

Washington County does have flood plains, but fortunately only a limited number of structures are within them. Only a small portion of Washington County is in the flood plains and the Washington County Flood Ordinance prohibits and/or restricts placing structures within the flood plains. However, there are structures within the flood plains which were built prior to the stricter adherence to and enforcement of the flood plain regulations by the Washington County Office of Planning and Zoning. There can be a threat to health and safety with large flood events. Damage to property and crops will continue to worsen. Improperly managed watersheds can

cause erosion and the introduction of pollutants to water reservoirs. The estimated potential loss for structures in Washington that are near floodplains is 3-5% of the overall appraised value of structures in Washington County. The major sources of flooding in Washington County are the Nolichuckey River which is located in the Embreeville and Chuckey communities of Washington County. We also have flash flooding in the small tributaries throughout the county. As part of the National Flood Insurance Program (NFIP), floodplains and floodways on the Nolichuckey and its tributaries have been established and are regulated by the local floodplain management ordinance.

Future Probability and Potential Dollar Losses

At the very least, minor flash flooding is almost certain on a yearly basis. Heavier flooding events can be expected within each decade. As development increases, so does the instance of flooding. After analyzing the event data that the NCDC has published Washington County can experience at least two serious flooding events each year. These events will be magnified in the Downtown area of Johnson City until flood abatement procedures are taken. The Town of Jonesborough is still at risk for downtown flooding but has seen a big change since their flood abatement project that was completed in the spring of 2007. Other areas of the county will also continue to experience flooding issues because of structures that were allowed to be constructed in flood plain areas. One specific area that is located in a flood plain is that of Caramal Village which is a single/double wide trailer park located off of Huffine Road in Washington County. Serious flooding occurs in this trailer park yearly and due to past floods, homes and land, have been purchased to prevent further building construction and inhabitation on this land.

3.3.5 Hazardous Materials Release

Hazard Analysis

Washington County, Tennessee has two major interstates that run through the county. The first interstate is I-81 which runs north to South through Washington County and I-26 that runs east to West through Washington County. There is also a state route, Hwy 11 E that runs from Greene County through Jonesborough, TN, Johnson City, TN to the Sullivan County Line. There is a large amount of commercial truck traffic that flows through Washington County each day. Hazardous Materials releases my range form a small spill to a tanker car explosion or airline crash. The initial release can be brief causing a temporary disrupting or can last for weeks requiring prolonged evacuation. Hazardous materials can be found anywhere in Washington County but specifically at the below targeted industrial sites:

- Aerojet Ordinance – Jonesborough, TN
- Washington County Industrial Park – Telford, TN
- Johnson City Industrial Parks – Johnson City, TN

Aerojet Ordinance is Department of Defense contractor that uses heavy metals to make ordinance for the military. The main threat at this facility is through its use of depleted uranium.

Aerojet has an excellent safety program and keeps the community aware of what is going on around them. If there was a problem at this facility it would impact a small portion of the community in Washington County.

The Washington County Industrial Park is located just west of Jonesborough on Hwy 11 E in Telford. There are various industries that occupy this industrial park with various chemical hazards present. An incident at this industrial park would impact a four lane state highway and numerous subdivisions near the industrial park.
The City of Johnson City has pockets of industry within the incorporated limits of Johnson City. These industrial partners would pose a small risk to the community because of their location within the community.

History in Washington County

Over the past 15 years Washington County has seen a huge amount of growth in residential, commercial and industrial areas. Along with this growth have come traffic flow problems. We feel that we are more at risk for hazardous materials releases by having two major interstates going through our county. We also have been made aware of a newly designated WIPP route, Waste Isolation Pilot Plant that allows truck traffic carrying transuranic waste to come through Washington County. We also have shipments of secure nuclear grade weapons that come through our county as scheduled by the Office of Secure Transportation. We have had our share of hazardous materials spills and plan on having these issues in the future.
Another factor that puts our county more at risk for hazardous materials releases via highway transportation is the fact that when the leg of Interstate 40 is shutdown going towards Asheville, North Carolina , all traffic is rerouted along Interstate 81 to Interstate 26 which runs through Johnson City to North Carolina. At the time of this plan we are currently experiencing an increase of 15, 000 to 20,000 vehicles a day on Interstate 26 due to a rockslide that has shut down Interstate 40 going towards Asheville, NC. We have seen an increase in commercial truck traffic and traffic accidents on Interstate 26.

Vulnerability Assessment

Statistics show that Washington County can experience between 5-7 serious Hazardous Materials Incidents per year. Extremely Hazardous Substance areas could endanger as many as 1000 lives at a given time. However, the worst risk is from a spill from a traffic accident involving EHS. Traffic tie-ups, need for specialized Hazardous Materials Response Teams, evacuation, sheltering, medical care and treatment/cleanup of the contaminated areas are all looked at when we analyze the risk of hazardous materials spills within Washington County. The people most at risk would be those people that live in or near interstate 81 or 26. The people at risk next would be those people who live near the various industrial parks in Washington County.

Future Probability and Potential Dollar Losses

The likelihood of future events of hazardous materials spills is very high with the continued increase in traffic. The Washington County Local Emergency Planning Committee has taken hands on approach when it comes to industrial TIER II reports and we are currently using the EPLAN web based system to track chemicals used by fixed site industry. The Johnson City Fire Department developed a hazardous materials response team that is in the process of being accredited by the Tennessee Emergency Management Agency. With both these processes in place we believe that potential dollar loss would be moderate for any type of traffic related incident especially one involving a traffic death. The potential for future releases from fixed site industrial facilities is low because of the various state and federal regulations. However the community would be at more danger from a fixed site facility release because of their proximity to the community.

3.3.6 Earthquake

Hazard Analysis

An earthquake is the sudden motion or trembling in the earth caused by an abrupt release of slowly accumulating strain. This sudden release results in ground shaking, surface faulting, and/or ground failures. Earthquakes occur along faults, which are fractures or fracture zones in the earth across which there is relative motion. If the rocks across a fault are forced to slide past one another, they accumulate strain energy for centuries or millennia, and then release it almost instantaneously. The energy released radiates outward from the source as a series of waves, an earthquake. Ground shaking may affect areas many miles from the epicenter, the point on the ground surface above the focus. As the stress builds, an impending earthquake may produce signal phenomena, which occur in a characteristic way prior to an earthquake.

Although earthquake prediction is difficult, there can be warning signs that indicate both the place and the time of an impending event. Precursors include an increase in micro-seismicity, which has been credited with causing unusual animal behavior. Well water quality may change, as well as spring discharge. The ground surface may also be deformed. The velocities of seismic waves through stress rocks may decrease immediately prior to an event.

Earthquakes most commonly occur in the same place as prior earthquakes. Active faults are commonly indicated by micro seismicity, earthquakes so small they can only be detected by instruments, and by presence of scarps, which are steep linear slopes up to 65 feet high, showing offset of ground surface.

The Mercalli scale is the method most commonly used in the United States for measuring

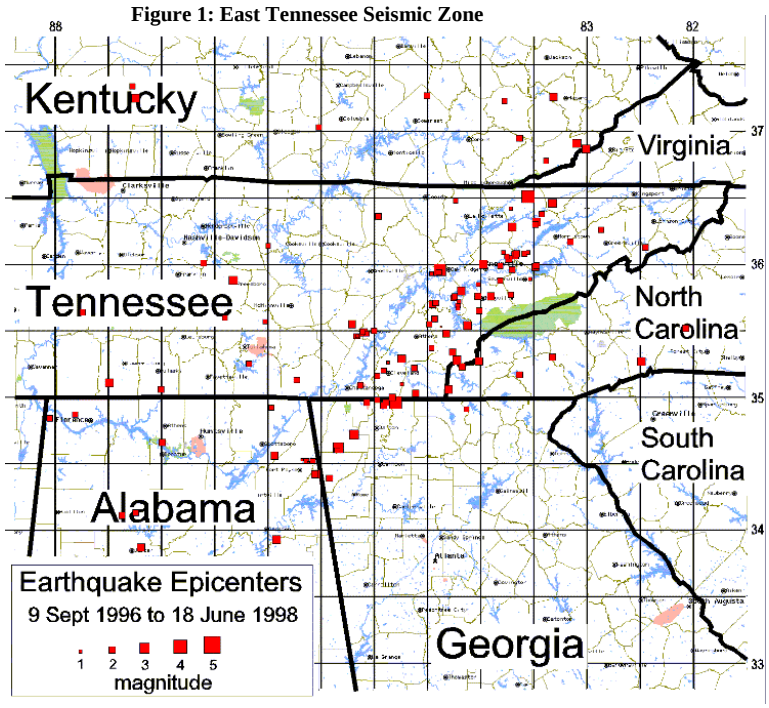
earthquake intensity. This twelve tier scale ranks observed effects from I, felt only under especially favorable circumstances, to XII, total destruction (See Table 3.3.5-1). The magnitude of an earthquake is measured through the use of the Richter scale. Earthquake magnitudes describe the subject on an absolute scale. An earthquake or magnitude 8, for example, is ten times stronger than a magnitude 7 earthquake, and 100 times stronger than a magnitude 6 earthquake. There is no highest or lowest value. *Please refer to* ***Appendix C Table 7*** ***on page C-8.***

TABLE 3.3.5-1 MOIFIED MERCALLI SCALE OF EARTHQUAKE INTENSITY

SCALE	MERCALLI SCALE(INTENSITY	DESCRIPTION OF EFFECTS	MAXIMUM ACCELERATION(MM/SEC)	CORRESPONDING RICHTER SCALE (MAGNITUDE)
I	INSTRUMENTAL	DETECTED ONLY ON SESMOGRPHS	<10	
II	FEEBLE	SOME PEOPLE FEEL IT	<25	<4.2
III	SLIGHT	FELT BY PEOPLE RESTING	<50	
IV	MODERATE	FELT BY PEOPLE WALKING	<100	
V	SLIGHTLY STRONG	SLEEPERS AWAKE;CHURCH BELLS RING	<250	<4.8
VI	STRONG	TREES SWAY;SUSPENDED OBJECTS SWING, OBJECTS FALL OFF SHELVES	<500	<5.4
VII	VERY STRONG	WALLS CRACK;PLASTER FALLS	<1000	<6.1
VIII	DESTRUCTIVE	MOVING CARS UNCONTROLLABLE; POORLY CONSTRUCTED BUILDINGS DAMAGED	<2500	
IX	RUINOS	SOME HOUSE COLLPASE; GROUND CRACKS; PIPES BREAK OPEN	<5000	<6.9
X	DISASTROUS	GROUNDS CRACKS PROFUSELY; MANY BUILDINGS DESTROYED; LIQUEFACTION AND LANDSLIDES WIDESPREAD	<7500	<7.3
XI	VERY DISASTROUS	MOST BUILDINGS COLLAPSE; PIPES, ROADS, BRIDGES, RAILWAYS DESTROYED; TRIGGERS OTHER HAZARDS	<9800	<8.1
XII	CATASTROPHIC	TOTAL DESTRUCTION; TREES FALL;GROUND RISES AND FALLS IN WAVES	>9800	>8.1

History in Washington County

Figure 1: East Tennessee Seismic Zone



East Tennessee is seldom thought of as "earthquake country." However, the National Earthquake Information Center recently categorized portions of Tennessee as "High Risk" in recognition of the state's vulnerability to earthquakes that occur both within and outside its borders. Each year more than 400 seismic events occur largely unfelt by the populace. ***Figure 1 depicts historic earthquake occurrences in East Tennessee.***

In 1993, the Eastern Tennessee Seismic Zone (ETSZ) was

identified as running roughly parallel to Interstate 75 form Chattanooga northward to Oak Ridge, then eastward toward the Knoxville area. Part of a crescent of moderate seismic activity risk extends from Charleston, South Carolina, northwestward into Eastern Tennessee, then curving northeastward into central Virginia; the zone in Eastern Tennessee is 300 km long by 50 km wide.

Vulnerability Assessment

The ETSZ has not produced a damaging earthquake in historical time; the largest on recorded magnitude was 4.6 in 1973. The Sothern Appalachian Regional Seismic Network (SARSN) has monitored the ETSZ since 1981 and stations in the network have recorded numerous measurements. While researchers have noted a ten fold increase in registered seismic activity in the area in the period of 1980 to 1990, the activity tends to be on the low side of the Modified Mercalli Scale and generally does not raise much public interest. According to the Tennessee Hazard Mitigation Plan the area is considered at slight risk of being affected by an earthquake in the next 100 years. ***Please see Figure 2.***

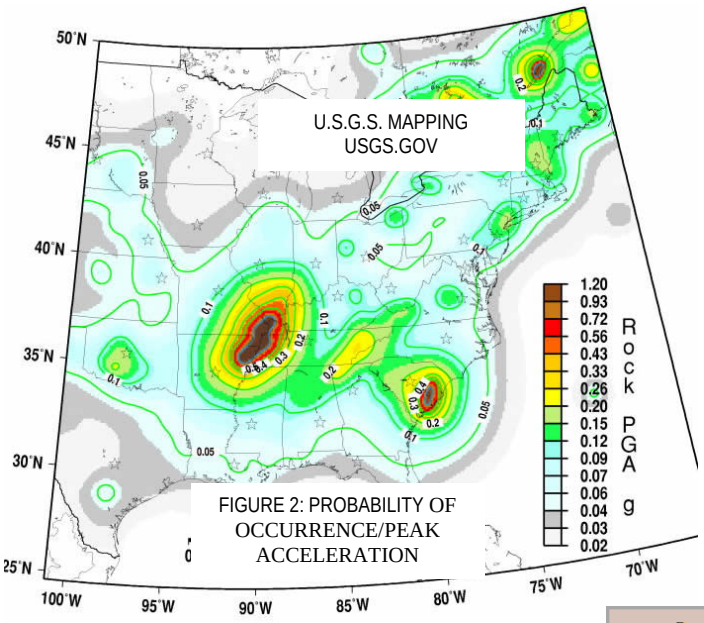


FIGURE 2: PROBABILITY OF OCCURRENCE/PEAK ACCELERATION

Washington County is located in an active but deep seismic zone, and seismologists postulate that a Richter scale 5.0 magnitude quake is possible within a ten year period. Washington County's risk of being affected by a large New Madrid earthquake is more of a possibility. There have been no earthquakes in this area with MMI intensity greater than IV since 1928.

The U.S. Survey shaking hazard map for the United States is based on current information about the rate at which earthquakes occur in different areas and on how far shaking extends from earthquake sources. Colors on this map show the level of horizontal shaking that have a 1 in 50 chance of being exceeded in a 50 year period. Shaking is expressed as a percentage of g (g is the acceleration of a falling object due to gravity. ***Figure 3*** shows Washington County to be in the 32-48 percent g range, which is considered to be a high earthquake hazard. The major form of damage from most earthquakes is damage to construction. Bridges are

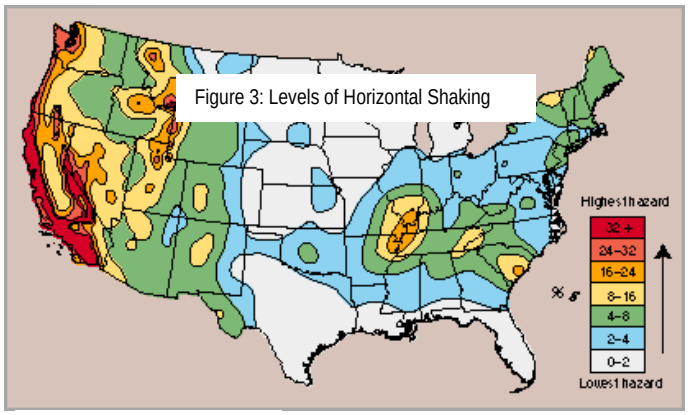


Figure 3: Levels of Horizontal Shaking

U.S.G.S. MAPPING
USGS.GOV

particularly vulnerable to collapse and dam failure may generate major downstream flooding. Buildings vary in susceptibility, dependent upon construction and the types of soils on which they are built. Fires caused by ruptured gas mains may also destroy structures. The damage caused by both ground breaking and ground shaking can lead to the paralysis of the local infrastructure: police, fire, medical, and government services. As with many catastrophes, the worst hazard to the survivors is their own shock and inability to respond to the necessity for prompt, effective action. Earthquakes are considered the most potentially damaging disaster in Tennessee because of their universal secondary effects resulting from distortion of surface materials such as water, soil or structures. ***Please see Figure 4.***

Future Probability and Potential Dollar Losses

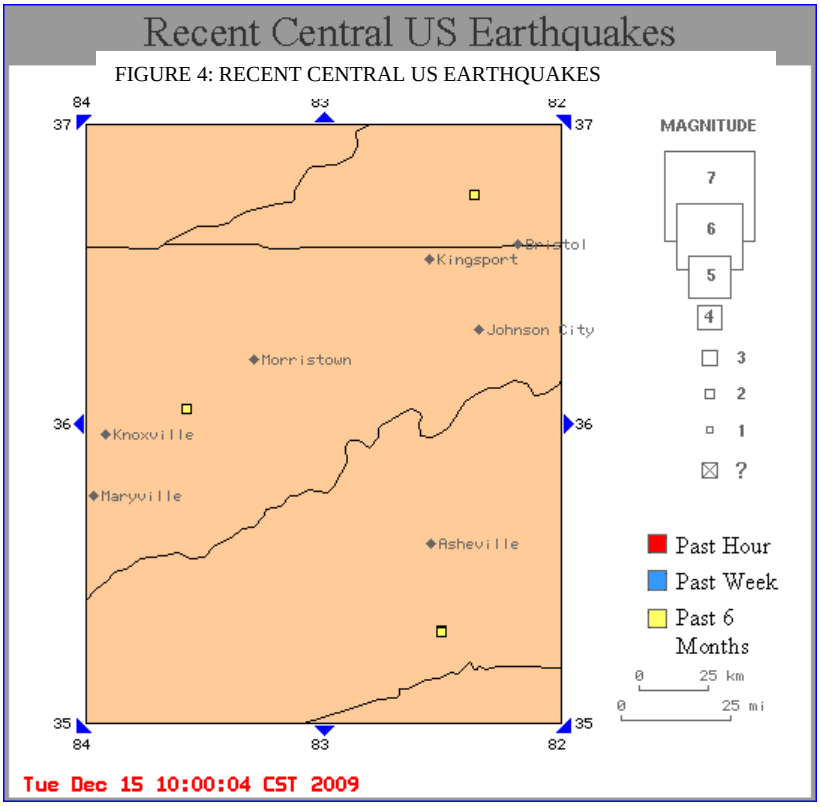


FIGURE 4: RECENT CENTRAL US EARTHQUAKES

In the past six months there have been seven earthquakes in the immediate areas surrounding Washington County. The most recent earthquake occurred on 10/3/2009 and was centered SSW of Laurel Park, NC which is about 83 miles from Washington County, Tennessee. The event measured a magnitude 2.5 on the Richter scale. Although this was a minor earthquake and little if any damage was reported, this only serves to remind us of the need to be prepared.

3.3.7 Washington County, Tennessee Repetitive Loss Assessment

The following information was received from the Tennessee Emergency Management Agency when looking at mitigation actions for repetitive losses in the flood prone areas of the county. We found that the numbers were skewed because of the lack of insurance reporting by local businesses and residences during and after flooding.

Please refer to Appendix C for repetitive loss data documentation from TEMA *on page C-10*

SECTION 4.0
MITIGATION STRATEGIES

4.1 Purpose

The Federal emphasis for hazard mitigation is on reducing payouts from disaster declarations. Disaster payments are projected to increase to a point where they can no longer be sustained so it only makes sense to develop programs to bring those costs back under control. A key feature of FEMA's strategy for achieving this goal is to provide technical and financial assistance to local units of government for planning and projects to reduce overall risks to the local community. FEMA encourages local governments to use a variety of techniques to influence the location, type, intensity, design, quality, and timing of development. Many of these tools can be used to mitigate natural hazards and enhance the community's resilience and ability to recover from hazards. FEMA recommends that the following tools be used in a local mitigation strategy:

Hazard Mitigation Tools

Building standards specify how buildings are constructed. In addition to traditional building codes, building standards can include flood-proofing requirements, seismic design standards, and wind-bracing and anchoring requirements for new construction and similar requirements for retrofitting existing buildings.

Development regulations, which may include separate zoning and subdivision ordinances, regulate the location, type, and intensity of new development. Development regulations can include flood-zone regulations; setbacks from faults, steep slopes, and coastal erosion areas; and overlay zoning districts that apply additional development standards for sensitive lands, such as wetlands, dunes, and hillsides.

Capital improvement programs can be an effective way to implement mitigation throughout a community. Local public policies supporting hazard mitigation should be incorporated into these programs. Locating schools, fire stations, and other public buildings, streets, storm sewers, and other utilities outside of high hazard areas is an obvious policy. When placing public facilities in hazardous locations is necessary, communities can incorporate hazard reduction measures into the design or require retrofits where economically feasible. Public facility placement is a key determinant of the location of new privately financed growth in a community. As such, facilities, particularly roads and utilities, should not be sited where they have the potential to encourage growth in high hazard zones.

Land and property acquisition means purchasing in hazard-prone areas with public funds, and restricting development to uses that are less vulnerable to disaster-related damages. This can be accomplished through acquisition of undeveloped lands, acquisition of development rights, transfer of development rights to lower-risk areas, relocation of buildings, and acquisition of damaged buildings.

Taxation and fiscal policies can be used to distribute the public costs of private development of high hazard areas more equitably, specifically shifting more of the cost burden directly onto owners of such properties. Employing impact taxes to cover the public costs of development in areas of high hazards or providing tax breaks for reducing land use intensities in hazardous areas are two options.

Public awareness through information dissemination on natural hazards, and providing educational materials to the construction industry, homeowners, tenants, and businesses are also important. Included in this category are hazard disclosure requirements for the real estate industry and public information campaigns to increase awareness in all sectors of the community.

4.2 Mitigation Strategies

The mitigation strategies are presented in the same order of prioritization given to the hazards in Section 3.0, based on the results of community surveys. A cost benefit review or each mitigation project will be conducted at the time of implementation. This list covers many hazards, but it does not preclude the event of other natural or manmade hazards that could occur in Washington County; and this list does not include every possible mitigation project or action for the hazards identified. Mitigation strategies were developed through the Washington County Core Team Meetings, LEPC meetings and Public Comment sessions by using the hazard assessment tool and by review past historical incidents of the hazards.

4.3 All Hazards

Goal(s)

Protect public health, safety and welfare by increasing the awareness of governmental agencies and the public to existing hazards and by fostering both individual and public responsibility in mitigating risks due to those hazards in Washington County and all incorporated areas within.

Objective(s)

Increase public awareness of natural hazards that affect Washington County.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Actions

- Continue to publish articles in the local newspapers to increase public awareness of the risks associated with natural hazards that are prevalent to Washington County and all incorporated areas within.(County Wide)
- Continue to participate in awareness campaigns such as Severe Weather Awareness Week and Earthquake Awareness Week. (County Wide)
- Encourage Businesses and private property owners to adopt appropriate mitigation actions to existing and new construction. (County Wide)
- Educate property owners on affordable, individual mitigation and preparedness measures that can be performed on existing as well as new construction. (County Wide)
- Provide information on tools, partnership opportunities, and funding sources to assist in implanting mitigation activities. (County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Emergency Management Agency Budget
- Responsibility to Implement: Local Emergency Planning Committee, Local Jurisdictions

4.4 Severe Winter Storms

Goal(s)

- Protect health and safety of county residents and visitors during and after winter storm events.
- Maintain minimum disruption to power systems and transportation systems.
- Limit property damage resulting from high winds and heavy snow.

Objective(s)

- Increase public awareness and promote preparedness activities for future events.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Actions

- Work with utility companies to implement underground power lines when and where feasible. The Johnson City Power Board can identify areas within the county that is most troublesome for them during periods of inclement weather and how that weather affects their aboveground infrastructure. (County Wide)
- Routine trimming of branches/vegetation near power lines and structures. (County Wide)
- Review/revisions of local building codes – improve structural ability to withstand high winds/ snow load. (County Wide)
- Work with the National Weather Service and the Community to see that the community receives winter weather advisories. (County Wide)
- Work with the community and promote the purchase and installation of S.A.M.E. compliant weather radios within the homes of the citizens of Washington County. (County Wide)
- Work with the local governments to see that they have adequate warning technology in place to warn them of impending severe weather. (County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Local Jurisdictions
- Responsibility to Implement: Local Jurisdictions

Please see Table 4-1 on page 4-10 & 4-11 for a recommended mitigation strategies matrix.

4.5 Severe Storms (Hail, Lightning and High Winds)

Goal(s)

- Minimize threat to people and limit property damage resulting from high winds, lighting, and heavy rains.
- Protect county residents and visitors during and after severe storm events.

Objective(s)

- Increase public awareness and promote preparedness activities for future events.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Actions

- Work with utility companies to implement underground power lines when and where feasible. The Johnson City Power Board can identify areas within the county that is most troublesome for them during periods of inclement weather and how that weather affects their aboveground infrastructure. (County Wide)
- Routine trimming of branches/vegetation near power lines and structures. (County Wide)
- Review/revisions of local building codes – improve structural ability to withstand high winds. (County Wide)
- Work with the National Weather Service and the Community to see that the community receives winter weather advisories. (County Wide)
- Work with the community and promote the purchase and installation of S.A.M.E. compliant weather radios within the homes of the citizens of Washington County. (County Wide)
- Work with the local governments to see that they have adequate warning technology in place to warn them of impending severe weather. (County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Local Jurisdictions
- Responsibility to Implement: Local Jurisdiction

Please see Table 4-1 on page 4-10 & 4-11 for a recommended mitigation strategies matrix.

4.6 Fire

Goal(s)

- Protect the health and safety of county residents and visitors during fire events.
- Maintain minimum disruption to power systems and transportation systems.
- Reduce the number of human caused fires.

Objective(s)

- Encourage all fire departments to become actively involved in community fire prevention. Address fire code violations in buildings
- Address opening burn policy in the urban wildland interfaces.
- See that all fire departments train in wildland fire fighting.
- Encourage all fire departments to maintain an open line of communication with the Tennessee Division of Forestry.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Actions

- Pursue additional fire training.(County Wide)
- Continue school education programs.(County Wide)
- Community awareness in fire prevention procedures related to urban wildland fire interfaces.(County Wide)
- Institute/Review fire codes, laws and ordinances. (County Wide)
- Institute/Review open burning policies. (County Wide)
- Pursue additional wildland fire fighting training. (County Wide)
- Washington County Volunteer Fire Departments work in cooperation with government agencies overseeing wildland fire protection strategies. (County Wide)
- Incident Command training for all public safety entities within Washington County. (County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Local Jurisdictions
- Responsibility to Implement: Local Jurisdictions

Please see Table 4-1 on page 4-10 & 4-11 for a recommended mitigation strategies matrix.

4.7 Flooding

Goal(s)

- Reduce loss of life and property from future flooding in Washington County and all incorporated areas.
- Reduce the repeated flooding of the transportation infrastructure.
- Improve the county's technical capability by using their existing geographic information system in conjunction with HAZUS-MH system to generate natural hazards information for the county and the municipalities and re-establish the HAZUS User Group.

Objective(s)

- Protect, raise, relocated and/or acquire structures in the flood hazard areas within Washington County.
- Encourage and continue participation in the National Flood Insurance Program.
- To address the concerns of our transportation infrastructure there will need to be an assessment of the major/most travelled routes in the county.
- Train Washington County, City of Johnson City and Town of Jonesborough technical staff to use the GIS in conjunction with the HAZUS-MH system.
- Train personnel from the municipalities with information needed to include them in the HAZUS-MH system.
- Record all structures within existing floodplains, as well as areas of repetitive losses due to flooding.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Actions

- Continue to participate in the National Flood Insurance Program and not issue any new building permits within the 100 year floodplain unless they meet the requirements of the flood plain regulations. (County Wide)
- Adopt a storm water utility fee to provide a funding source to help fund future storm water projects (City of Johnson City, Town of Jonesborough)
- Conduct watershed studies to determine which watersheds and/or sub-watershed areas may need additional storm water detention requirements or where regional flood control facilities would be effective. Amend the development regulations as necessary. (County Wide)
- Conduct watershed studies for each municipality's watersheds and update mappings of the existing storm water systems. (County Wide)
- Through the proposed storm water fee, municipalities shall employ a Storm Water Manager and maintenance crew to perform routine inspections of the storm water systems and make necessary repairs to ensure the system is clear of debris and flowing

Properly. (City of Johnson City, Town of Jonesborough)Repair or replace floodwater and rain gauges used as part of the city's early warning system. (County Wide)

- Prohibit development within flood hazard areas. (County Wide)
- Adopt and promote Low Impact Development regulations. (County Wide) The following techniques help to reduce downstream flooding due to development and improve water quality at the same time:
    - Minimize impervious surfaces.
    - Minimize street widths.
    - Provide roadway swales in lieu of curb and gutter and closed storm drain systems.
    - Bio-retention or rain gardens.
    - Disconnection of impervious area allowing grass or other vegetation to absorb and filter the storm water.
    - Preserve natural vegetation especially large expanses of forest, wetlands, and meadows.
- Buy property upstream of Downtown Jonesborough, such as but not limited to the Causey property on Old Boones Creek Road, to construct a regional detention pond to reduce the potential for flooding in the downtown area of Jonesborough. (Town of Jonesborough)
- Now that the new Washington County Justice Center is in operation, remove the jail annex from the back of the courthouse in Downtown Jonesborough and open up the creek (Un-encapsulate) to provide for additional flood storage. (Town of Jonesborough)
- Buy property upstream of the flooding areas in Downtown Johnson City to construct a regional detention pond and/or remove buildings over the existing creeks to restore a natural floodplain to reduce the potential for flooding of buildings and streets in the downtown area of Johnson City. (City of Johnson City)
- Ensure Washing County and all municipalities understand they must remain in good standing with the National Flood Insurance Program to be eligible for any mitigation funding and for residents to be able to obtain flood insurance. (County Wide)
- Ensure that citizens are aware that flood insurance is available to all residents of Washington County through their local insurance agency. (County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Local Jurisdictions
- Responsibility to Implement: Local Jurisdictions

Please see Table 4-1 on page 4-10 & 4-11 for a recommended mitigation strategies matrix.

4.8 Hazardous Materials

Goal(s)

- Reduce the chances that the public or responders will be hurt by hazardous material releases. Ensure that Washington County and all other jurisdictions within are in compliance with the latest changes to Sara Title III
- Ensure that there is an active LEPC within Washington County.
- Address the procedures and who is required to submit Tier I and II reports.**Objective(s)**
- We would like to better prepare our responders for hazardous materials incidents through training and exercises. Make the public aware of the process in which they can protect themselves from hazardous materials releases as well as the "Right to Know" act where they can view the various chemicals that are being used in their community.
- Review/Implement protocols to meet SARA title III.
- Review/Implement Washington County LEPC practices yearly.
- Review/Implement a system that would allow the local EMA office to receive Tier II reports from industry within Washington County.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Action(s)

- Develop/Acquire a database where all emergency responders can see Tier II reports. (County Wide)
- Develop a countywide hazardous materials response team. (County Wide)Provide training to the local volunteer fire departments in defensive hazardous materials response. (County Wide)
- Provide advanced Hazardous Materials Response training for the local volunteer fire departments. (County Wide)
- Develop a system in which we can work more closely with local industry. (County Wide)
- Address the transportation of radioactive materials on Interstate 26 and 81. Provide training specific to radioactive materials.(County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Local Jurisdictions
- Responsibility to Implement: Local Jurisdiction

Please see Table 4-1 on page 4-10 & 4-11 for a recommended mitigation strategies matrix.

4.9 Earthquake

Goal(s)

- To reduce loss of life and property from future earthquake events in Washington County.
- Maintain minimum disruption to power systems and transportation systems.
- Minimize losses to existing structures within Washington County.

Objective(s)

- Improve the county's capacity to identify areas needing future mitigation.
- Improve/Implement/Review building codes.
- Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices.

Participating Jurisdictions

- Washington County
- City of Johnson City
- Town of Jonesborough

Mitigation Actions

- Develop a database that identifies properties which have received damage from hazards identified within the mitigation plan.(County Wide)
- Require that new structures or structures undergoing significant renovations meet code requirements.(County Wide)
- Require ground anchors to be installed at each mobile home space in mobile home parks to ensure mobile homes are tied down.(County Wide)
- Provide information to government officials, school managers and teachers on securing bookcases, filing cabinets, light fixtures and other objects that can cause injuries and block exits.(County Wide)
- Encourage facility managers, business owners, and teachers to refer to FEMA's practical guidebook: Reducing the risks of Nonstructural Earthquake Damage.(County Wide)
- Encourage homeowners and renters to use "Is your home protected from an Earthquake Disaster?: A homeowners guide to Earthquake Retrofit" for economic and efficient mitigation techniques.(County Wide)
- Continue to require the Emergency Management Agency personnel to regularly attend FEMA's Earthquake Non-structural Mitigation Management training.(WC/JC EMA)
- Provide earthquake insurance information to Washington County residents.(County Wide)

Mitigation Timeline, Funding and Responsibility

- Time Frame: On-going
- Funding : Local Jurisdictions
- Responsibility to Implement: Local Jurisdictions

Please see Table 4-1 on page 4-10 & 4-11 for a recommended mitigation strategies matrix.

HAZARD	MITIGATION MEASURE	PROJECT COST	RESPONSIBLE PARTY
All	Public awareness campaign	TBD	WC/JC EMA
All	Severe Weather awareness	TBD	WC/JC EMA
All	New construction mitigation	TBD	Washington County Zoning
All	Preparedness measures for citizens	TBD	WC/JC EMA
Winter Storms	Underground power line mitigation	TBD	Johnson City Power Board
Winter Storms	Vegetation management	TBD	Johnson City Power Board
Winter Storms	Building code reviews	TBD	COJC/TOJ/WASHCO * Code Enforcement
Winter Storms	Quick weather advisories	TBD	WC/JC EMA
Winter Storms	Weather radio campaign	$25 per radio	WC/JC EMA
Winter Storms	Adequate warning	TBD	WC/JC EMA
Winter Storms	Aggressive shelter program	TBD	WC/JC EMA/RED CROSS
Winter Storms	Food distribution centers	TBD	WC/JC EMA
Severe Storms	Underground power line mitigation	TBD	Johnson City Power Board
Severe Storms	Vegetation Management	TBD	Johnson City Power Board
Severe Storms	Review local building codes	TBD	COJC/TOJ/WASHCO * Code Enforcement
Severe Storms	Preparedness measures for citizen	TBD	WC/JC EMA
Severe Storms	Weather radio campaign	$25 per radio	WC/JC EMA
Severe Storms	Adequate warning	TBD	WC/JC EMA
Flooding	Participate in the NFIP	TBD	WC/JC EMA
Flooding	Adopt storm water fee	TBD	COJC/TOJ/WASHCO * Water/Sewer
Flooding	25 to 100 year storm water detention	TBD	COJC/TOJ/WASHCO * Planning Departments
Flooding	Conduct watershed study	TBD	COJC/TOJ/WASHCO * Planning Departments
Flooding	Institute storm water management program	TBD	COJC/TOJ/WASHCO* Planning Departments
Flooding	Repair/Replace floodwater rain gauges	TBD	Washington County Public Works
Flooding	Prohibit development in flood zones	TBD	COJC/TOJ/WASHCO * Planning Departments
Flooding	Rain garden requirements for construction zones	TBD	COJC/TOJ/WASHCO * Public Works
Flooding	Swales in subdivisions which would slow and street runoff	TBD	COJC/TOJ/WASHCO * Code Enforcement
Fire	Additional fire training for fire fighters	TBD	COJC/TOJ/WASHCO * Fire Departments
Fire	School fire awareness programs	TBD	COJC/TOJ/WASHCO * Fire Departments
Fire	Fire Prevention/Wildland Urban Interface	TBD	COJC/TOJ/WASHCO * Fire Departments
Fire	Review fire codes	TBD	COJC/TOJ/WASHCO * Fire Code Enforcement
Fire	Review open burning policies	TBD	COJC/TOJ/WASHCO * Fire Code Enforcement
Fire	Additional wildland fire fighter training	TBD	COJC/TOJ/WASHCO * Fire Departments
Fire	Wildland fire protection strategies	TBD	COJC/TOJ/WASHCO * Fire Departments
Fire	Incident Command Training	TBD	WC/JC EMA

HAZARD	MITIGATION MEASURE	PROJECT COST	RESPONSIBLE PARTY
Earthquake	Earthquake insurance for homeowners	TBD	COJC/TOJ/WASHCO *
Earthquake	Encourage preparedness using FEMA's guidance for homeowners	TBD	WC/JC EMA
Earthquake	Review building codes	TBD	COJC/TOJ/WASHCO *
Earthquake	Ground anchors for mobile homes	TBD	COJC/TOJ/WASHCO *
Earthquake	Provide guidance for securing items in government buildings	TBD	COJC/TOJ/WASHCO *
Hazardous Materials	Develop/Implement Tier II database for responders	TBD	WC/JC EMA
Hazardous Materials	Develop countywide hazardous materials response team	TBD	WC/JC EMA
Hazardous Materials	Provide Hazardous Materials training to volunteer fire departments	TBD	WC/JC EMA
Hazardous Materials	Provide advanced hazardous materials response training	TBD	WC/JC EMA
Hazardous Materials	Address transportation of Radioactive Materials on I-81 and I-26	TBD	WC/JC EMA

Table 4-1. Summary of Recommended Mitigation Strategies

TOJ – Town of Jonesborough
COJC – City of Johnson City
WASHCO – Washington County

SECTION 5.0
PLAN MAINTENANCE PROCEDURES

5.1 Plan evaluation and Maintenance

Planning is a constant and continuing process. This document will grow and adapt in order to stay current with growth and change in Washington County. The Disaster Mitigation Act of 2000 requires that the local plan be evaluated and updated at least every five years to remain eligible for assistance. WC/JC EMA staff will collect incoming information to prepare for future plan revisions. It is recommended that the WC/JC EMA staff along with the Washington County Multi Jurisdiction Hazard Mitigation Plan Core Committee discuss the plan evaluation and revision annually from the month the plan is adopted. Each incorporated jurisdiction that has adopted the plan will also evaluate it and discuss updates at this time, prompted by a reminder from the WC/JC EMA staff. The Plan will be updated every five years to comply with DMA2K requirements.

5.1.1 Plan Evaluation and Maintenance Described

The plan will be reviewed yearly by the Washington County Multi Jurisdictional Hazardous Mitigation Core Team from the plans approved date as determined by FEMA. During these reviews risk assessments will be conducted to uncover any new trends in Natural Disaster Occurrence. This information will be noted and used to update the plan at the appropriate time.

A survey or public open house will also be conducted at least every five years to solicit comments from the general public. The public will be asked for thoughts on the progress of various projects, or the pertinence of plan information. New community assets or emerging vulnerabilities will be identified and added. WC/JC EMA staff will keep all stakeholders and the public updated on the status of project progress. It is important to let people know of the things the plan has accomplished and the actions are actually being implemented.

5.2 Plan Implementation

Once the plan has been approved, stakeholders will be informed and provided information on how to access the plan. The public will have easy access to the plan via the WC/JC EMA website and availability at local libraries and centers of local government.

During implementation of the actions laid forth in the plan, WC/JC EMA staff will act as the overseer. EMA staff will report progress or concerns to the Washington County Multi Jurisdiction Hazard Mitigation Plan Core Committee. As developers of the plan the WC/JC EMA staff will monitor its progress.

Along with monitoring the progress of the action projects, WC/JC EMA staff will work with local jurisdictions to secure funding to implement the mitigation projects within the plan. State and federal agencies, non-profit organizations, and foundations are continually making grants available. WC/JC EMA will research grant opportunities to determine eligibility for the county and all local units of government

The role of department administrators, elected officials, local administrators and planning boards are to ensure that adopted actions from Section 4.0 are considered into their budgets. It is understood that projects may not be carried out as they are scheduled due to budget constraints. However, since many of these action projects are considered an investment in safeguarding the health, safety and property of the public, they should be carefully considered as priority projects. The use of fees, bonds and loans can also be considered if there is proper state enabling legislation, local authority and political drive.

5.3 Incorporation into Existing Planning Mechanism

The Washington County Multi Jurisdiction Hazardous Mitigation Plan will be published and placed in the local libraries and government buildings for use by other government agencies in their respective plans. Numerous health care facilities use the data that is contained our plan to construct their own Hazardous Mitigation Plan for their facilities. Some other areas where our plan can be used:

- Washington County Basic Emergency Operations Plan
- East Tennessee State University Hazardous Mitigation Planning
- Washington County Floodplain Planning
- City of Johnson City Floodplain Planning
- Town of Jonesborough Floodplain Planning
- Washington County Zoning Planning and Review
- Town of Jonesborough Zoning, Planning and Review
- City of Johnson City Zoning, Planning and Review

5.4 Plan Adoption

The adoption of the Washington County Multi Jurisdiction Hazard Mitigation Plan lends itself to serve as a guiding document for all local government officials. It also certifies to program and grant managers from FEMA and TEMA that the recommendations in the plan have been properly considered and approved by the governing authorities and local citizens. It also helps to ensure the continuity of mitigation programs and policies over time because elected officials, staff, and other community decision makers can refer to the document when making decisions that may affect the future of the community.

Once the plan has been completed, it is submitted to the State Hazard Mitigation Officer (SHMO) at TEMA. The SHMO will determine if the plan meets requirements of DMA2K and other applicable requirements. Upon approval of the draft by TEMA, the SHMO is responsible for sending the plan to the FEMA region office for review.

Upon approval of FEMA the plan will be then submitted to the Washington County Commission, City of Johnson City Commission and the Town of Jonesborough Board of Mayor and Alderman to be formally adopted. This adoption must be done by resolution. Incorporated communities that do not adopt the plan cannot apply for mitigation grant funds unless they opt to prepare, adopt and submit their own plan. ***Resolutions of adoption are included in Appendix D*.**

Adoption of the Plan gives the jurisdiction legal authority to enact ordinances, policies or programs to reduce hazard loss and implement other mitigation actions. Jurisdictions that adopt a hazard mitigation plan qualify for mitigation funding after a disaster declaration. According to FEMA, unincorporated areas do not have to adopt the plan and are included under the umbrella of the county's adoption.

APPENDIX A

PUBLIC MEETINGS DOCUMENTATION

Mitigation Plan Meeting	Meeting Date: 20 April 09	
Facilitator: Washington County / Johnson City EMA	Place/Room: ETSU	
Name	**Address**	**Phone (work)**
Tara E. Burgan	2922 Chestnut Lane Apt. 4 Johnson City, TN 37601	(276) 613-2163
Hopelyn Clift	1403 College Heights Rd, #3 Johnson City, TN 37604	(423) 384-5186
Russell Sharp	2141 Longreen Rd. Kingsport TN 37660	(423) 863-7328
Crystal Patrick	615 Telford New Victory Rd Telford, Tn 37690	(423) 773-2882

Mitigation Plan Meeting	Meeting Date: 20 April 09	
Facilitator: Washington County / Johnson City EMA	Place/Room: ETSU	
Name	**Address**	**Phone (work)**
Andy Murdoch	ajmurdoch@comcast.net	865 387 8863 ~~434-9967~~
Thomas Johnson	Johnsoth@etsu.edu	434-9967
Jessica Kilgore	jessiek1296@gmail.com	423-863-7965
Matthew McGahey	zmdm40@goldmail.etsu.edu	423-737-7436
John Bulla	116 Amherst Circle Johnson City, TN 37601 zjdb67@goldmail.etsu.edu	423-213-0506

Mitigation Plan Meeting	**Meeting Date:** April 20, 2009	
Facilitator: **Washington County / Johnson City EMA**	**Place/Room:** ETSU	
Name	**Address**	**Phone (work)**
Nathan Baker	PO Box 164433 Johnson City, TN 37614	(918)697-5121
Virginia Herron	P.O. Box 13242 Johnson City, TN 37614	(423) 920-8264
Brian Carroll	1707 Buccaneer Drive Johnson City, TN. 37604	(423)314-7019
Christina Smith	2212 midway St. Johnson city, TN 37601	(423)963-3166
Cody Rhodes	568 Rangewood Rd. Piney Flats, TN 37686	(423) 282-6275
Lance Lowery	824 Rolling Hills Dr. Apt 30 Johnson city, TN 37604	(423) 557-6088
Brett Goeringer	611 Pardee St. Johnson City, TN 37601	(865)919-4192
Michael Bennett	109 Chippendale Sq. Kingsport TN 37660	(423) 392-4655
DEANNA GREEN	583 ROCKY BRANCH RD Blountville, TN 37617	(423) 212-0159
ADAM Bullock	902 Ashley Rd. Apt. 01 Johnson City, TN 37604	(865) 806-9803
Autumn Aldridge	304 Lamont St. Johnson City TN 37604	(336) 471-5699
Jessica Miller	1401 Colony PK. Dr. Apt. 4 Johnson City, TN 37604	(423)220-9601

Mitigation Plan Meeting	Meeting Date: 20 April 09	
Facilitator: Washington County / Johnson City EMA	Place/Room: ETSU	
Name	**Address**	**Phone (work)**
Karen Price	40 Campbell Rash Rd. Elizabethton, TN 37643	735-5536
Glenn Walker	11513 Primrose Ln Rockville, VA 23146	(804) 310-4375
Annie Ross	310 Allen Ave. Eliz. TN 37643	(423) 316-0022
Laken Bailey	326 Hwy 75 Blountville, TN 37617	(423) 990-8986
Jerad Cook	77 Charleston Square Johnson City T.N. 37601	(865) 696-6482
Joshua Jackson	412 Fritz Street Damascus, VA 24236	(276) 698-8034
Brandon Poff	1000 University Blvd. Apt C-31 Kpt, TN 37660	(423) 956-2121

Mitigation Plan Meeting	Meeting Date: 20 April 09	
Facilitator: **Washington County / Johnson City EMA**	**Place/Room:** ETSU	
Name	**Address**	**Phone (work)**
Amanda Allen	P.O. Box 4092 Bristol TN 37625	423-335-0708
Kendall Flegel	255 E. Main Street Apt 2 Johnson City, 37604	(423) 677-9982

Mitigation Plan Meeting	Meeting Date: 20 April 09	
Facilitator: Washington County / Johnson City EMA	Place/Room: ETSU M.C. #229	
Name	**Address**	**Phone (work)**
Diana Velasco	8 vine st apt 1 JC	423 833-318
Sami Barbir	2914 S. Greenwood Dr. Apt. 14	423-773-6982
Elizabeth May	183 Old State Rt 34 Apt 28 Jonesborough	423-483-488
Brooke Marshall	628 Old Union Rd Church Hill, TN 37642	423-378-4753
Damaris Wood	2006 Michael Drive Johnson City TN 37604	423-431-8360

Mitigation Plan Meeting	Meeting Date: April 22nd, 2009	
Facilitator: Washington County / Johnson City EMA	Place/Room: Johnson City Municipal Bldg	
Name	**Address**	**Phone (work)**
Paul Greene	505 E. Main St	975-2852
Mark Finucane	505 E. Main St., JC 37601	975-2844
Adam Guinn	2203 McKinney Rd. Suite 219 JC 37604	928-3561
Jerry Tunnell	501 S Wilcox Dr Kingsport TN 37660	378 8700
Chris Williams	505 E. Main St. JC 37601	483-5821
David Harrison	101 Lincoln St. Unicoi TN 37692	791-4755
Jennifer Stout	258 Cedar Ln Gray TN 37615	788-7178
Angie Minor	NETRHO 1233 Southwest Ave. EXT. Johnson City, TN 37604	423-979-4659
Adam Thomas	N/A	
Wendell Messimer	175 E Highland Rd J.C.	928-4407
Richard Duggen	IPMC 2000 Brookside Kingsport, TN 37660	423 857 7744
Phil Scheuermann	Box 70682 ETSU Johnson City TN 37614	423-439-7078
Marian Bond	PO Box 1403 Johnson City TN 37605	926-0140

Mitigation Plan Meeting	Meeting Date: April 22nd, 2009	
Facilitator: Washington County / Johnson City EMA	Place/Room: Johnson City Municipal Bldg	
Name	**Address**	**Phone (work)**
JOHN LOWRY	PO BOX 2150 c/o JCPD JOHNSON CITY TN 37605	434-6159
Mike Conway	4509 W. Stone Dr Kingsport, TN 37660	765-3257
Pam Woodruff	146 Cutting Edge Court Telford, TN. 37690	913-3608 913-1008
DAVID M. ALEXANDER	212 CHIMNEY TOP LA JONESBOROUGH, TN	(423) 737-0361
Steves Bishop	Eastman Chemical Company P.O. Box 511 South Eastman Road Bldg 177 Kingsport, TN 37662	423-229-4720

WC/JC E.M.A. CLASS ROSTER

Project: WC/JC Hazard Mitigation Plan **Meeting Date:** WC Fire Chiefs Assoc
Facilitator: Chad R. Bruckman **Place/Room:** Washington County

Name	Title	Company	Phone	Fax	E-Mail
Charles A. Baines	Chief	Nolichucky FD	423 257-2803		nufd600@yahoo.com
Bruce Brocklebank	Chief	Sulphur Springs VFD	423 416 5882		chief411550fd@emb
Stephen Archer	Chief	Limestone VFD	423 257-2571		lVfdfireChief@yahoo.com
David A. Hawkins	Chief	Gray VFD	423 477-0443		gvfd.hawkins@comcast.ne
Grant Colbaugh	FF	Watauga	423 928-4160		
Keith LaFleur	asst Chief	Watauga	423 928-4160		
Ian Wirth	FF	Gray	423 483-2605		Gray FF534@yahoo.com
Trever Rees	FF	Gray	423 963-0403		Fbfireman@comcast.n
Randall W Lewis	Asst. Dir	Wash Co 911	423 928-9111		rlewis@wc911.org
Jim Gabs	Capt	Jonesborough Fire Dept	423 753-1019		J
Danny Baines	LT	Jonesborough FD	863-3717		Firefighterdanny1@gm
Earl Greene	Chief	Embreeville VFD	423 753-5551		eufd700@embarqmail.c
Frank Mosley	Asst. Chief	Embreeville VFD	423 202-0469		fmosley716@embarqmail.com
Roger Phillips	Chief	Fall Branch VFD	348-6520		Pfbvfd@comcast.net

WC/JC E.M.A. MEETING ROSTER

Project: WC/JC Hazard Mitigation Plan
Facilitator: Chad R. Brockman
Meeting Date: 12/7/2009
Place/Room: MSHA

Name	Title	Company	Phone	Fax	E-Mail
Hank Phillips	Corp Dir Safety & Emergency Mgmt	MSHA	431-3643	431 5489	PhillipsHan@MSHA.com
MARK MOODY	SR. DIRECTOR Engr - Safety Security - EMA	MSHA	431.7775		MoodyMS@MSHA.com
CHAD PROFFITT	INVESTIGATOR / TRAINING OFFICER	JONESBOROUGH POLICE DEPT	753-1053	753-1072	Chadp@jonesboroughtn.org
Mike Wechsler	AEC ARES	ARES	423-247 9734		n4oFar@charter.net
Ed Ingraham	AEC ARES	ARES	423-943 -3113		ED@WX4S.NET
ROBERT JOHNSON	TRAINING OFFICER	JCFD	676-6599		RJOHNSON @ JOHNSONCITYTN.ORG
Andy Caldwell	Training Officer	JCFD	791-4400		acaldwell@ johnsoncitytn.org
MARK FINUCANE	Interim Fire Chief	Johnson City FD	975-2840 975-2844	975-2846	MFinucane@johnsoncitytn.org
Mitch Hathaway	Base Leader Wings Air Rescue	MSHA	423-773-8801		HathawayMS@MSHA.com
Randall W. Lewis	Asst. Dir.	WC911	928-9111		rlewis@wc911.org
Bob McNeill	Director	WC911	928-9111	979 2324	bmcneill@wc911.org
Tim Carson	Director	Washington County Health Dept	975-7927	975-2210	Tim.Carson@tn.gov
Michelle Ramsey	Reg Hosp Coordinator	NE Reg Health	979-4663	979-3268	michelle.x.ramsey@gov
Lewis Tester	Safety Officer / Emerg. Mgt Coord.	MSHA	431-3665	431-3558	testerlh@msha.com

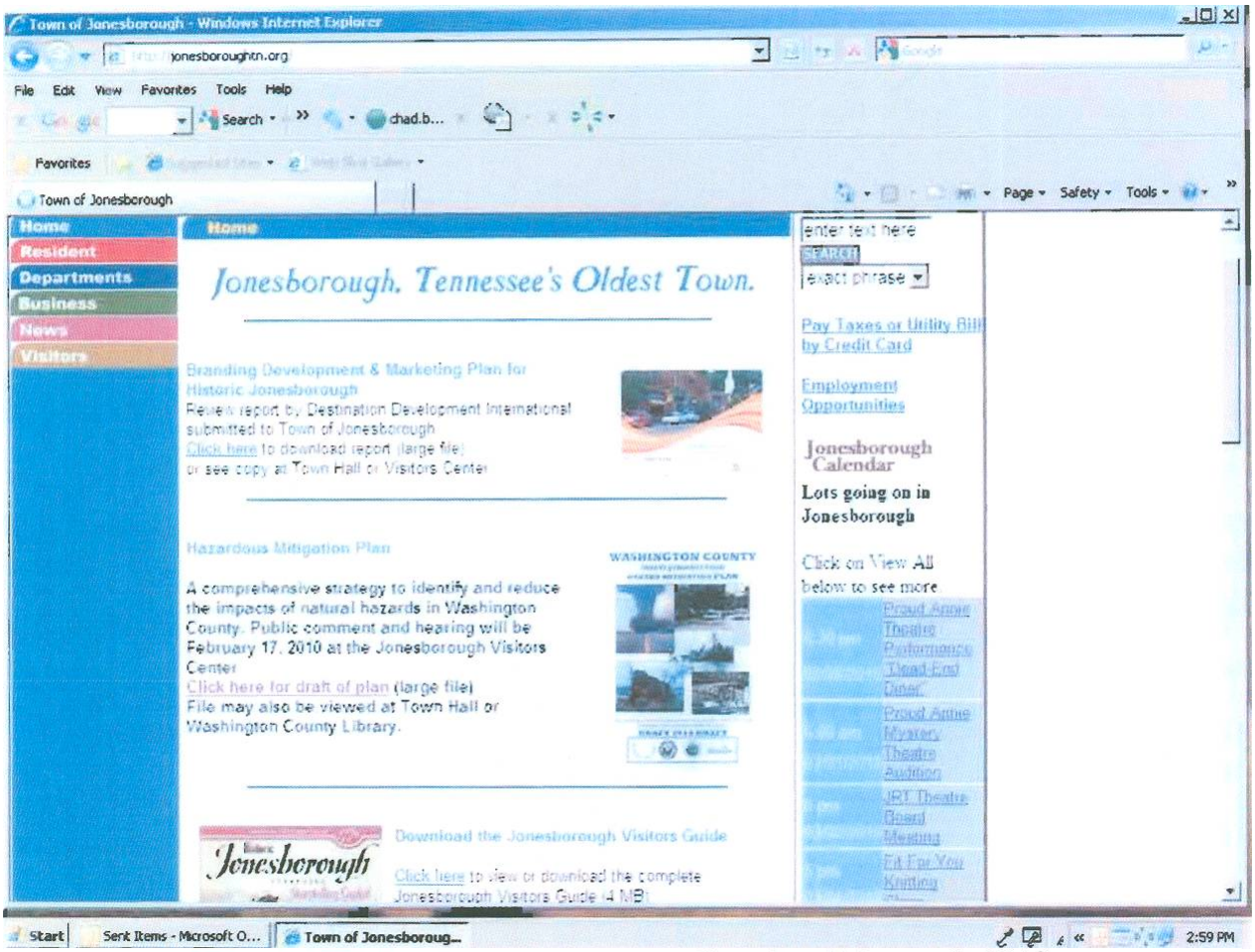
Page 1 of 1

Mitigation Plan Meeting	Meeting Date: 12/17/2009	
Facilitator: Washington County / Johnson City EMA	Place/Room: Washington County EMA	
Name	**Address**	**Phone (work)**
Dan Wheeley	296 Wesley St JC TN 37601	423-791-0739
Lewis Tested	400 N. State of Franklin Rd JC TN 37604	423-431-3665
Phil Scheuerman	Box 70682 ETSU JC TN 37614	423-439-7028 ~~423-48~~
Dan O'Brien	Box 70653 ETSU JC TN 37614	423-439-774

Mitigation Plan Meeting	Meeting Date: February 17, 2010	
Facilitator: Washington County / Johnson City EMA	Place/Room: Jonesborough Visitor's Center	
Name	**Address**	**Phone (work)**
Glenn K Berry	167 Mountain Creek Cr Jonesborough, TN 37659	423 434.6272
PHIL FRITTS	123 BOONE ST. JONESBOROUGH, TN. 37659	423 753-1047
Nes Levotch	306 S. Cherokee St Jonesborough TN 37659	423-753-9190
Chad Bruckman	2013 Dusty Drive Johnson City, TN 37604	423-926-3579
CHARLIE WILLIAMS	697 DOUBLE SPRINGS RD FALL BRANCH TN 37656	423-348-6372
Jimmy Martin	204 Rosemont St. Kingsport TN 37660	423-791-3243
Sandy Levotch	306 S. Cherokee St Jonesborough, TN	423 788-1414

Mitigation Plan Meeting	Meeting Date: 3/4/2010	
Facilitator: Washington County / Johnson City EMA	Place/Room: Johnson City Municipal Bldg	
Name	**Address**	**Phone (work)**
Becky Hilbert	130 Bowman Tr, JC, Tn 37601	483-5802
Samuel Hughes	113 Hart Rd. Elizabethton Tn.	483-5925
April Moore	232 Spice Hollow Rd JC Tn.	434-6019
Carole Davrosa	175 Cherry Lane, Eliz Tn. 37643	434-6248
[illegible]	1404 Skyline Drive. JC 37604	434-6022
Bob Wilson	309 Shadowood D, J.C.	434-6004
[illegible] Phillips	164 Ezee St. Eliz.	213-7167
[illegible]	126 Hills Ave - 37601	434-6249
[illegible]	1700 Pack Drive	434-6002
Gerry Slamp	1404 Lester Harris Rd	928-6682
Angela Charles	83 Mulberry Bend	434-6059
Steve Ballin	603 Bert Street	434-6291

PUBLIC COMMENT ADVERTISEMENT

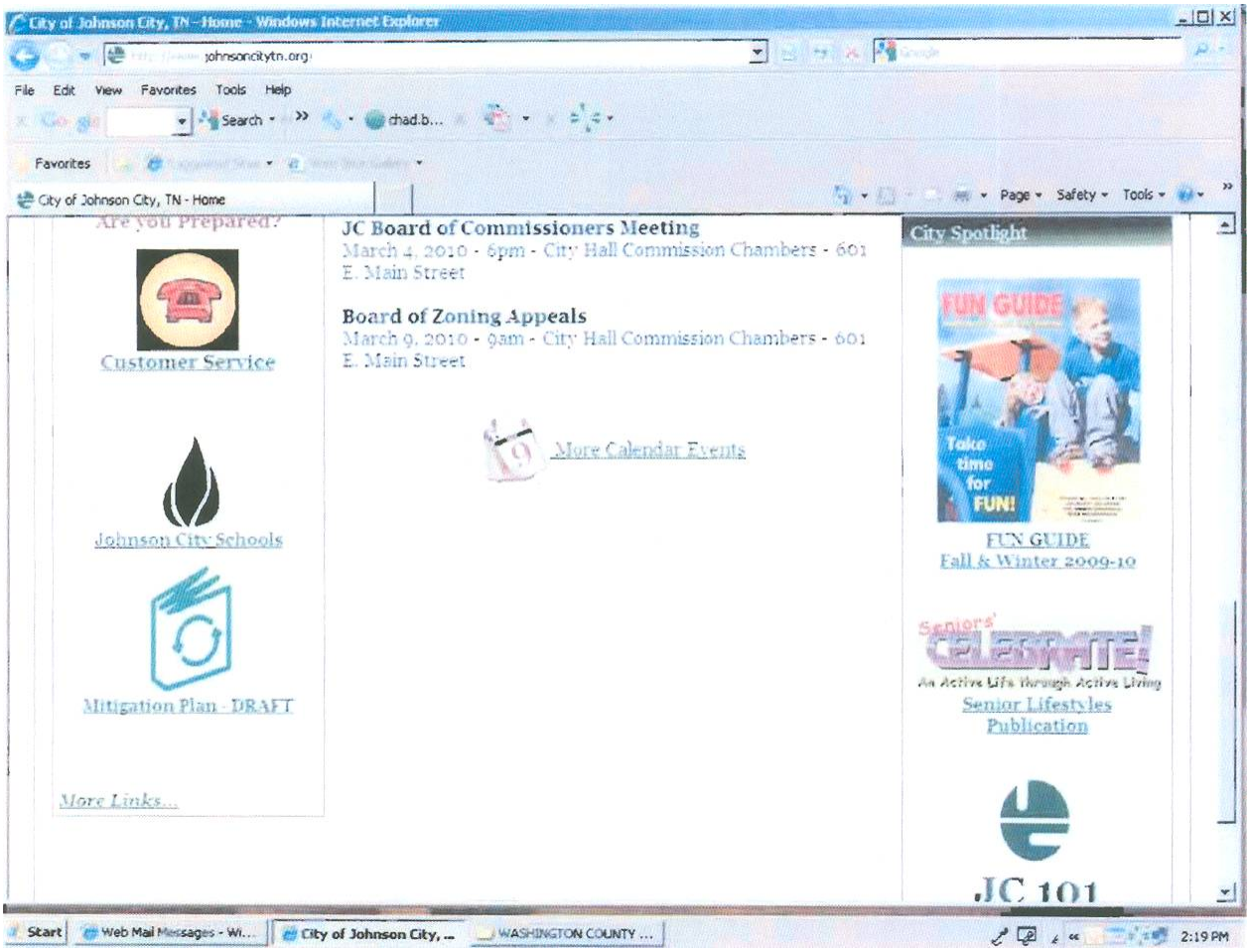


HERALD & TRIBUNE Tuesday, February 9, 2010

COMMUNITY EVENTS

Town to hold public comment session on Hazard Mitigation Plan

On Feb. 17, at 1 p.m., a public comment session will be held on a proposed Washington County Multi-Jurisdiction Mazard Mitigation Plan. The session will be held at the Jonesborough Visitors Center. A copy of the plan is available at the Town of Jonesborough website, Town Hall, and the Washington County Library. The plan is for all of Washington County including the Town of Jonesborough and Johnson City. The public is encouraged to attend.


City of Johnson City, TN - Home - Windows Internet Explorer
File Edit View Favorites Tools Help
Favorites
City of Johnson City, TN - Home
Page Safety Tools
Customer Service
Johnson City Schools
Mitigation Plan - DRAFT
More Links...
JC Board of Commissioners Meeting
March 4, 2010 - 6pm - City Hall Commission Chambers - 601 E. Main Street
Board of Zoning Appeals
March 9, 2010 - 9am - City Hall Commission Chambers - 601 E. Main Street
More Calendar Events
City Spotlight
FUN GUIDE
Take time for FUN!
FUN GUIDE
Fall & Winter 2009-10
Senior Lifestyles Publication
JC 101
Start
Web Mail Messages - Wi...
City of Johnson City, ...
WASHINGTON COUNTY ...
2:19 PM

City of Johnson City Tennessee

601 East Main Street • P.O. Box 2150 • Johnson City, TN 37605 • (423) 434-6021

Office of Community Relations

Feb. 23, 2010
For immediate release

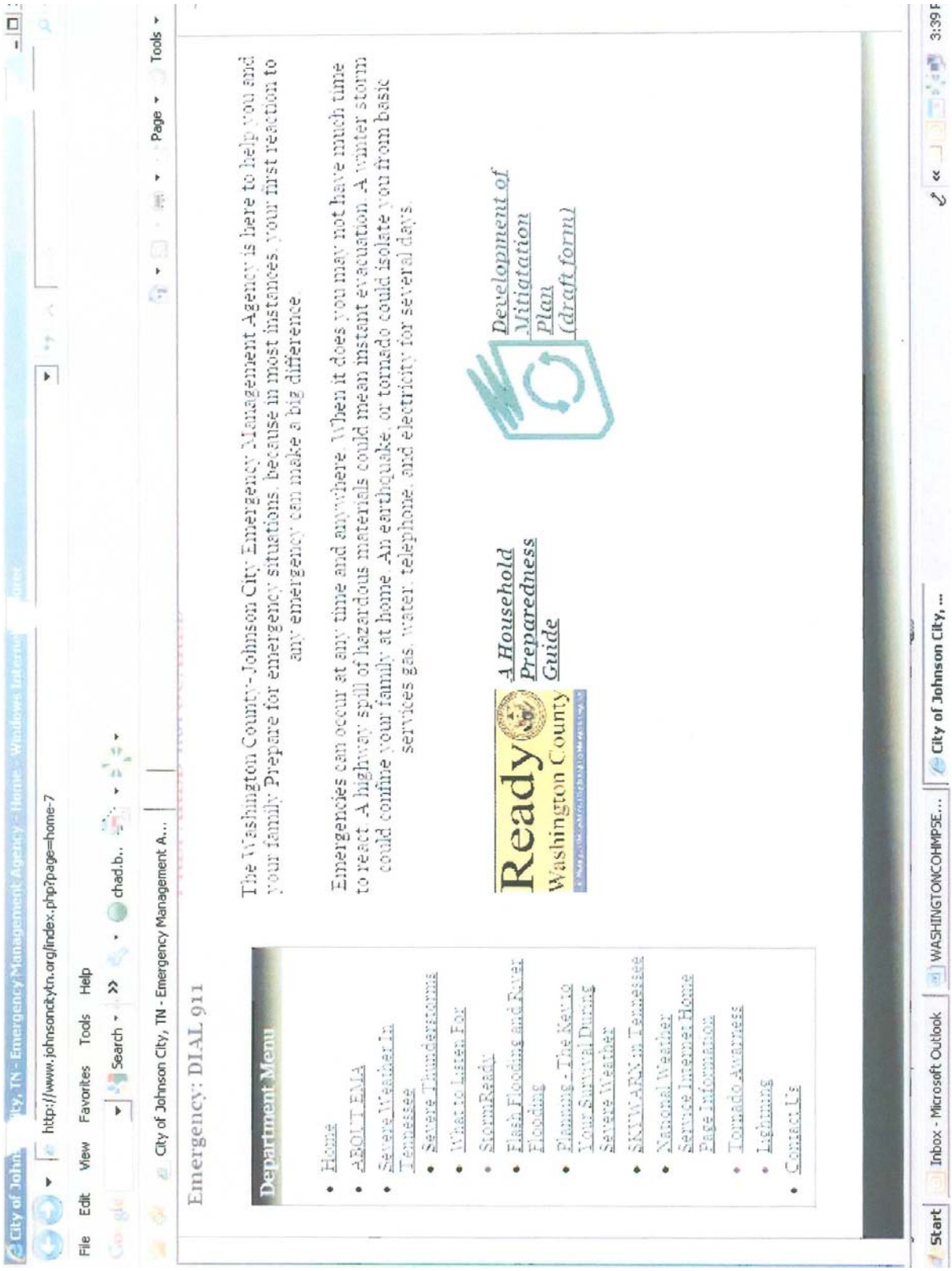
CONTACT: Chad Bruckman, operations and training officer
Emergency Management Agency
(423)434-6082

EMA to hold public comment session on hazard mitigation plan

The Washington County/Johnson City Emergency Management Agency will hold a public comment session on the Washington County Multi-Jurisdictional Hazard Mitigation Plan on Thursday, March 4, from 1-2 p.m. This session will take place in the Commission Chambers of the Municipal and Safety Building, 601 E. Main St.

The Multi-Jurisdictional Hazard Mitigation Plan is for all of Washington County including the City of Johnson City and the Town of Jonesborough. Plans will be available for review during this session. A draft plan is also available at www.washingtoncountytn.com, www.johnsoncitytn.org, and www.jonesboroughtn.org.

###


City of John... City, TN - Emergency Management Agency - Home - Windows Internet
http://www.johnsoncitytn.org/index.php?page=home-7
File Edit View Favorites Tools Help
Google Search chad.b...
City of Johnson City, TN - Emergency Management A...
Page Tools
Emergency: DIAL 911
Department Menu
Home
ABOUT EMA
Severe Weather in Tennessee
Severe Thunderstorms
What to Listen For
StormReady
Flash Flooding and River Flooding
Planning - The Key to Your Survival During Severe Weather
SKYWARN in Tennessee
National Weather Service Inserver Home Page Information
Tornado Awareness
Lightning
Contact Us
The Washington County-Johnson City Emergency Management Agency is here to help you and your family Prepare for emergency situations, because in most instances, your first reaction to any emergency can make a big difference.
Emergencies can occur at any time and anywhere. When it does you may not have much time to react. A highway spill of hazardous materials could mean instant evacuation. A winter storm could confine your family at home. An earthquake, or tornado could isolate you from basic services gas, water, telephone, and electricity for several days.
Ready Washington County
A Household Preparedness Guide
Development of Mitigation Plan (draft form)
Start Inbox - Microsoft Outlook WASHINGTONCOHMPSE... City of Johnson City, ...
3:39 P

CORE TEAM MEETING DATES AND ATTENDEES

The Washington County Multi Jurisdictional Hazard Mitigation Plan Core Team met on January 20th, 2010 at 10:00a.m at the WC/JC EMA Office. Those in attendance were:

Phil Fritts – Town of Jonesborough
Andy Best- City of Johnson City
Todd Wood – Town of Jonesborough/Washington County
Phil Pinzola – City of Johnson City
Nes Levotch – WC/JC EMA
Chad Bruckman – WC/JC EMA

The Washington County Multi Jurisdictional Hazard Mitigation Plan Core Team met on March 30th, 2010 at 9:00 a.m. at the WC/JC EMA Office. Those in attendance were:

Phil Fritts – Town of Jonesborough
Andy Best – City of Johnson City
Chad Bruckman – WC/JC EMA

APPENDIX B

Table 1: Washington County Population 1980 to 2000 by Jurisdiction

Jurisdiction	CENSUS 1980	% of County	CENSUS 1990	% of County	CENSUS 2000	% of County	Growth 1980 - 1990		Growth 1990 - 2000	
							Number	% Change	Number	% Change
Johnson City	39,738	44.8%	49,381	53.5%	55,469	51.7%	9,643	19.5%	6,088	11%
Jonesborough	2,829	3.1%	3,091	3.3%	4,168	3.9%	262	8.5%	1,077	26%
Unincorporated	46,188	52.1%	39,843	43.2%	47,561	44.4%	-6,345	-16%	7,718	16.2 %
County Totals	88,755	100%	92,315	100%	107,198	100%	3,560	3.9%	14,883	14%

Source: U.S. Census 1980, 1990, 2000.

Table 2: Annual Estimates of the Population for Areas in Washington County, TN: July 1, 2003 to July 1, 2008

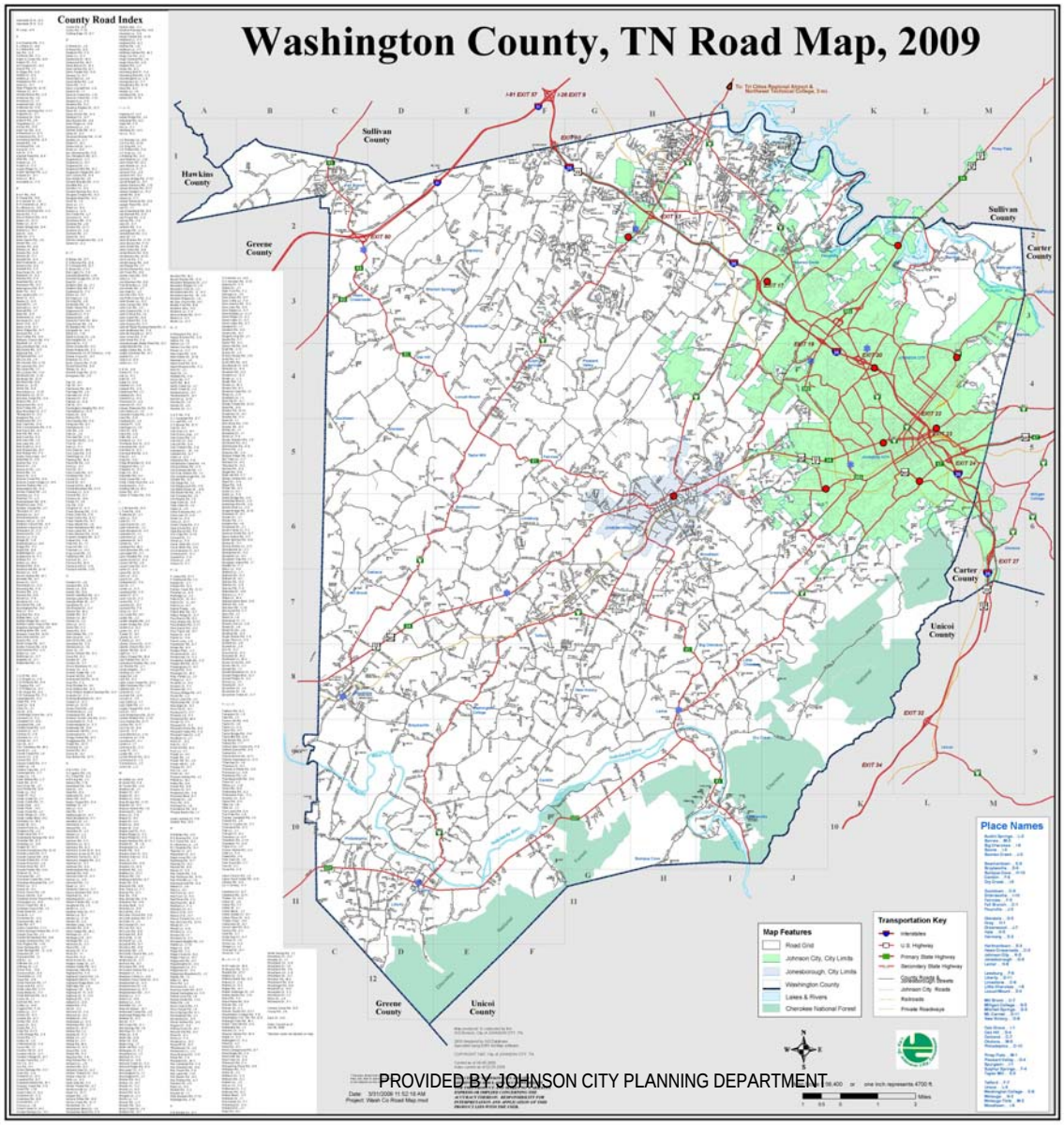
Area	Resident Population Estimate (July 1)						Resident Population Census Estimates Base April 1, 2000	Census 2000 Population
	2008	2007	2006	2005	2004	2003		
Johnson City	61,990	60,990	60,333	58,718	57,658	57,251	55,485	55,469
Jonesborough	5,221	5,038	4,735	4,550	4,483	4,399	4,168	4,168
Unincorporated Washington Co.	51,428	50,442	49,568	49,239	48,786	48,339	47,545	47,561
County Totals	118,639	116,470	114,636	112,605	111,093	110,143	107,198	107,198

Source: Population Estimates Branch, U.S. Census Bureau

Table 3: Washington County Census projections 2005 - 2025

	2005	2010	2015	2020	2025
Washington	112,764	120,236	127,230	133,790	140,467
Johnson City	57,329	61,224	64,887	68,340	71,848
Jonesborough	4,488	4,809	5,115	5,405	5,703
Unincorporated	50,868	54,118	57,126	59,938	62,803

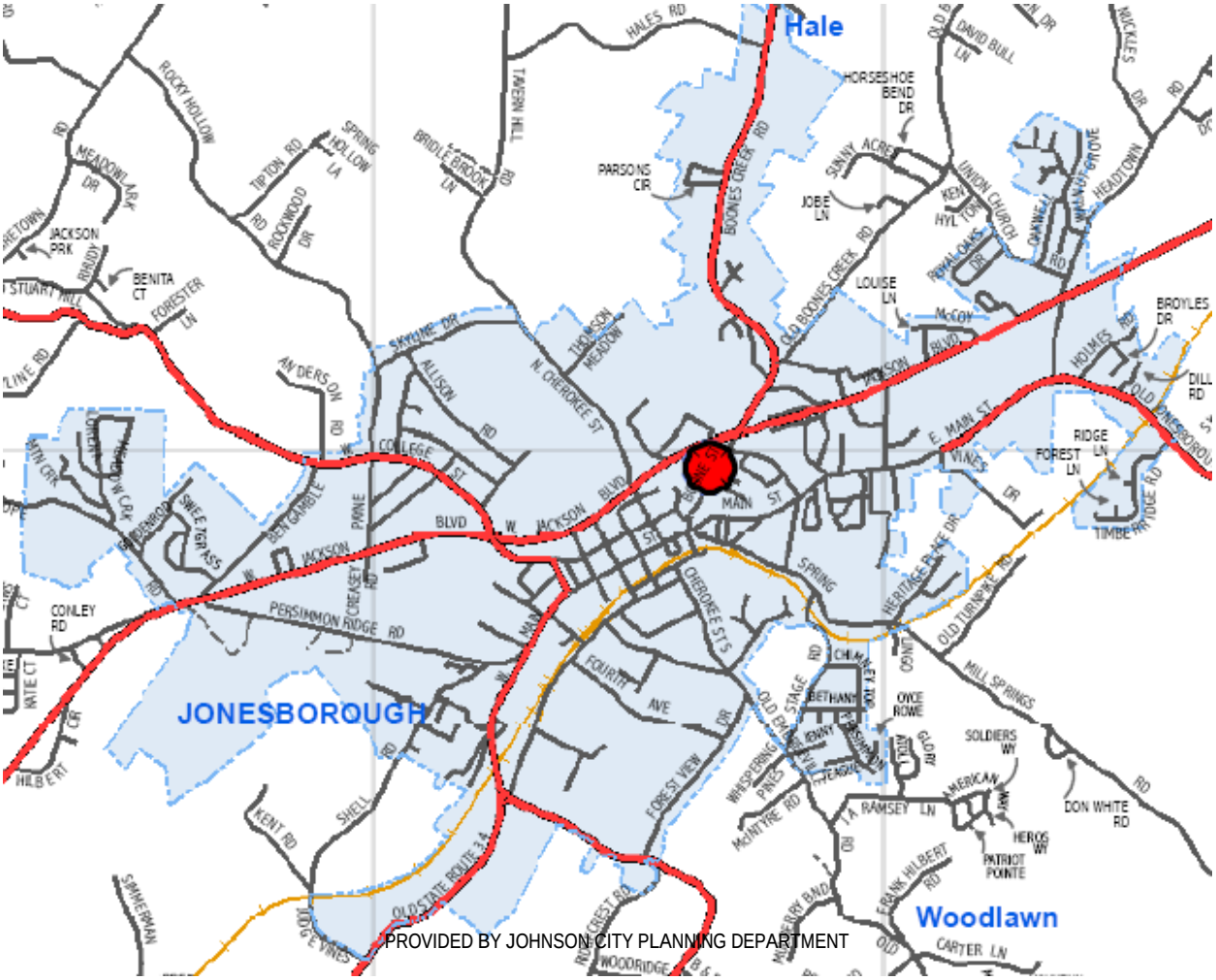
Source: U.S. Census Projections 2005-2025



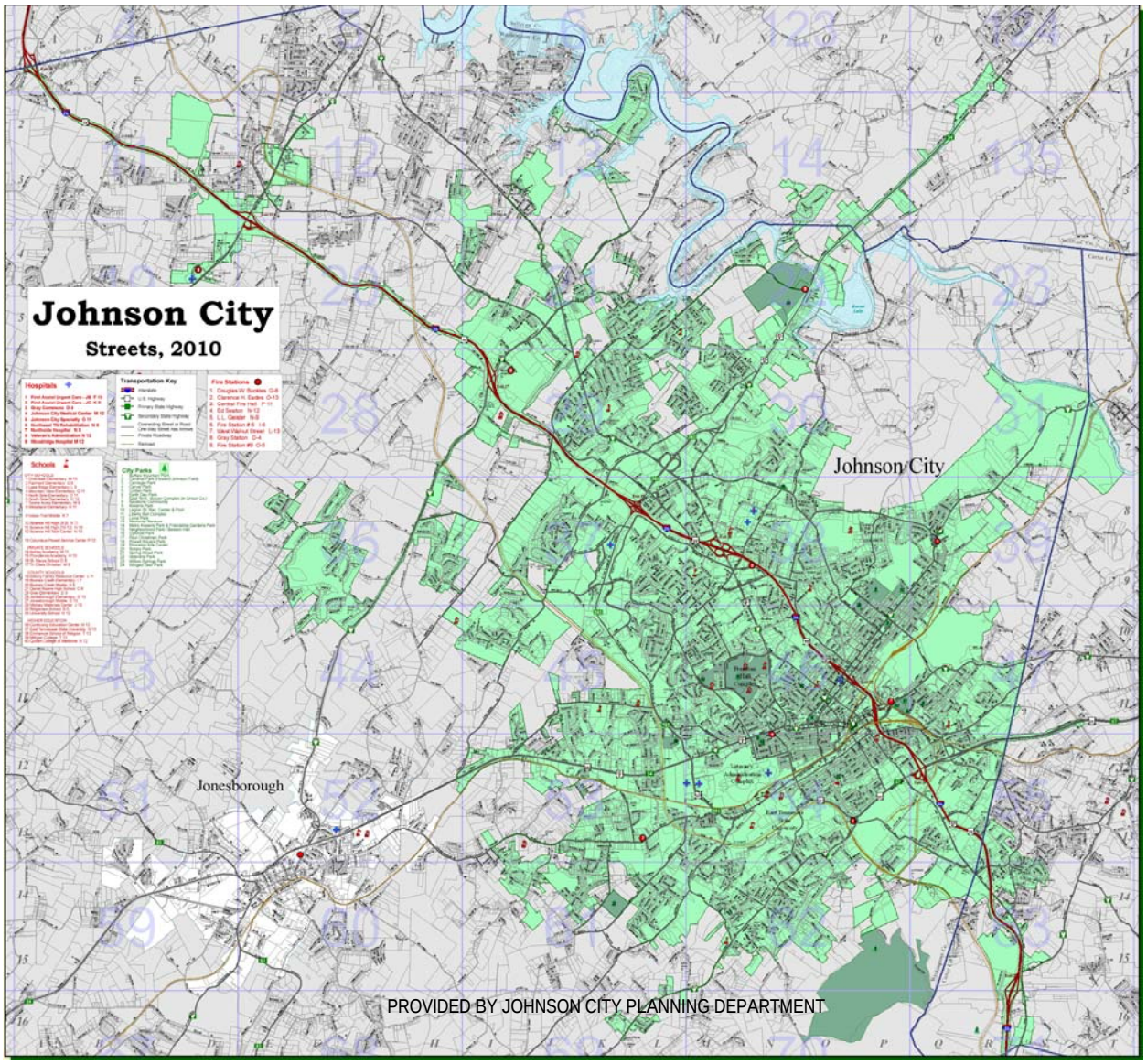
PROVIDED BY JOHNSON CITY PLANNING DEPARTMENT

WASHINGTON COUNTY UNINCORPORATED AREAS SHADED IN WHITE
CITY OF JOHNSON CITY INCORPORARTED AREAS SHADED IN GREEN
TOWN OF JONESBOROUGH INCORPORATED AREAS SHADED IN BLUE

TOWN OF JONESBOROUGH INCORPORATED AREA SHADED IN BLUE



CITY OF JOHNSON CITY INCORPORATED AREA SHADED IN GREEN



CRITICAL INFRASTRUCTURE/FACILITIES

GOVERNMENT BUILDINGS	ADDRESS
City of Johnson City Municipal Building	601 East Main Street, Johnson City, TN 37601
Town of Jonesborough Town Hall	123 Boone Street, Jonesborough, TN 37659
Washington County Justice Center	108 West Jackson Blvd, Jonesborough, TN 37659
Washington County Mayor's Office	101 West Main Street, Jonesborough, TN 37659
Washington County Courthouse (OLD)	100 East Main Street, Jonesborough, TN 37659
Washington County Downtown Center (OLD)	101 East Market Street, Johnson City, Tn 37601
WASHINGTON COUNTY FIRE/RESCUE STATIONS	ADDRESS
Embreeville Volunteer Fire Department	4061 Highway 81 South, Erwin, TN 37650
Fall Branch Volunteer Fire Department	106 Ruritan Road, Fall Branch, TN 37656
Gray Volunteer Fire Department	106 Gray Ruritan Road, Gray, TN 37615
Jonesborough Fire Department	123 Boone Street, Jonesborough, TN 37659
Limestone Volunteer Fire Department	3865 Old State Route 34, Limestone, TN 37681
Nolichuckey Volunteer Fire Department	2634 Highway 107, Chuckey, TN 37641
Sulphur Springs Volunteer Fire Department	1309 Gray Station/Sulphur Springs Road,Jonesborough, TN 37659
Watauga Volunteer Fire Department	100 South 4th Street, Watuaga, TN 37694
Johnson City Fire Department Station #1	2238 Watauga Road, Johnson City, TN 37601
Johnson City Fire Department Station #2	702 Cherokee Road, Johnson City, TN 37601
Johnson City Fire Department Station #3	505 East Main Street, Johnson City, TN 37601
Johnson City Fire Department Station #4	800 West Main Street, Johnson City, TN 37604
Johnson City Fire Department Station #5	203 Broyles Drive, Johnson City, TN 37604
Johnson City Fire Department Station #6	Browns Mill Court, Johnson City, TN 37604
Johnson City Fire Department Station #7	2830 West Walnut Street, Johnson City, TN 37604
Johnson City Fire Department Station #8	106 Gray Commons Circle, Gray, TN 37615
Johnson City Fire Department Station #9	105 Carroll Creek Road, Johnson City, TN 37604
Johnson City Fire Marshall	333 East Maple Street, Johnson City, TN 37601
WC/JC EMS Station #1	507 East Main Street, Johnson City, TN 37601
WC/JC EMS Station #2	400 North State of Franklin Road, Johnson City, TN 37604
WC/JC EMS Station #3	296 Wesley Street, Johnson City, TN 37601
WC/JC EMS Station #4	148 Bob Fitz Road, Gray, TN 37615
WC/JC EMS Station #5	2737 Hwy 11E, Telford, TN 37690
WC/JC EMS Station #6	Browns Mill Court, Johnson City, TN 37604
WC/JC EMS Station #7	1019 West Oakland Avenue, Johnson City, TN 37604
WC/JC EMS Station #8	3285 Hwy 81 South, Jonesborough, TN 37659
WC/JC EMS Station #9	694 Hwy 93, Fall Branch, TN 37656
WC/JC EMA Offices/EOC	333 East Maple Street, Johnson City, TN 37601
LAW ENFORCEMENT STATIONS	ADDRESS
Washington County Sheriff's Office	108 West Jackson Blvd, Jonesborough, TN 37659
Johnson City Police Department	601 East Main Street, Johnson City, TN 37601
Jonesborough Public Safety	123 Boone Street, Jonesborough, TN 37659
ETSU Public Safety	807 University Parkway, Johnson City, TN 37614
Veteran Affairs Police	Lamont/Veteran's Way, Mountain Home, TN 37684
Tennessee Highway Patrol	184 Joe McCrary Road, Fall Branch, TN 37656

JOHNSON CITY SCHOOLS	ADDRESS
Science Hill Highschool 10-12 Campus	1509 John Exum Parkway, Johnson City, TN 37604
Science Hill Highschool 8-9 Campus	1318 Pactolas Road, Johnson City, TN 37604
Technology Center	501 Liberty Bell Blvd, Johnson City, TN 37604
Henry Johnson Alternative Center	810 West Market Street, Johnson City, TN 37604
Indian Trail Middle School	307 Car-Mol Drive, Johnson City, TN 37601
Cherokee Elementary School	2100 Cherokee Road, Johnson City, TN 37604
Fairmont Elementary School	1405 Lester Harris Road, Johnson City, TN 37601
Lake Ridge Elementary School	1001 Lake Ridge Square, Johnson City, TN 37601
Mountain View Elementary School	907 Kings Springs Road, Johnson City, TN 37601
North Side Elementary School	1000 North Roan Street, Johnson City, TN 37601
South Side Elementary School	1011 Southwest Avenue, Johnson City, TN 37604
Town Acres Elementary School	2310 Larkspur Drive, Johnson City, TN 37604
Woodland Elementary School	2303 Indian Ridge Road, Johnson City, TN 37604
WASHINGTON COUNTY SCHOOLS	ADDRESS
Asbury Optional High School	2002 Indian Ridge Road, Johnson City, TN 37604
Boones Creek Elementary School	348 Christian Church Road, Gray, TN 37615
Boones Creek Middle School	4352 North Roan Street, Johnson City, TN 37615
Daniel Boone Highschool	1440 Suncrest Drive, Gray, TN 37615
David Crockett Highschool	684 Old State Route 34, Jonesborough, TN 37659
Fall Branch Elementary School	1061 Hwy 93, Fall Branch, TN 37656
Grandview Elementary School	2891 Hwy 11E, Telford, TN 37690
Gray Elementary School	755 Gray Station Road, Gray, TN 37615
Jonesborough Elementary School	308 Forest Drive, Jonesborough, TN 37659
Jonesborough Middle School	306 Forest Drive, Jonesborough, TN 37659
Lamar School	3261 Hwy 81 S, Jonesborough, TN 37659
Ridgeview Elementary School	252 Sam Jenkins Road, Gray, TN 37659
South Central School	2955 Hwy 107, Chuckey, TN 37641
Sulphur Springs School	1518 Gray Station/Sulphur Springs Road, Jonesborough, TN 37659
West View Elementary School	2847 Old State Route 34, Limestone, TN 37681
University School	100 CR Drive, Johnson City, TN 37614
UNIVERSITIES	ADDRESS
East Tennessee State University	807 University Parkway, Johnson City, TN 37614
V.A. College of Medicine	VA Grounds, Johnson City, TN
HOSPITALS	ADDRESS
Johnson City Medical Center	400 North State of Franklin Road, Johnson City, TN 37604
Franklin Woods Hospital	300 Med Tech Parkway, Johnson City, TN 37604
V.A. Hopsital	Lamont/Veteran's Way, Mountain Home, TN 37684
HEALTH DEPARTMENT	ADDRESS
Washington County Health Department	415 North State of Franklin Road, Johnson City, TN 37604
Northeast Tennessee Regional Health Office	1233 SW Avenue Extension, Johnson City, TN 37604

UTILITIES INFRASTRUCTURE	ADDRESS
Johnson City Power Board	2600 Boones Creek Road, Johnson City, TN 37615-4448
Atmos Gas	2833 W Market St, Johnson City, TN 37604
Centurylink	1914 North Roan Street, Johnson City, TN 37601
Regional Waster Water Plant	228 Airport Road, Gray, TN 37615
Brush Creek Water Plant	857 Riverview Road, Johnson City, TN 37601
Knob Creek Waste Water Plant	509 Austin Springs Road, Johnson City, TN 37601
Watauga Water Treatment Plant	203 Dalewood Drive, Johnson City, TN 37605
Town of Jonesborough Water Treatment Plant	301 Arnold Road, Jonesborough, TN 37659
Town of Jonesborough Waste Water Plant	130 Britt Drive, Jonesborough, TN 37659
Johnson City Services Complex	209 Water Street, Johnson City, TN 37601
TRANSPORTATION	ADDRESS
Johnson City Transit	137 West Market Street, Johnson City, TN 37604

APPENDIX C

TABLE 1 -SNOW/ICE EVENTS FOR WASHINGTON COUNTY, TN 1950 – 2009

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 WASHINGTON	12/20/1993	2200	Snow	N/A	0	0	1K	0
2 WASHINGTON	1/16/1994	1800	Snow	N/A	0	0	5K	0
3 WASHINGTON	2/9/1994	2000	Ice Storm	N/A	0	0	500K	0
4 WASHINGTON	1/17/1995	400	Heavy Snow	N/A	0	0	0	0
5 Southwest And	1/17/1995	1700	Ice	N/A	0	0	500K	0
6 WASHINGTON	2/7/1995	1200	Snow	N/A	0	0	1K	0
7 WASHINGTON	1/6/1996	9:00 PM	Winter Storm	N/A	0	0	0	0
8 WASHINGTON	1/11/1996	7:00 PM	Winter Storm	N/A	0	0	0	0
9 WASHINGTON	2/2/1996	2:00 AM	Winter Storm	N/A	0	0	0	0
10 WASHINGTON	12/18/1996	4:00 PM	Winter Storm	N/A	0	0	0	0
11 WASHINGTON	1/10/1997	11:00 AM	Winter Storm	N/A	0	0	0	0
12 WASHINGTON	12/30/1997	4:00 AM	Winter Storm	N/A	0	0	0	0
13 WASHINGTON	1/27/1998	7:30 PM	Winter Storm	N/A	1	0	1.0M	0
14 WASHINGTON	12/22/1998	1:00 AM	Ice Storm	N/A	0	0	0	0
15 WASHINGTON	1/6/1999	7:00 AM	Winter Storm	N/A	0	0	0	0
16 WASHINGTON	3/13/1999	4:00 AM	Winter Storm	N/A	0	0	0	0
17 WASHINGTON	1/22/2000	10:00 AM	Winter Storm	N/A	0	0	0	0
18 WASHINGTON	12/2/2000	6:00 PM	Winter Storm	N/A	0	0	0	0
19 WASHINGTON	12/18/2000	6:00 PM	Winter Storm	N/A	0	0	0	0
20 WASHINGTON	1/1/2001	2:00 AM	Winter Storm	N/A	0	0	0	0
21 WASHINGTON	1/20/2001	3:00 AM	Winter Storm	N/A	0	0	0	0
22 WASHINGTON	1/5/2002	10:00 PM	Winter Storm	N/A	0	0	0	0
23 WASHINGTON	1/5/2003	4:00 AM	Heavy Snow	N/A	0	0	0	0
24 WASHINGTON	1/16/2003	1:00 PM	Winter Storm	N/A	0	0	0	0
25 WASHINGTON	1/22/2003	7:00 PM	Winter Storm	N/A	0	0	0	0
26 WASHINGTON	1/25/2004	8:00 AM	Ice Storm	N/A	0	0	0	0
27 WASHINGTON	2/15/2004	9:00 PM	Heavy Snow	N/A	0	0	0	0
28 WASHINGTON	2/26/2004	12:00 PM	Heavy Snow	N/A	0	0	0	0
29 WASHINGTON	1/29/2005	12:00 AM	Ice Storm	N/A	0	0	0	0
30 WASHINGTON	2/11/2006	4:00 AM	Heavy Snow	N/A	0	0	0	0
				TOTALS:	1	0	2.006M	0

Courtesy of the National Weather Service

2.6 MILLION DOLLAR LOSS FROM 1950 – 2009

TABLE 2 SEVERE WEATHER EVENTS (HAIL) FOR WASHINGTON COUNTY, TN 1950 -2009

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 WASHINGTON	10/8/1960	1515	Hail	3.00 in.	0	0	0	0
2 Johnson City	6/26/1995	1915	Hail	0.75 in.	0	0	0K	0
3 Gray	5/25/1996	3:50 PM	Hail	1.00 in.	0	0	0	0
4 Johnson City	11/30/1997	4:20 PM	Hail	0.75 in.	0	0	0	0
5 Gray	4/3/1998	6:45 PM	Hail	1.00 in.	0	0	0	0
6 Gray	5/7/1998	4:07 PM	Hail	1.00 in.	0	0	0	0
7 Johnson City	5/7/1998	8:01 PM	Hail	1.00 in.	0	0	0	0
8 Jonesboro	6/5/1998	7:45 PM	Hail	0.75 in.	0	0	0	0
9 Gray	7/19/1998	4:25 PM	Hail	1.00 in.	0	0	0	0
10 Garber	5/7/1999	3:30 PM	Hail	1.00 in.	0	0	0	0
11 Johnson City	6/10/1999	12:50 PM	Hail	0.75 in.	0	0	0	0
12 Spurgeon	7/28/2000	4:20 PM	Hail	1.75 in.	0	0	0	0
13 Gray	6/11/2003	4:15 PM	Hail	0.75 in.	0	0	0	0
14 Countywide	6/11/2003	4:44 PM	Hail	0.75 in.	0	0	0	0
15 Jonesboro	8/4/2003	9:25 PM	Hail	0.75 in.	0	0	0	0
16 Gray	4/13/2004	2:55 PM	Hail	1.00 in.	0	0	0	0
17 Johnson City	4/13/2004	2:55 PM	Hail	1.00 in.	0	0	0	0
18 Jonesboro	5/14/2005	5:33 PM	Hail	0.75 in.	0	0	0	0
19 Johnson City	4/3/2006	1:20 AM	Hail	0.75 in.	0	0	0	0
20 Johnson City	4/22/2006	12:55 AM	Hail	0.88 in.	0	0	0	0
21 Gray	4/25/2006	6:30 PM	Hail	0.75 in.	0	0	0	0
22 Johnson City	5/18/2006	7:50 PM	Hail	0.88 in.	0	0	0	0
23 Johnson City	5/26/2006	3:05 PM	Hail	1.00 in.	0	0	0	0
24 Johnson City	5/26/2006	3:35 PM	Hail	0.75 in.	0	0	0	0
25 Jonesboro	6/10/2006	5:59 PM	Hail	1.00 in.	0	0	0	0
26 Johnson City	6/12/2007	15:30 PM	Hail	1.75 in.	0	0	0K	0K
27 Gray	6/9/2008	16:50 PM	Hail	0.75 in.	0	0	0K	0K
28 Gray	6/9/2008	17:08 PM	Hail	0.88 in.	0	0	0K	0K
29 Johnson City	7/8/2008	15:15 PM	Hail	0.75 in.	0	0	0K	0K
30 Johnson City	7/22/2008	17:52 PM	Hail	0.75 in.	0	0	0K	0K
31 Johnson City	8/2/2008	14:50 PM	Hail	0.75 in.	0	0	0K	0K
				TOTALS:	0	0	0	0

Courtesy of the National Weather Service

NO RECORDED ESTIMATED LOSSES 1950 – 2009

TABLE 3 SEVERE WEATHER EVENTS (LIGHTNING) FOR WASHINGTON COUNTY, TN 1950 -2009

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 Johnson City	4/27/1994	1400	Lightning	N/A	0	0	50K	0
2 Embreeville	1/6/1995	1730	Lightning	N/A	0	0	5K	0
3 Johnson City	6/21/1995	1700	Lightning	N/A	0	0	1K	0
				TOTALS:	0	0	56K	0

Courtesy of the National Weather Service

$56 THOUSAND DOLLAR LOSS FROM 1950-2009

TABLE 4 SEVERE WEATHER EVENTS (THUNDERSTORM & HIGH WINDS) 1950 - 2009

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 WASHINGTON	10/8/1960	1515	Tstm Wind	0 kts.	0	0	0	0
2 WASHINGTON	6/7/1963	1530	Tstm Wind	0 kts.	0	0	0	0
3 WASHINGTON	5/16/1970	1415	Tstm Wind	0 kts.	0	0	0	0
4 WASHINGTON	4/4/1974	300	Tstm Wind	0 kts.	0	0	0	0
5 WASHINGTON	3/18/1977	1025	Tstm Wind	0 kts.	0	0	0	0
6 WASHINGTON	6/6/1977	1320	Tstm Wind	0 kts.	0	0	0	0
7 WASHINGTON	7/10/1980	1300	Tstm Wind	0 kts.	0	0	0	0
8 WASHINGTON	7/3/1982	1400	Tstm Wind	0 kts.	0	0	0	0
9 WASHINGTON	5/7/1984	1800	Tstm Wind	0 kts.	0	0	0	0
10 WASHINGTON	9/3/1984	1505	Tstm Wind	0 kts.	0	0	0	0
11 WASHINGTON	6/3/1985	200	Tstm Wind	0 kts.	0	0	0	0
12 WASHINGTON	5/6/1989	1130	Tstm Wind	0 kts.	0	0	0	0
13 WASHINGTON	6/2/1989	1215	Tstm Wind	0 kts.	0	0	0	0
14 WASHINGTON	6/22/1990	1000	Tstm Wind	0 kts.	0	1	0	0
15 WASHINGTON	4/9/1991	1620	Tstm Wind	0 kts.	0	0	0	0
16 WASHINGTON	7/12/1991	1800	Tstm Wind	0 kts.	0	0	0	0
17 WASHINGTON	8/4/1991	1930	Tstm Wind	0 kts.	0	0	0	0
18 WASHINGTON	3/9/1992	2330	Tstm Wind	0 kts.	0	0	0	0
19 WASHINGTON	9/10/1992	1630	Tstm Wind	0 kts.	0	0	0	0
20 Johnson City	8/20/1993	1408	Thunderstorm Winds	0 kts.	0	0	5K	0
21 Gray	8/20/1993	1418	Thunderstorm Winds	0 kts.	0	0	1K	0
22 Limestone	6/11/1994	2300	Thunderstorm Winds	0 kts.	0	0	5K	0
23 Johnson City	6/16/1994	2000	Thunderstorm Winds	0 kts.	0	0	5K	0
24 Johnson City	6/19/1994	1815	Thunderstorm Winds	0 kts.	0	0	1K	0
25 Johnson City	6/21/1994	1430	Thunderstorm Winds	0 kts.	0	0	1K	0
26 WASHINGTON	4/11/1995	630	High Winds	0 kts.	0	4	1.0M	0
27 Limestone	4/11/1995	1945	Thunderstorm Winds	0 kts.	0	0	5K	0
28 Johnson City	5/14/1995	920	Thunderstorm Winds	0 kts.	0	0	5K	0
29 Fall Branch	5/18/1995	2100	Thunderstorm Winds	0 kts.	0	0	5K	0
30 Jonesborough	7/16/1995	1745	Thunderstorm Winds	0 kts.	0	0	2K	0
31 Johnson City	7/31/1995	1330	Thunderstorm Winds	0 kts.	0	0	2K	0
32 WASHINGTON	10/5/1995	30	High Winds	0 kts.	0	0	2.0M	0
33 Countywide	4/13/1996	5:00 PM	Tstm Wind	0 kts.	0	0	0	10K
34 Countywide	5/25/1996	1:00 AM	Tstm Wind	0 kts.	0	0	0	5K
35 Countywide	7/2/1996	2:00 PM	Tstm Wind	0 kts.	0	0	10K	5K

Courtesy of the National Weather Service

TABLE 4 CONTINUED SEVERE WEATHER EVENTS (THUNDERSTORM & HIGH WINDS) 1950 – 2009

35 Countywide	7/2/1996	2:00 PM	Tstm Wind	0 kts.	0	0	10K	5K
36 Gray	7/14/1996	5:15 PM	Tstm Wind	0 kts.	0	0	10K	0
37 Jonesboro	8/17/1996	4:40 PM	Tstm Wind	0 kts.	0	0	15K	2K
38 Countywide	6/13/1997	7:20 PM	Tstm Wind	0 kts.	0	0	0	4K
39 Sulphur Spgs	7/16/1997	2:30 PM	Tstm Wind	0 kts.	0	0	25K	40K
40 Countywide	7/21/1997	8:10 PM	Tstm Wind	0 kts.	0	0	15K	12K
41 Telford	7/22/1997	4:45 PM	Tstm Wind	0 kts.	0	0	0	12K
42 Fall Branch	2/17/1998	11:30 AM	Tstm Wind	0 kts.	0	0	4K	0
43 Bowmantown	5/26/1998	12:10 AM	Tstm Wind	0 kts.	0	0	0	9K
44 Jonesboro	6/2/1998	7:00 AM	Tstm Wind	0 kts.	0	0	0	10K
45 Jonesboro	6/24/1998	3:00 PM	Tstm Wind	0 kts.	0	0	15K	0
46 Jonesboro	6/24/1998	4:45 PM	Tstm Wind	0 kts.	0	0	0	16K
47 Countywide	7/7/1999	4:35 PM	Tstm Wind	0 kts.	0	0	25K	0
48 Taylor Mill	7/28/1999	7:25 PM	Tstm Wind	0 kts.	0	0	1K	0
49 Gray	8/19/1999	10:30 PM	Tstm Wind	0 kts.	0	0	8K	0
50 Countywide	2/14/2000	12:00 AM	Tstm Wind	0 kts.	0	0	21K	17K
51 Jonesboro	2/14/2000	12:00 AM	Tstm Wind	0 kts.	0	0	10K	0
52 Garber	5/27/2000	8:50 PM	Tstm Wind	0 kts.	0	0	0	2K
53 Limestone	6/3/2000	1:15 PM	Tstm Wind	0 kts.	0	0	0	5K
54 Limestone	6/14/2000	3:50 PM	Tstm Wind	0 kts.	0	0	0	7K
55 Limestone	6/15/2000	6:15 PM	Tstm Wind	0 kts.	0	0	0	9K
56 Limestone	7/14/2000	10:10 PM	Tstm Wind	0 kts.	0	0	0	8K
57 Limestone	7/14/2000	10:15 PM	Tstm Wind	0 kts.	0	0	0	5K
58 Johnson City	7/28/2000	4:20 PM	Tstm Wind	0 kts.	0	0	12K	11K
59 Johnson City	8/10/2000	12:00 AM	Tstm Wind	0 kts.	0	0	0	19K
60 Countywide	11/9/2000	6:40 PM	Tstm Wind	0 kts.	0	0	0	26K
61 Countywide	11/9/2000	7:05 PM	Tstm Wind	0 kts.	0	0	0	21K
62 Johnson City	6/29/2001	3:30 PM	Tstm Wind	0 kts.	0	0	0	10K
63 Fall Branch	6/29/2001	4:10 PM	Tstm Wind	0 kts.	0	0	20K	0
64 Gray	7/4/2001	4:05 PM	Tstm Wind	0 kts.	0	0	0	8K
65 Countywide	7/8/2001	4:05 PM	Tstm Wind	0 kts.	0	0	0	14K
66 Countywide	1/24/2002	8:30 AM	Tstm Wind	0 kts.	0	0	7K	0
67 Johnson City	4/28/2002	5:15 PM	Tstm Wind	0 kts.	0	0	5K	0
68 Countywide	7/3/2002	2:32 PM	Tstm Wind	0 kts.	0	0	20K	0
69 Gray	7/4/2002	4:11 PM	Tstm Wind	0 kts.	0	0	10K	0
70 Johnson City	8/24/2002	2:30 PM	Tstm Wind	0 kts.	0	0	45K	0
71 WASHINGTON	2/3/2003	10:00 PM	Strong Wind	40 kts.	0	0	33K	0
72 Countywide	5/2/2003	2:15 PM	Tstm Wind	60 kts.	0	0	10K	0
73 Johnson City	6/11/2003	5:10 PM	Tstm Wind	55 kts.	0	0	10K	0
74 Countywide	7/9/2003	3:15 PM	Tstm Wind	60 kts.	0	0	0	0
75 Countywide	8/4/2003	9:00 PM	Tstm Wind	60 kts.	0	0	0	0
76 Limestone	8/17/2003	2:30 PM	Tstm Wind	60 kts.	0	0	0	0
77 Johnson City	8/28/2003	3:15 AM	Tstm Wind	60 kts.	0	0	0	0
78 Spurgeon	8/28/2003	4:50 PM	Tstm Wind	60 kts.	0	0	0	0
79 Gray	5/26/2004	4:52 PM	Tstm Wind	65 kts.	0	0	10K	0

Courtesy of the National Weather Service

TABLE 4 CONTINUED SEVERE WEATHER EVENTS (THUNDERSTORM & HIGH WINDS) 1950 – 2009

80 Johnson City	5/26/2004	5:30 PM	Tstm Wind	65 kts.	0	0	20K	0
81 Johnson City	5/31/2004	3:30 AM	Tstm Wind	65 kts.	0	0	20K	0
82 Johnson City	7/5/2004	8:30 PM	Tstm Wind	60 kts.	0	0	4K	0
83 Jonesboro	8/2/2004	5:15 PM	Tstm Wind	50 kts.	0	0	2K	0
84 Liberty	4/22/2005	9:47 PM	Tstm Wind	65 kts.	0	0	3K	0
85 Johnson City	5/14/2005	5:40 PM	Tstm Wind	60 kts.	0	0	15K	0
86 Johnson City	6/7/2005	7:10 PM	Tstm Wind	65 kts.	0	0	18K	0
87 Jonesboro	6/27/2005	6:35 PM	Tstm Wind	60 kts.	0	0	10K	0
88 Countywide	7/1/2005	5:15 PM	Tstm Wind	60 kts.	0	0	30K	0
89 Johnson City	7/28/2005	2:35 PM	Tstm Wind	55 kts.	0	0	15K	0
90 Johnson City	7/28/2005	3:10 PM	Tstm Wind	56 kts.	0	0	3K	0
91 Johnson City	7/28/2005	3:10 PM	Tstm Wind	55 kts.	0	0	6K	0
92 Jonesboro	7/28/2005	3:20 PM	Tstm Wind	60 kts.	0	0	30K	0
93 Countywide	4/2/2006	8:40 PM	Tstm Wind	60 kts.	0	0	10K	0
94 Fall Branch	4/17/2006	11:25 AM	Tstm Wind	60 kts.	0	0	6K	0
95 Gray	4/25/2006	6:30 PM	Tstm Wind	65 kts.	0	0	15K	0
96 Jonesboro	5/18/2006	7:25 PM	Tstm Wind	60 kts.	0	0	6K	0
97 Johnson City	5/18/2006	7:45 PM	Tstm Wind	57 kts.	0	0	3K	0
98 Johnson City	5/20/2006	4:45 PM	Tstm Wind	60 kts.	0	0	10K	0
99 Johnson City	5/26/2006	4:00 PM	Tstm Wind	60 kts.	0	0	20K	0
100 Jonesboro	5/26/2006	7:30 PM	Tstm Wind	60 kts.	0	0	20K	0
101 Countywide	6/10/2006	8:20 PM	Tstm Wind	60 kts.	0	0	8K	0
102 Gray	7/4/2006	8:40 PM	Tstm Wind	60 kts.	0	0	20K	0
103 Countywide	8/29/2006	5:20 PM	Tstm Wind	60 kts.	0	0	35K	0
104 Johnson City	9/28/2006	2:20 PM	Tstm Wind	60 kts.	0	0	9K	0
WASHINGTON	12/1/2006	12:00 PM	High Wind	60 kts.	0	0	30K	0K
106 Johnson City	4/3/2007	22:52 PM	Thunderstorm Wind	50 kts.	0	0	15K	0K
107 Johnson City	7/30/2007	16:10 PM	Thunderstorm Wind	60 kts.	0	0	0K	0K
108 Johnson City	3/4/2008	17:30 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
109 Gray	6/9/2008	17:48 PM	Thunderstorm Wind	65 kts.	0	0	15K	0K
110 Sulphur Spgs	7/9/2008	13:20 PM	Thunderstorm Wind	55 kts.	0	0	0K	0K
111 Johnson City	6/11/2009	15:00 PM	Thunderstorm Wind	60 kts.	0	0	20K	0K
112 Mc Kinley	6/16/2009	19:05 PM	Thunderstorm Wind	60 kts.	0	0	20K	0K
113 Jonesboro	6/17/2009	14:12 PM	Thunderstorm Wind	60 kts.	0	0	20K	0K
114 Johnson City	6/18/2009	14:20 PM	Thunderstorm Wind	60 kts.	0	0	15K	0K
115 Little Cherokee	6/18/2009	15:53 PM	Thunderstorm Wind	55 kts.	0	0	8K	0K
116 Little Cherokee	6/20/2009	15:53 PM	Thunderstorm Wind	55 kts.	0	0	8K	0K
117 Gladstone	7/9/2009	16:30 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
118 Crouch Xrd	7/12/2009	16:50 PM	Thunderstorm Wind	50 kts.	0	0	0K	0K
119 Johnson City	8/16/2009	17:12 PM	Thunderstorm Wind	60 kts.	0	0	20K	0K
				TOTALS:	0	5	3.886M	287K

Courtesy of the National Weather Service

$3.8 MILLION DOLLAR LOSS FROM 1950-2009

TABLE 5 FLOODING EVENTS 1950 – 2009

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 Johnson City	12/4/1993	1600	Flash Flood	N/A	0	0	5K	0
2 Jonesborough	2/11/1994	200	Flash Flood	N/A	0	0	5K	0
3 Johnson City	3/27/1994	1800	Flash Flooding	N/A	0	0	50K	0
4 Southern Washington	1/14/1995	830	Flood	N/A	0	0	5K	0
5 Johnson City	5/13/1995	1600	Flash Flooding	N/A	0	0	5K	0
6 Boones Creek	8/19/1995	1631	Flash Flood	N/A	0	0	10K	0
7 Countywide	1/19/1996	8:00 PM	Flash Flood	N/A	0	0	0	0
8 Countywide	5/26/1996	10:15 AM	Flash Flood	N/A	0	0	0	0
9 Countywide	7/11/1999	11:00 AM	Flood	N/A	0	0	0	0
10 Johnson City	6/22/2001	2:30 PM	Urban/sml Stream Fld	N/A	0	0	0	0
11 Countywide	8/4/2001	3:00 AM	Flood	N/A	0	0	0	0
12 Countywide	8/30/2001	10:30 AM	Urban/sml Stream Fld	N/A	0	0	0	0
13 WASHINGTON	3/17/2002	8:45 AM	Flood	N/A	0	0	5.0M	0
14 Countywide	3/18/2002	8:45 AM	Flash Flood	N/A	0	0	0	0
15 WASHINGTON	2/14/2003	12:00 PM	Flood	N/A	0	0	18.1M	0
16 WASHINGTON	2/21/2003	11:00 AM	Flood	N/A	0	0	0	0
17 WASHINGTON	4/10/2003	8:00 AM	Flood	N/A	0	0	0	0
18 Johnson City	6/11/2003	6:00 PM	Flash Flood	N/A	0	0	0	0
19 Johnson City	6/30/2003	4:45 PM	Flash Flood	N/A	0	0	0	0
20 Johnson City	8/16/2009	17:22 PM	Flash Flood	N/A	0	0	0K	0K
				TOTALS:	0	0	23.130M	0

Courtesy of the National Weather Service

$23 MILLION DOLLAR LOSS FROM 1950-2009

TABLE 6 WILDFIRE EVENTS 2004-2009

The following data was received from the Tennessee Division of Forestry for Wildfire Events occurring within Washington County, Tennessee.

- 2300 Acres Burned
- Cause = 40 % Arson
- Cause = 40 % Debris
- Cause = 20% Miscellaneous
- 34 Structures were saved at a cost savings of $3,528,300
- 4 Cell towers were saved at a cost savings of $2,500,000
- 2 Structures lost at an estimated lost of $40,000

TABLE 7 RECENT EARTHQUAKE EVENTS PAST FIVE YEARS

MAGNITUDE	DATE	LATITUDE	LONGITUDE	LOCATION
2.5	2009/10/3	35.301N	82.500W	1 MI SSW OF LAUREL PARK, NC
2.5	2009/10/2	36.047N	83.57W	4 MI SSW IF NEW MARKET, TN
2.9	2009/08/14	36.764N	82.363W	3 MI ENE OF NICKLESVILLE, VA
1.5	2009/07/13	35.299N	82.505W	1 MI SSW OF LAUREL PARK , NC
1.9	2009/07/13	35.314N	82.505W	1 MILE W OF LAUREL PARK , NC
1.7	2009/07/13	35.302N	82.504W	1 MILE SW OF LAUREL PARK, NC
2.1	2009/07/12	35.306N	82.500W	1 MILE SW OF LAUREL PARK, NC

http://folkworm.ceri.memphis.edu/recenteqs/Maps/83-36.html

TABLE 8 Roadside Survey Location Summary Hazardous Materials Transportation Flow Survey: An Evaluation of Hazardous Materials Transported in Washington County, Tennessee by Dan O'Brien ETSU

Location	Commercial Vehicles	HAZMAT	Prevalent Hazard Class
Boones Creek	4719	263	Class 3 - Flammable
Okolono Road	1488	113	Class 5.1 - Oxidizer
HWY 11E	1220	99	Class 3 – Flammable
HWY 321	1521	87	Class 3 – Flammable

WASHINGTON COUNTY DISASTER DECLARATIONS

Tennessee FEMA-1197

Declaration Date:
January 13, 1998

Incident Type:
Severe Storms and flooding

Incident Period:
January 6 through and including February 12, 1998

Counties designated for disaster assistance
as of March 6, 1998:
Bledsoe, Bradley, Campbell, Cannon, Chester,
Clay, Cocke, Crockett, Cunberland, De Kalb,
Fentress, Gibson, Greene, Grundy, Hawkins,
Haywood, Jackson, Jefferson, Madison, Meigs,

Morgan, Overton, Pickett, Polk, Putnam, Rhea,
Roane, Scott, Sequatchie, Sevier, Sullivan,
Tipton, Van Buren, Warren,
and White for Public Assistance only. (35)

Carter, Johnson, Unicoi, and Washington for
Individual and Public Assistance. (4)

Total counties (39).

Disaster Summary for FEMA-1387-DR, Tennessee

Declaration Date:
August 15, 2001

Incident Type:
Severe Storms & Flooding

Incident Period:
July 27, 2001 through August 22, 2001

Counties Declared and Types of Assistance as of August 27, 2001:
Carter, Cocke, Greene, Johnson, Unicoi and Washington Counties
for Public Assistance and Individual Assistance. (6)

Shelby County for Individual Assistance. (1)

Disaster Summary For FEMA-3217-EM, Tennessee

Declaration Date: September 5, 2005
Incident Type: Hurricane Katrina Evacuation
Incident Period: August 29, 2005, and continuing

Designations and Types of Assistance
Specifically, FEMA is authorized to provide Public Assistance Category B (emergency protective measures), including direct Federal assistance, at 100 percent Federal funding.

This assistance is for all 95 counties in the State of Tennessee.

Repetitive Loss Properties: According to the National Flood Insurance Program, repetitive flood loss is defined as a facility or structure that has experienced two or more insurance claims of at least $1,000 in any given 10 year period since 1978. Local businesses in Johnson City make up the majority of the repetitive loss properties in the county. Most of the properties on the list experienced damages during a July 2003 flood event. Below is a chart providing repetitive loss properties information by location, type of structure, flood zone, number of losses, and payments as of July 2010.

Repetitive Loss Properties for Washington County

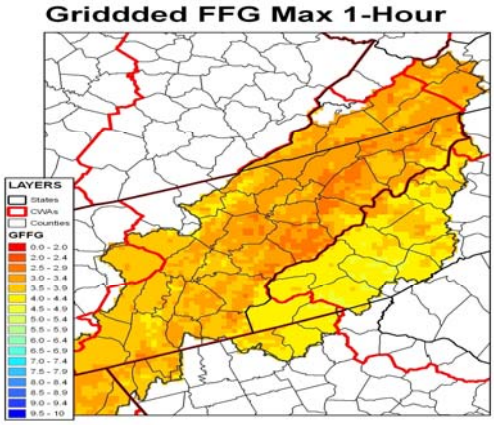
Location	Type of Structure	Zone	Number of Losses	Total Building Payment	Total Contents Payment	Total Paid
Johnson City	Non Residential	X	2	27,550.99	0	27,550.99
Johnson City	Non Residential	B	2	36,982.39	0	36,982.39
Johnson City	Non Residential	AE	2	6,975.61	0	6,975.61
Johnson City	Non Residential	AE	3	564,504.01	539,421.82	1,103,925.83
Johnson City	Multi-Family Residential	AE	2	12,985.04	0	12,985.04
Johnson City	Non Residential	AE	2	22,529.03	911.12	23,440.15
Johnson City	Single Family Residential	A	2	36,311.97	10,000.00	46,311.97
Johnson City	Non Residential	X	2	24,327.94	52,000.00	29,527.94
Washington Co Unincorporated	Single Family Residential	X	2	20,702.26	999.99	21,702.25
Washington Co Unincorporated	Single Family Residential	X	2	18,304.14	0.00	18,304.14
Washington Co Unincorporated	Single Family Residential	A	2	30,336.55	8,809.78	39,146.33

National Flood Insurance Program: The National Flood Insurance Program (NFIP) is a pre-disaster flood hazard mitigation and insurance protection program which has reduced the increasing cost of disasters. The intent of the program is to: require new and substantially improved structures be designed and constructed to minimize or eliminate future flood damage; provide floodplain residents and business owners with financial insurance assistance in the form of insurance after floods, especially after small floods that do not warrant federal disaster assistance; and it transfers most of the cost of private property flood losses from the taxpayers to floodplain property owners through flood insurance premiums. Participation in the NFIP is based on an agreement between communities and FEMA. Currently all three jurisdictions of Washington County are active participants in the NFIP. Below is a chart providing an overview of NFIP insurance information as of July 2010.

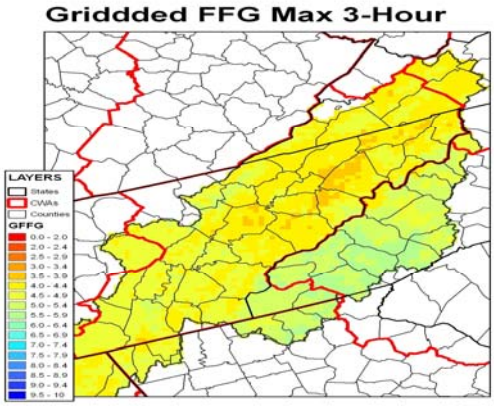
NFIP Insurance Overview

Jurisdiction	Total Number of Policies	Total Premiums	Insurance in Force	Total Number of Closed Paid Losses	$ of Closed Paid Losses
Washington County Unincorporated	74	$44,654	$12,548,800	16	$176,909
Johnson City	178	$154,844	$31,509,400	41	$1,512,306
Jonesborough	24	$16,953	$3,780,100	6	$10,860

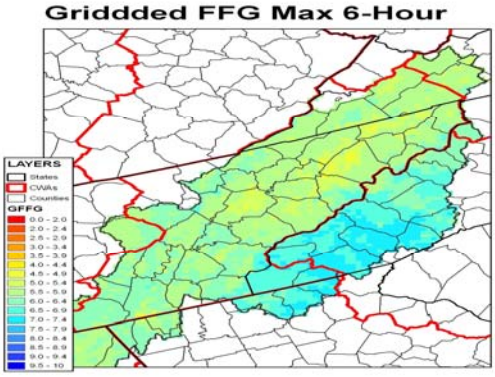
East Tennessee Area Flash Flood Guidance Limits



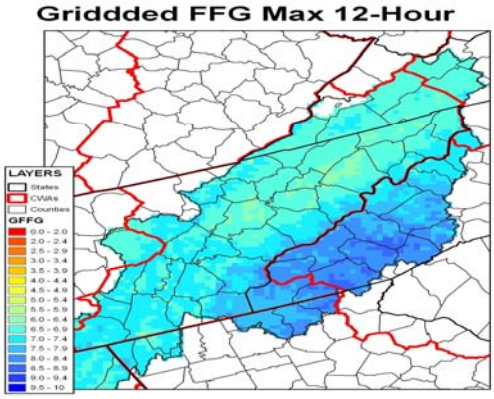
NWS 1 HOUR RAINFALL ESTIMATED RAINFALL TOTALS FOR EAST TENNESSE



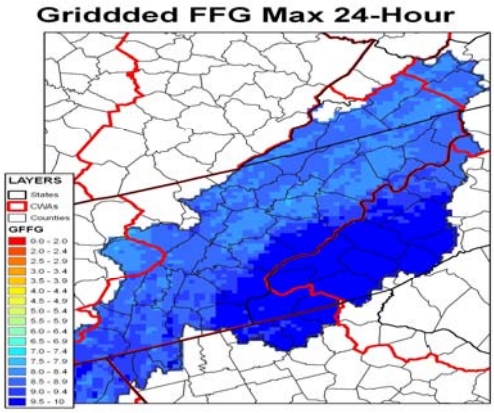
NWS 3 HOUR RAINFALL ESTIMATED RAINFALL TOTALS FOR EAST TENNESSE



NWS 6 HOUR RAINFALL ESTIMATED RAINFALL TOTALS FOR EAST TENNESSE



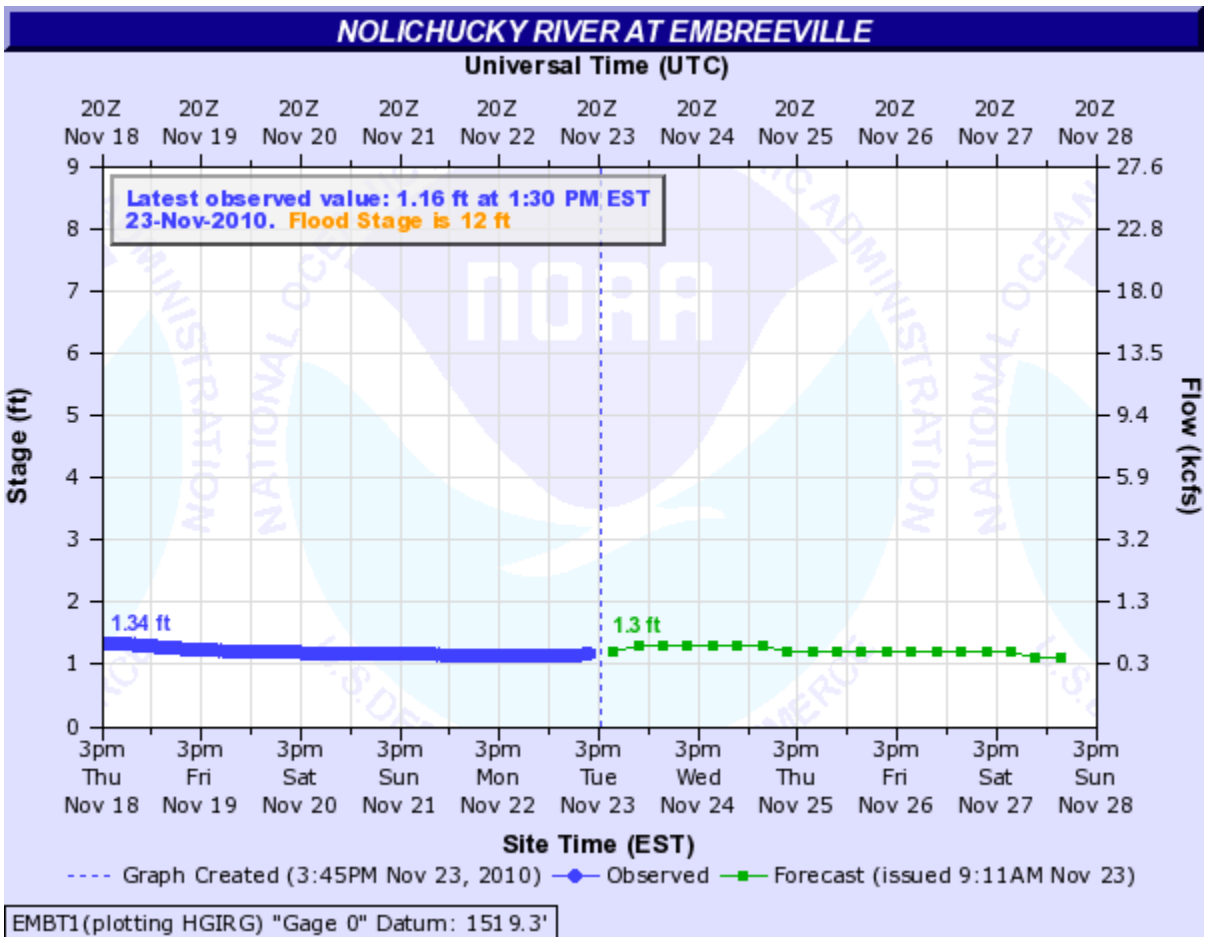
NWS 12 HOUR RAINFALL ESTIMATED RAINFALL TOTALS FOR EAST TENNESSE



NWS 24 HOUR RAINFALL ESTIMATED RAINFALL TOTALS FOR EAST TENNESSE

Nolichucky River at Embreeville 12 feet (Flood Stage) 14.9 feet(Crest Stage)

The total rainfall amount of 13-15 inches eclipses what the National Weather Service has for a maximum limit for flash flooding in their models for a 24 hour time frame.



Example of the Nolichukey River Guage at Embreeville (NWS)

Our agency monitors this flood gauge during times of heavy precipitation

Flood Categories (in feet)

Major Flood Stage:	20
Moderate Flood Stage:	16
Flood Stage:	12
Action Stage:	10

Historical Crests

(1) 24.00 ft on 05/21/1901
(2) 21.52 ft on 11/06/1977
(3) 18.60 ft on 08/13/1940
(4) 15.55 ft on 09/17/2004
(5) 14.92 ft on 09/08/2004
(6) 13.90 ft on 08/16/1928
(7) 12.76 ft on 03/12/1963
(8) 11.63 ft on 08/17/1994
(9) 11.59 ft on 03/26/1965
(10) 11.52 ft on 02/13/1966

APPENDIX D

APPENDIX D PLAN ADOPTION

The governing bodies of Washington County, City of Johnson City and the Town of Jonesborough will adopt this plan, once finalized.

The governing body of the City of Johnson City will adopt the Hazard Mitigation Plan for Sullivan County for all annexed areas of the City of Johnson City that are located in Sullivan County.

The governing body of the City of Johnson City will adopt the Hazard Mitigation Plan for Carter County for all annexed areas of the City of Johnson City that are located in Carter County.

APPENDIX E

TOWN OF JONESBOROUGH
FLOOD PLAIN STUDY

US Army Corps
of Engineers
Nashville District

Submitted
with
Flood Prevention
Program
Phase III

Detailed Project Report And Environmental Assessment

Section 205, Flood Control
Little Limestone Creek and Tributary
Jonesborough, Tennessee

HISTORIC
JONESBOROUGH
1779

March 1994

Supplement

Little Limestone Creek and Tributary
Jonesborough, Tennessee

Detailed Project Report and Environmental Assessment
November 2002

This supplement updates a Detailed Project Report and Environmental Assessment dated March 1994 that addressed flooding on Little Limestone Creek and Tributary in Jonesborough, Tennessee. The Ohio River Division approved the report on July 12, 1994. (See Attachment A.) Construction documents were about 90% completed and Headquarters committed construction funds and authorized us to sign the Project Cooperation Agreement on July 7, 1996. However, the Town of Jonesborough decided not to proceed with the project and requested termination. In the fall of 2001, after significant flooding, the town requested that the project be reconsidered.

The original project recommendations have been reevaluated by updating costs, benefits, and environmental consequences of the 2 most promising plans. The plans provide protection from either a 25- or 50-year storm. Each plan requires adding a culvert to carry the unnamed tributary directly to Little Limestone Creek, constructing a berm to pond the tributary at the inlet of the culvert, and constructing the outlet of the culvert to blend into the historic district. Only culvert size differentiates the plans. A 6 X 8-foot culvert carries the 50-year flood, while a 6 X 6-foot culvert carries the 25-year flood.

Benefits

Table 1 contains the average annual costs and benefits of each plan in October 2002 dollars at 6 1/8 percent as measured against the without project condition. As can be seen, both plans are economically justified with positive net benefits and benefit to cost ratios greater than 1. The 25-year plan has the greatest net benefits ($24,680) and BCR (1.34) and is therefore the National Economic Development (NED) plan. The Town of Jonesborough believes the additional protection provided by the 50-year culvert is worth the additional investment. They are willing to "buy-up" to the higher level of protection. Thus, 6 X 8-foot culvert is the recommended and locally preferred plan. It has a BCR of 1.24 and net benefits of $19,435.

Table 1 - Benefits			
Damages by Event	**Without Project**	**50-year Plan**	**25-year Plan**
2-year	$ 103,634	$ -	$ -
25-year	$ 172,013	$ 8,436	$ 8,436
50-year	$ 190,342	$ 27,815	$ 132,892
100-year	$ 210,066	$ 81,596	$ 144,224
Average Annual Damages	$ 114,360	$ 13,824	$ 16,044
Average Annual Benefits	**n/a**	**$ 100,536**	**$ 98,316**
Average Annual Costs			
Interest and Amortization (61/8%)		$ 79,401	$ 72,236
Operation and Maintenance		$ 1,700	$ 1,400
Total Annual Costs		**$ 81,101**	**$ 73,636**
Benefit Cost Ratio		1.24	1.34
Net Benefits		$ 19,435	$ 24,680

Costs

Table 2 contains the first costs and the cost sharing break down for the 25-year plan. Cost sharing is 65% Corps and 35% local. The local share includes all real estate - lands, easements, rights of way, relocations, and borrow and disposal areas (LERRD). If the real estate costs are less than 35%, the local sponsor pays cash toward project construction. The cost of preparing construction documents is initially federally funded, but included in total project costs for cost sharing purposes. All utilities are not created equal, however, and only the utilities owned by the town - water, sanitary sewer, storm sewers and roads – are eligible for cost sharing by the Corps. These total $78,000. The costs to relocate the gas lines, phone lines, cable TV and electric lines impacted by the project are an economic cost and are included in the calculations of net benefits and BCRs. They are just not eligible for Corps cost sharing. These relocations total $136,000. Thus, the total cost project cost is $1,119,000 and the cost shared amount is $983,000 - $639,000 Corps and $480,000 local (including $76,000 real estate, $78,000 cost shared utilities, $190,000 cash and $136,000 non-cost shared utilities).

Table 3 contains the costs of the 50-year plan. The difference between the 25- and 50-year plans is the size of the culvert. The cost difference is

$111,000. The total cost of the 50-year plan is $1,230,000 - $639,000 Corps and $591,000 local/other. Since the 50-year plan is not the NED plan, the costs above $983,000 are not shared.

Table 2 – 25 – Year Costs

25-year Plan	Total	Corps	Local	Not Cost Shared
Lands & Damages	$ 76,000	$ -	$ 76,000	
Relocations	$ 78,000	$ -	$ 78,000	
Total LERRD	**$ 154,000**	$ -	**$ 154,000**	
Non Cost Shared Relocations	$ 136,000	$ -	$ -	$ 136,000
Planning, Engineering and Design	$ 262,000	$ 262,000	$ -	
Construction & Management	$ 36,000	$ 36,000	$ -	
Construction	$ 531,000	$ 341,000	$ 190,000	
Total Cost of 25-year Plan	$ 1,119,000			
Total Cost Shared Amount	**$ 983,000**	**$ 639,000**	**$ 344,000**	**$ 136,000**
Local Share (35% of total amount cost shared)	**$ 344,000**			
Local Cash (Local share- LERRD)	**$ 190,000**			

Table 3 – 50 –Year Costs

50-year Plan	Total	Corps	Local	Not Cost Shared
Cost of 25-year Plan	$ 1,119,000	$ 639,000	$ 344,000	$ 136,000
Construction Buy-up	$ 106,000		$ 106,000	
Construction Management buy-up	$ 5,000		$ 5,000	
Total Cost to Buy up (Difference between 25 & 50 yr)	$ 111,000			
Total cost of 50-year plan	**$ 1,230,000**	**$ 639,000**	**$ 455,000**	**$ 136,000**

Table 4 contains costs that are not shared by the Corps – the buy-up ($111,000) and the gas, electric, cable and telephone relocations ($136,000). This $247,000, however, is eligible for cost sharing under the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP) guidelines. Cost sharing under the HMGP is 75% federal and 25% local. As seen below, the 50-year plan would cost $1,230,000 - FEMA $185,000, the Corps $639,000 and the Town of Jonesborough $406,000.

Table 4 – HMGP Cost Sharing

Total Not Cost Shared/Eligible for HMGP	Total	FEMA	Local	
Betterment (Buy up to 50-yr)	$ 111,000			
Non Cost Shared Relocations	$ 136,000			
Total Eligible for HMGP (75/25)	$ 247,000	$ 185,000	$ 62,000	
Total Project Recap	**Total**	**COE**	**FEMA**	**Local**
	$ 1,230,000	$ 639,000	$ 185,000	$ 406,000
Total Local Cash Expected at Construction	$ 301,000			

Environmental

A new environmental assessment was prepared and is included at the end of the supplement. It has been circulated to the Town of Jonesborough, US Fish and Wildlife Service, Tennessee Valley Authority, Environmental Protection Agency, various offices of the state of Tennessee. Project activities are permitted under Section 404 Department of the Army Nationwide Permits. An Aquatic Resources Alteration Permit (ARAP) was issued by the state of Tennessee on December 4, 2002.

Conclusions and Recommendations

This study supplement presents updated the costs, benefits, and environmental impacts of the NED and locally preferred plans. The increased project costs are offset by a corresponding increase in project benefits. Both the 25- and 50-year plans remain cost effective and the NED plan remains the 25-year plan. Therefore the 1994 project recommendations remain unchanged. I endorse the recommendation to approve the 50-year, locally preferred plan, for project implementation.

Stephen W. Eli, P.E.
Chief, Planning Branch

Attachment A

Approvals and

Aquatic Resource Alteration Permit

From: RUSS RANGOS
To: X400.MCX(Gesling-Raymond-T-CEORD-ET-PF,Furman-Rich...
Date: 07/02/96 (Tue) 22:43pm
Subject: JONESBOROUGH, TN SEC205 091748

We have committed construction funds for the subject project. After satisfying appropriate environmental and regulatory requirements, you are authorized to execute the PCA and advertise for bids.

The baseline award date for project construction is 13 December 1996, and the baseline cost is $870,300.

Mr. Lancaster, ASA(CW), will notify the Congressional delegation of this action. He has directed that the Nashville District Engineer keep the delegation informed of future progress on the project.

CC: Sue L Ferguson

From: RUSS RANGOS
To: X400.MCX(Gesling-Raymond-T-CEORD-ET-PF,Furman-Rich...
Date: 07/02/96 (Tue) 22:43pm
Subject: JONESBOROUGH, TN SEC205 091748

We have committed construction funds for the subject project. After satisfying appropriate environmental and regulatory requirements, you are authorized to execute the PCA and advertise for bids.

The baseline award date for project construction is 13 December 1996, and the baseline cost is $870,300.

Mr. Lancaster, ASA(CW), will notify the Congressional delegation of this action. He has directed that the Nashville District Engineer keep the delegation informed of future progress on the project.

CC: Sue L Ferguson

----------Forwarded----------

From: X400.MCX.Rangos-Russ-CECW-PM

To: X400.MCX.Gesling-Raymond-T-CEORD-ET-PF,
X400.MCX.Furman-Richard-J-CEORD-ET-PF,
X400.MCX.Wilson-Ron-L-CEORD-DL-P

cc: X400.MCX.Kitch-Harry-E-CECW-PC,
X400.MCX.Sherman-Rennie-H-CECW-PM,
X400.MCX.Smith-Richard-3-CECW-PM,
X400.MCX.Fitzsimmons-Cliff-L-CENPW-PL-PF,
X400.MCX.Ferguson-Sue-L-CEORN-EP-P

Subject: JONESBOROUGH, TN SEC205 091748

CEORD-PE-PF (CEORD-PE-PF/12 Jul 94) (1105) 2nd End
Mr. Butcher/3159
SUBJECT: Detailed Project Report/Environmental Assessment, Little Limestone Creek, Jonesborough, Tennessee, Section 205 CWIS 91748

DA, Corps of Engineers, Ohio River Division, P.O. Box 1159, Cincinnati, OH 45201-1159 26 August 1994

FOR Commander, Nashville District

Approval to proceed to plans and specs on the subject study is referred for your action. Funds will be provided by separate correspondence.

BETTY MAE E EBERHARDT
Chief, Planning Division

CECW-PE (CEORN-EP-P/1 Apr 94) 1st End HARDESTY/272-1723/gmh
SUBJECT: Section 205, Detailed Project Report and Environmental Assessment, Little Limestone Creek, Jonesborough, Tennessee, (CWIS #91748)

HQ, U.S. Army Corps of Engineers, Washington, D.C. 20314-1000

FOR Commander, Ohio River Division, ATTN: CEORD-PE-PS 11 AUG 1994

1. We approve the initiation of plans and specifications for the subject project. Funds required for the preparation of plans and specifications will be provided by separate correspondence.

2. The deviation to the model LCA, which was submitted to HQUSACE on 8 July 1994, is currently under review in this office.

wd all encls

HARRY E. Kitch, P.E.
Acting Chief, Planning Division
Directorate of Civil Works

CORPS OF ENGINEERS
P. O. BOX 1159
CINCINNATI, OHIO 45201-1159

REPLY TO
ATTENTION OF

CEORD-PE-PF (1105) 12 July 1994

MEMORANDUM FOR CDRUSACE (CECW-PE), 20 Mass. Ave. N.W., WASH DC 20314-1000

SUBJECT: Detailed Project Report/Environmental Assessment, Little Limestone Creek, Jonesborough, Tennessee, Section 205 (CWIS #91748)

1. The subject report has been approved by this office. A copy of the project Fact Sheet, an information copy of the report, and our approval letter to the district are enclosed.

2. Request that Nashville District be authorized to begin plans and specifications and that the district be funded $40,000 to initiate this work.

3 Encls

BETTY MAE E. EBERHARDT
Chief, Planning Division

NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO

CEORN-EP-P (1105-2-10b) 1 April 1994

MEMORANDUM FOR Commander, Ohio River Division, ATTN: CEORD-PE-PS, P.O. Box 1159, Cincinnati, Ohio 45201-1159

SUBJECT: Detailed Project Report/Environmental Assessment, Little Limestone Creek, Jonesborough, Tennessee, Section 205 (CWIS #91748)

1. Enclosed are 5 copies of subject report and fact sheet. The District's Technical Review Committee (TRC) has reviewed the report; technical assurance certificaion is also enclosed.

2. The enclosed draft Project Cooperation Agreement (PCA) has one minor deviation. The term betterment was added to reflect the Sponsor's intention to "buy up" to a higher level of protection.

3. The final plans consisted of adding culvert capacity on the unnamed tributary to provide 25-, 50-, and 100-year protection. All three plans had the same basic components - a training dike, culvert, open outlet channel and bank protection along Little Limestone Creek. The 25-year plan produced the highest net benefits and was designated the NED plan.

4. The town of Jonesborough, however, is willing to pay the additional costs of the 50-year plan. This locally preferred plan is recommended. The federal cost of the project is $484,800, while the nonfederal cost is $238,000 including $76,400 for the betterment.

5. I recommend that the project be approved for construction and that the District be funded $100,000 in FY 94 to begin plans and specifications. A total of $32,700 will be needed in FY 95 to complete them, advertise and award the project. Plans and specifications are scheduled to begin in June and be completed in October.

Encls

J. DAVID NORWOOD
LTC, Corps of Engineers
Commanding

Received 12/09/02

TENNESSEE DEPARTMENT OF ENVIRONMENT & CONSERVATION
Division of Water Pollution Control
401 Church Street
7th Floor, L & C Building
Nashville, TN 37243-1534

December 4, 2002

Certified Mail Receipt # 7000 0600 0024 8552 0038

Town of Jonesborough
Mr. Robert Browning, Town Administrator
123 Boone Street
Jonesborough, TN 37659

Re: Aquatic Resource Alteration Permit; NRS File #02.409
General Permit for the Alteration of Wet Weather Conveyances
Unnamed Tributary to Little Limestone Creek, Washington County, Tennessee

We have reviewed your application for the referenced alteration of a wet weather conveyance. This activity is regulated by the *Tennessee Water Quality Control Act of 1977*, T.C.A. § 69-3-101 et seq., and the *General Permit for the Alteration of Wet Weather Conveyances*. The work is hereby approved for construction. The work must be accomplished in conformance with approved plans, specifications, data, and other information submitted in support of the referenced application and the limitations, requirements, and conditions set forth in the *General Permit for the Alteration of Wet Weather Conveyances* (enclosed).

The activity may not result in the discharge of waste or other substances that may be harmful to humans or wildlife. Please be advised that alterations to wet weather conveyances cannot cause pollution to other waters of the State. In addition, adequate erosion controls must be installed prior to construction and maintain during construction of the project. All disturbed areas must be revegetated or otherwise stabilized upon completion of construction. A copy of this permit must also be provided to the contractor(s) performing the work and a copy must be kept onsite during all work activities. Please make the necessary provisions for these circumstances.

The work may also require authorization from the U. S. Army Corps of Engineers. They may be reached at 615-369-7500. **This authorization is valid for one year from the date of this letter.** If you need additional information or clarification, please contact Eric Chance at 615-253-2245.

Thank you,

Dan Eagar
Manager, Division of Water Pollution Control
Natural Resources Section

Cc:
Eric Chance, WPC
File copy

TENNESSEE DEPARTMENT OF ENVIRONMENT & CONSERVATION
Division of Water Pollution Control
401 Church Street
7th Floor, L & C Building
Nashville, TN 37243-1534

December 4, 2002

Certified Mail Receipt # 7000 0600 0024 8552 0038

Town of Jonesborough
Mr. Robert Browning, Town Administrator
123 Boone Street
Jonesborough, TN 37659

Re: Aquatic Resource Alteration Permit; NRS File #02.409
General Permit for Bank Stabilization Activities
Little Limestone Creek, Washington County, Tennessee

We have reviewed your application for the referenced bank stabilization activity. This activity is regulated by the *Tennessee Water Quality Control Act of 1977*, T.C.A. § 69-3-101 et seq., and the *General Permit for Bank Stabilization Activities*. The work is hereby approved for construction. The work must be accomplished in conformance with approved plans, specifications, data, and other information submitted in support of the referenced application and the limitations, requirements, and conditions set forth in the *General Permit for Bank Stabilization Activities* (enclosed).

The placement of riprap is limited to three hundred (300) linear feet of stream bank. Please note that unnecessary vegetation removal is prohibited. In addition, adequate erosion controls must be installed prior to construction and maintained during construction of the project. All disturbed areas must be revegetated or otherwise stabilized upon completion of construction. A copy of this permit must also be provided to the contractor(s) performing the work and a copy must also be kept onsite during all work activities. Please make the necessary provisions for these circumstances.

The work may also require authorization from the U. S. Army Corps of Engineers. They may be reached at 615-369-7503. **This authorization is valid for one year from the date of this letter.** If you need additional information or clarification, please contact Eric Chance at 615-253-2245.

Thank you,

Dan Eagar
Manager, Division of Water Pollution Control
Natural Resources Section

Cc:
Eric Chance, WPC
File copy

GENERAL PERMIT FOR BANK STABILIZATION ACTIVITIES

This general permit allows the repair and protection of eroded stream banks. Bank stabilization activities typically include grading of the stream bank to the appropriate slope in conjunction with placement of riprap or application of bioengineering techniques. Bioengineering involves the use of cedar tree revetments, rock or log current deflection weirs, live willow post application, log crib structures and other techniques that incorporate primarily materials found in the natural riparian environment. Bio-engineering is the preferred method and is permitted without notification where no work is done instream with mechanized equipment or where the work is done in accordance with an approved bio-engineering plan from the United States Department of Agriculture, Natural Resource Conservation Service. Bank stabilization activities are hereby permitted provided the activity is done in accordance with the terms and conditions below.

Exclusions

This general permit cannot be used to authorize work in the following circumstances:

(a) where wetlands will be adversely affected by the proposed work;

(b) when the activity is located in any waterway which is identified by the Department as having contaminated sediments, and where the proposed work will likely mobilize the contaminants;

(c) when the project will adversely affect a species formally listed on State or Federal lists of threatened or endangered species; or

(d) when an individual permit is required.

Bank stabilization projects not qualifying for authorization by this general permit may be authorized by individual permit provided all requirements of the *Tennessee Water Quality Control Act of 1977* are met.

Notification

1) No notification to the Division is required where the length of stream bank to be treated is less than three times the top-of-bank width of the stream channel, not to exceed a total length of fifty feet, and where the total volume of soil, sand or gravel disturbed or re-deposited is less than ten cubic yards. Bank stabilization work conducted in accordance with this provision is limited to one site per 1000 linear feet of stream, and may be done only once without notification.

2) No notification to the Division is required where the work is done and maintained in accordance with a bio-engineering plan developed or approved by the United States Department of Agriculture, Natural Resource Conservation Service, or where recognized bio-engineering techniques are used and no work is done instream with mechanized equipment.

3) Notification to the Division is not required where the activity is located within water resource development project lands and waters, including flowage easement, managed by the Tennessee Valley Authority or the U. S. Army Corps of Engineers. However, prior to commencement of construction, the applicant must have received any necessary authorizations pursuant to applicable provisions of §10 of *The Rivers and Harbors Act of 1899*, §404 of *The Clean Water Act* and §26a of *The Tennessee Valley Authority Act*.

4) Except as provided in item one of this section, notification must be submitted to the Division where the primary bank protection is not conventional bioengineering techniques and the activity is not located within water resource development project lands and waters, including flowage easement, managed by the Tennessee Valley Authority or the U. S. Army Corps of Engineers. Notification shall be in the form of an original, signed document which includes the following minimum information:

   (a) a map showing the exact location of the proposed work; and

11) Adverse impact to formally listed state or federal threatened or endangered species or their critical habitat, or to cultural, historical, or archeological features or sites is prohibited.

Effective Date	July 1, 2000	APPROVED: Daniel C. Cogan
Expiration Date	June 30, 2005	for Paul Davis, Director

DETAILED PROJECT REPORT

AND

ENVIRONMENTAL ASSESSMENT

Section 205, Flood Control

LITTLE LIMESTONE CREEK & TRIBUTARY

JONESBOROUGH, TENNESSEE

Nashville District
Corps of Engineers

March 1994

DETAILED PROJECT REPORT AND ENVIRONMENTAL ASSESSMENT

Section 205, Flood Damage Reduction

LITTLE LIMESTONE CREEK & TRIBUTARY JONESBOROUGH, TENNESSEE

Table of Contents

Paragraph		Page
	Section 1 - The Study and Report	
1.01	Scope of Study	1
1.02	Authority of Study	1
1.03	Description of Study Area	2
1.06	Contents of Report	2
1.07	Local Interest and Support	3
1.09	Coordination	3
1.10	Earlier Studies and Reports	3
	Section 2 - Resources and Economy	
2.01	Stream Description	4
2.04	Climate	5
2.05	Physiography and Geology	5
2.05	Physiography	5
2.07	Bedrock	5
2.09	Overburden	6
2.11	Groundwater	6
2.14	Environmental Setting	6
2.15	Historical Setting	6
2.16	Economy	7
2.16	Population	7
2.17	Employment	7
2.18	Transportation	7

Table of Contents (Con't)

Paragraph		Page
6.08	Environmental and Cultural Resources Analysis	21
6.10	Views of Sponsor	21
6.11	Risk and Uncertainty	21

Section 7 - The Selected Plan

7.01	Selection	23
7.02	Cost Sharing	24
7.03	Description	25
7.03	Culvert and Trench	25
7.04	Relocations	25
7.05	HTRW	25
7.06	Training Dike and Inlet	26
7.07	Outlet	26
7.08	Headwalls	27
7.09	Real Estate Requirements	27
7.11	Environmental and Cultural Considerations	28
7.11	Environmental Setting	28
7.12	Endangered Species	28
7.13	Environmental Impacts	28
7.14	Cultural Resource Impacts	29
7.17	Project Implementation Schedule	30
7.19	Construction Impacts	30

Section 8 - Conclusions and Recommendations

8.01	Conclusions	32
8.02	Recommendations	32

Table of Contents (Con't)

Environmental Assessment

List of Appendicies

A - Project Economics
B - Hydrology and Hydraulics
C - Geotechnical Assessment
D - Relocations
E - Design
F - Real Estate
G - Project Costs
H - HTRW Phase I Environmental Site Assessment

DETAILED PROJECT REPORT AND
ENVIRONMENTAL ASSESSMENT
Section 205, Flood Damage Reduction

LITTLE LIMESTONE CREEK & TRIBUTARY JONESBOROUGH, TENNESSEE

Section 1 - The Study and Report

Scope of Study

1.01 This report addresses the feasibility of options to alleviate flood damages from Little Limestone Creek and its unnamed tributary within the town of Jonesborough. The seat of Washington County, Jonesborough is in the extreme northeastern corner of Tennessee, 6 miles south of Johnson City and within 30 miles of the Virginia and North Carolina state lines. See Figure 1. Flooding, typically the result of heavy thunderstorms in the late summer, has been a persistent problem. Intense rainfall, combined with steeply sloped terrain and extensive basin development are the main ingredients for flooding. The last major flood occurred in August 1977 when six downtown businesses sustained considerable damage. In the early 1980's, the town, working with the Tennessee Valley Authority, improved Little Limestone Creek providing flood relief to much of downtown. Flooding from Little Limestone Creek and its unnamed tributary still poses a significant threat with potential damages averaging almost $95,300 annually.

Authority

1.02 This report was prepared under the authority of Section 205 of the 1948 Flood Control Act, as amended. Feasibility study costs are being shared in accordance with the Water Resources Development Act of 1986 (P.L. 99-662). The Feasibility Study Cost Sharing Agreement (Exhibit 1) was executed on August 27th, 1992.

Local Interest and Support

1.07 Local interest and support for this project is strong. The town's commitment to addressing Jonesborough's flooding problems is quite evident. The town has paid 50 percent of the costs of this feasibility study. In addition, the town made several improvements to Little Limestone Creek (with the assistance of TVA) including the purchase and demolition of two buildings.

1.08 The recommendations contained in this report were presented to Jonesborough's mayor, aldermen, and interested citizens at a board meeting on January 31, 1993. An updated letter of support is included as Exhibit 2.

Coordination

1.09 Scoping letters were sent on July 22, 1991 to the following agencies: Tennessee State Planning Office, Tennessee Wildlife Resources Agency, U.S. Fish and Wildlife Service, Tennessee Conservation League, Tennessee Historical Commission, State Historic Preservation Officer (SHPO), Advisory Council on Historic Preservation (ACHP), U.S. Environmental Protection Agency, Tennessee Department of Environment and Conservation, Tennessee State Conservationist, Agricultural Stabilization and Conservation Service, and Tennessee Valley Authority. The scoping letter and all responses are included in the Environmental Assessment. The U.S. Fish and Wildlife Service did not anticipate that the project will cause significant environmental impacts. The SHPO concurred that the project will not adversely affect properties eligible for or listed in the National Register of Historic Places. The ACHP did not object to the finding of no adverse effect. Coordination with the Town of Jonesborough included discussions with the Town Administrator and a public information workshop held on January 31, 1994..

Earlier Studies and Reports

1.10 Previous studies and reports include the precursor to this feasibility - a reconnaissance report completed by the Nashville District in January 1991. The "Flood Insurance Study, Town of Jonesborough, Washington County, Tennessee" was published by the Federal Emergency Management Agency on March 30, 1982.

1.11 A report entitled "Flood Damage Reduction Study, Town of

overtopped when the culvert headwater exceeds elevation 1691.5. The capacity of the culvert with this headwater is less than the discharge of the 2-year event.

Climate

2.04 The climate of the area is characterized by warm humid summers and relatively mild winters. The hottest month typically is July with an average temperature of 75 degrees Fahrenheit. The coldest month is January with an average temperature of 35 degrees Fahrenheit. Precipitation averages 41.5 inches yearly. The highest average monthly precipitation, 4.98 inches, occurs in July; the lowest precipitation, 2.25 inches, occurs in October.

Physiography and Geology

2.05 **Physiography** - Jonesborough and Washington County are within the Valley and Ridge physiographic province. This province is an area of northeast to southwest trending, parallel valley lowlands and narrow ridges that extends over 1200 miles from the Saint Lawrence Valley to Alabama. In Tennessee its average width is about 40 miles.

2.06 Stream courses are closely related to the structure and composition of the underlying rocks. A fault trellis drainage pattern, a system of subparallel streams aligned along the strike of the rock formations, has developed in the area. Most of the smaller streams are located in the northeast to southwest trending valleys.

2.07 **Bedrock** - The Valley and Ridge province is underlain almost entirely by sedimentary rocks deformed by folding and faulting that occurred at the end of the Paleozoic era, about 230 to 260 million years ago. A series of parallel thrust faults has brought together alternating bands of strong and weak rock. The resulting surface outcrop is a repetitive sequence of essentially parallel belts that strike northeast to southwest.

2.08 Bedrock is Upper Cambrian and Lower Ordovician carbonate rocks of the Knox Group. The Knox is composed of interbedded bluish-gray limestone and dolomite containing varying amounts of sand and clay. Beds range from a few inches to several feet in thickness and generally dip to the southeast at 15 to 40 degrees. Local variations occur where the strata have been folded or overturned by thrust faulting.

home of President Andrew Jackson and was visited by many other presidents. It was here in the Washington County courthouse that Andrew Jackson was admitted to the bar, and, a few years later, presided as judge. A walk through the downtown historic district presents one with a mix of historical events and a blend of architectural styles. The roots of Tennessee and America as a Nation are deeply embedded in the mountainous terrain of the area known as the "First Tennessee." Its rich heritage and significant role in the settlement of the Southwest Territory make Jonesborough and the Upper East Tennessee region a unique resource for historians, preservationists, and the restoration community.

Economy

2.16 **Population** - Washington County's population was over 91,000 in 1987. The population within a 300 mile radius is about 33.5 million. Jonesborough has a population of 3,500.

2.17 **Employment** - Total employment for Washington County reached 51,850 through 1987, a 33 percent increase from 1970. The state of Tennessee's total employment increased 29 percent during the same period. Manufacturing and service industries each comprise about 20 percent of the total work force in the county. Washington County's unemployment rate averaged 6.0 and 5.5 percent in 1987 and 1988, respectively. The state average was 5.8 for 1988.

2.18 **Transportation** - Washington County, Jonesborough and Johnson City all have adequate transportation facilities that tie in with other counties in the area. Interstate 81 and numerous U.S. and state highways along with various county roads provide excellent transportation. The area is served by the Tri-Cities Regional Airport located just north of Johnson City.

Section 3 - Problems and Needs

History of Flooding

3.1 Flooding has been recorded in Jonesborough since 1901. However, detailed information on flood damages is sketchy. With steep valleys, a high level of development, and low level of forestation, flash floods are typical for the Little Limestone Creek Basin. Generally floods are the result of localized, severe thunderstorms in mid-summer. The largest known flood on Little Limestone Creek occurred in June 1928. It had a recurrence interval of about

Table 1 - Existing Conditions
Average Annual Damages

Little Limestone Creek	$ 9,400
Unnamed Tributary	$ 85,900
Total	$ 95,300

Table 2 - Existing Conditions
Damages by Event

Event	2-yr	10-yr	50-yr	100-yr	500-yr
Little Limestone Creek	$2,293	$15,416	$60,622	$80,231	$192,341
Unnamed Tributary	$86,362	$125,946	$158,618	$175,055	$208,870
Total	$88,655	$141,362	$219,240	$255,286	$401,211

Future Conditions

3.04 Jonesborough is within the metropolitan area of Johnson City. The drainage basin of the unnamed tributary encompasses U. S. Highway 11E, the main connector to Johnson City. Further development will likely occur within the basin of the unnamed tributary. However, the town's stormwater ordinances require new development to provide stormwater detention. As long as the town enforces those ordinances, runoff within the basin of the unnamed tributary will not significantly increase flooding.

Section 4 - Plan Formulation

Study Objectives

4.01 The federal objective in water and related land resource planning is to contribute to the national economic development (NED) consistent with

insurance policies, flood forecasting and warning, flood proofing, small ring levees, raising in place, or permanent evacuation of the floodplain. Structural measures actually reduce or eliminate flood depths in problem areas. They may include dams and reservoirs, levees and floodwalls, bridge modifications, channel modifications, channel enlargement or clearing and snagging.

4.06 **Nonstructural** - None of the nonstructural measures described above can address the flooding problems in the town of Jonesborough. The town already participates in the flood insurance program and has floodplain ordinances. Flood forecasting and warning are not feasible because of the small drainage area and the rapid rate of rise of the stream being studied. Little time is available to respond to warnings. Flood proofing, ring levees, and raising in place are inappropriate because of the type of construction and historic nature of the structures being protected. In addition, ring levees and flood proofing require closure structures that necessitate a considerable warning time to be placed. The historic nature of the structures also eliminates permanent evacuation of the floodplain from serious consideration.

4.07 **Structural** - Only one of the structural measures described above could address the problems at Jonesborough. On the unnamed tributary there are no bridges that impede the stream flow or debris that clogs the channel. Thus, bridge modifications and clearing and snagging are not viable alternatives. Levees and floodwalls are impractical for several reasons - 1) there is very little unoccupied space in the area, 2) levees and floodwalls would degrade the historic quality of the town, and 3) the unnamed tributary would have to be virtually encircled. Upstream detention is not feasible because the drainage area of the unnamed tributary is highly developed and there is no suitable site for storage of flood waters.

4.08 Modification of the existing culvert is impractical because of its small capacity and its close proximity to numerous buildings. The capacity of the existing culvert would have to be more than doubled to carry the 10-year event. There is not physically enough room to add this amount of capacity without impacting building foundations and many utilities. Thus, adding a new culvert in the vicinity of the existing culvert is the only practicable alternative.

parallel to the existing culvert has the advantage of minimizing traffic impacts. However, it would travel beneath two buildings - the Exxon Station and Old Town Hall. The uncertainties associated with impacting the foundations of these buildings renders an alignment parallel to the existing culvert infeasible. Both Boone/Spring Street alignments avoid major impacts to buildings, however, they impact traffic and utilities. The straight alignment significantly impacts an underground optic fiber telephone line. Relocation of this line would cost roughly $75,000. The curved alignment avoids the optic fiber telephone line, but clips the edge of the Exxon Station in an area that previously contained underground tanks for gasoline storage. If all the material to be excavated beneath the Exxon Station is contaminated, special disposal would cost roughly $40,000, considerably less than the sure cost of relocating the optic fiber telephone line. Thus, the curved alignment is selected.

4.11 **Construction Materials** - The study team evaluated three discreet options for constructing the additional culvert. All but one were eliminated due to physical restrictions at the site (i.e. very limited vertical and horizontal space). The first option is polyethylene pipe. Although polyethylene pipes are flexible and easy to work with, they require a minimum of three feet of cover to support a roadway. Only seven feet of vertical space is available at the downstream end and a 6-foot diameter pipe is needed. Thus, polyethylene pipe was eliminated from further study due to cover requirements. Cover requirements for reinforced concrete pipe (RCP) preclude its use for the 50- and 100-year designs, but might be feasible for the 25-year design. In addition, compared to a cast in place concrete box, the RCP requires a larger trench to carry the same amount of flow. Based on trench width limitations and cover requirements, the RCP was eliminated from further study. Reinforced box culverts (RCBC), although more expensive, can be constructed within available vertical and horizontal space.

Section 5 - Final Plans

Development

5.01 In the third phase of plan formulation, the best intermediate alternatives are refined, evaluated, and compared in detail. The environmental, social, and national economic aspects of the plans are given full consideration. The plan that reasonably maximizes net economic development benefits (calculated by subtracting the annual costs of the alternative from its annual benefits) consistent

5.05 **Culvert** - The culvert follows a curved alignment. It begins at the north edge of Sabin Street, crosses Sabin and the front corner of the Exxon Station, travels down the middle of Boone Street, crosses Main Street at a slight angle barely clipping the sidewalk on the southwest corner, then proceeds down Spring Street to the open channel. Photographs on Figure 7 show a majority of the alignment. The culvert will be constructed of 1-foot thick, cast-in-place, reinforced concrete. The inlet of the box is at Elevation 1685.75 and the outlet is at 1682.00. The construction trench is 20 feet wide with vertical side slopes. Depth ranges from 8 to 19 feet. About 4500 cubic yards of material will be removed from the trench and stockpiled for backfill. Due to depth of cut and alluvium soils, shoring will be used along the entire trench. Standard plank shoring will be used except along the southwest corner of Main Street where the trench comes close to the foundation of the Old City Hall. Steel sheet piling will be used here. Construction of this alternative will require relocation or modification of numerous utilities including natural gas lines, sanitary sewers, water lines, and underground telephone and electric lines.

5.06 **Training Dike/Levee** - This component serves several functions. It trains or directs the flow of the unnamed tributary into both the new and existing culverts, at the same time preventing flood waters from reaching damageable structures downstream. In addition, the head or pressure created by the ponded flood waters increases the capacity of both culverts. The training dike/levee will be constructed of compacted clay and covered with grass. Side slopes will be gentle (3H:1V) to facilitate mowing. The dike will have a crest elevation of 1694.5 near Sabin Street, extending up to elevation 1695.0 near the visitor center. The dike will be about 325 feet long with a 1-foot top width. Its height averages 3 feet, varying from less than 1 foot to just under 7 feet. About 400 cubic yards of material, to be obtained at the inlet and outlet of the culvert, will be used to construct the dike along Sabin and Boone Streets right of ways. The area behind the dike is open, grassy and park like. Figure 8 includes photographs of the construction and ponding area. The first floor elevations of all structures behind the dike are above its crest by more than one foot and are well above the 500-year elevation for all plans considered..

5.07 Once the dike is constructed, the four existing 36-inch culverts must be extended through it. New concrete headwalls will be constructed at the inlet of these extensions and at the new culvert. One 80-foot long headwall is designed to serve both the new culvert and two existing precast concrete pipes. A separate headwall is needed for the other set of pipes. In addition, the invert of

reinforced box, 6 feet high and 6 feet wide. The trench for Alternative C would be 13 feet wide with depths similar to the other plans. About 2,300 cubic yards of material would be removed from the trench and be stockpiled for backfill. The outlet headwall would be about 8 feet wide and 8 feet high with very little exposed concrete. The combined headwall for the new and existing culverts would be shortened to about 73 feet.

Section 6 - Plan Evaluation

Hydraulic Performance

6.01 Alternative A would eliminate overflow from the unnamed tributary for all flows up to and including the 100-year event. For the 500-year event, Alternative A would reduce overflow by about 70%. Alternative B would eliminate overflow for the 2, 5, 10, 25, and 50 year events while overflow for the 100 and 500 year events would be reduced by about 81 and 57 percent, respectively. Alternative C would eliminate overflow for the 2, 5, 10 and 25-year events while reducing overflow from the 50-year event by 75 percent, the 100-year event by 68 percent and the 500-year event by 43 percent. All of the alternatives would improve the flow characteristics of Little Limestone Creek.

Economic Performance

6.02 Table 4 displays the number of structures sustaining damages under the with and without project scenarios. As discussed under existing conditions, 10 of the structures assigned to the unnamed tributary are also impacted by floods on Little Limestone Creek. Under the without project condition, only damages from the unnamed tributary are displayed. However, to accurately report the benefits and residual damages of the alternatives, damages to these structures from Little Limestone Creek are included for each alternative. None of the alternatives impact flooding of the two structures located upstream of Highway 11E.

6.03 As would be expected, Alternative A (100-year culvert) protects the greatest number of structures, has the smallest residual damages and the greatest benefits. Alternative A would eliminate flooding from the unnamed tributary in downtown Jonesborough through the 100-year event. However, damages beginning about the 25-year event would continue to three structures from Little Limestone Creek flooding. Seven structures now receiving damages at about a 2-year frequency would receive complete protection from a 100-year flood event. Average annual benefits are $84,135.

6.04 The amount of protection provided by Alternative B, the 50-year culvert, is similar to that provided by the 100-year culvert. Alternative B would eliminate tributary flooding in downtown Jonesborough through the 50-year event. Six structures (compared to seven for Alternative A) now receiving damages at about the 2-year event would receive complete protection through the 100-year event, and seven would receive protection through the 50-year event. The average annual benefits of Alternative B are $83,780, only $355 less than those of Alternative A.

6.05 Alternative C, provides considerably less protection than Alternatives A and B in both number of structures protected and average annual damages. With Alternative C, only three structures would receive protection from the 50- and 100-year events. Average annual benefits are $81,930, $1,850 less than Alternative B and $2,205 less than Alternative A.

Cost Comparison

6.06 Table 5 displays the costs of the alternatives including the first or construction cost, investment costs, annual maintenance costs, and total annual project costs. Construction costs were estimated using the MCACES Gold software program in accordance with EM 1110-2-1301, "Cost Estimates - Planning and Design Stages". The costs used in preparing the estimates were developed in detail or derived from historical data. The estimates include 18 percent overhead and 10 percent profit. Contingencies varied for each item based on the judgement of the estimator and design team. Investment costs represent the sum of the construction cost for each alternative and accrued interest. Maintenance costs were estimated on an average annual basis and are included in the total annual costs. Detailed estimated are included in Appendix G, Project Costs. Maintenance activities include mowing the training dike seasonally, inspecting and repairing culvert joints, and inspecting and

Table 6 - Cost-Benefit Comparison

Costs/Benefits	Alternative A 100-yr	Alternative B 50-year	Alternative C 25-year
Av. Annual Cost	$74,380	$63,467	$56,726
Av. Annual Benefit	$84,153	$83,780	$81,930
Benefit Cost Ratio	**1.1**	**1.3**	**1.4**
Net Benefits	**$9,755**	**$20,313**	**$25,204**

Environmental and Cultural Resources Analysis

6.08 From an environmental resources perspective, there is virtually no difference between the with project alternatives. The main design features of all three alternatives are the same with only small variances in the amount of trench and outlet channel excavation.

6.09 The Jonesborough flood control project will result in the protection of valuable and irreplaceable structures within the Jonesborough Historic District. Alternative A provides the maximum protection and is the preferred alternative from a cultural resources standpoint Alternative C, providing only 25-year protection is the least preferred alternative.

Views of Sponsor

6.10 A meeting with the Mayor, Board of Aldermen, and interested citizens of Jonesborough was held January 31, 1994 to discuss the results of this study. The Corps' planning process and plan selection criteria were briefly explained, followed by a description of the recommended plan and questions and answers. Exhibit 3 contains a memorandum of the meeting including comments from the public and our responses. The Board of Aldermen voted to pursue the 50-year plan.

Risk and Uncertainty

6.11 This study, like all flood control studies, contains aspects involving risks and uncertainty. Uncertainties arise from measurement errors and from the

Table 7 - Net Benefit Sensitivity

Options	Alternative A 100-year	Alternative B 50-year	Alternative C 25-year
Lower 0.25'			
Benefits	$99,876	$99,473	$97,400
BCR	1.3	1.6	1.7
Net Benefits	$25,496	$36,006	$40,674
Raise 0.25'			
Benefits	$69,410	$69,102	$67,489
BCR	0.9	1.1	1.2
Net Benefits	($4.970)	$5,635	$10,763
Lower 0.5'			
Benefits	$115,216	$114,758	$112,460
BCR	1.5	1.8	2.0
Net Benefits	$40,836	$51,291	$55,735
Raise 0.5'			
Benefits	$56,107	$55,845	$54,591
BCR	0.8	0.9	1.0
Net Benefits	($18,273)	($7,622)	($2,234)

Section 7 - The Recommended Plan

Selection

7.01 Based on a close consideration of the merits of each alternative, Alternative C, the 25-year culvert, is the NED plan. It maximizes net economic development benefits, balances the risks and uncertainties associated

Table 8 - Federal and Nonfederal Costs of The Locally Preferred Plan

Item	Federal	Nonfederal Cost
Lands and Damages		$36,100
Relocations		$67,200
Total LERRD		$103,300
Construction	$484,800	$134,700
TOTALS $722,800	$484,800	$238,000

Description

7.04 **Culvert and Trench** - The recommended plan consists of a single reinforced concrete box culvert 6 feet wide and 8 feet high, a training dike constructed of compacted clay at the inlet of the culvert, an open outlet channel and bank protection along Little Limestone Creek as shown on Figure 6B. The box culvert will be constructed in a 15-foot wide open trench with vertical side slopes varying in depth from 8 to 19 feet. Wooden shoring will be required the entire length of the trench except at the corner of Spring and Main Streets where sheet pile shoring may be required to stabilize the foundation of the 1 1/2 story building. The culvert walls will be 1 foot thick and placed on 4 inches of granular fill. The 3000 cubic yards of material to be removed from the trench is assumed to be 80 percent alluvium and 20 percent rock. All rock removal will be done without blasting. The excavated material will be stockpiled and used to backfill the trench upon completion of the culvert.

7.05 **Relocations** - Numerous utilities will be encountered along the trench. Relocation of the following utilities will be required during construction: 175 feet of natural gas lines, 150 feet of sanitary sewer lines (including 3 manholes), 45 feet of storm sewers (including the addition of 2 gate valves and 2 flap gates), 320 feet of water lines (including 4 valves), 155 feet of 200 pair underground telephone lines, and 70 feet of underground electric lines.

7.06 **HTRW** - An Hazardous, Toxic, and Radioactive Waste (HTRW) Phase I

connects to Little Limestone Creek. The channel will be 8 feet wide at its base with side slopes of 1.5H:1V. Excavation and minor shaping will also be needed. Precast, concrete interlocking blocks will be placed in the outlet channel and on the banks of Little Limestone Creek to prevent scouring and improve flow. Solid blocks will be used to line the channel, while hollow blocks, backfilled with soil and planted with grass, will be used on the banks. About 55 linear feet of protection (20 feet upstream and 25 feet downstream of the outlet) will be placed on each bank of Little Limestone Creek. Filter fabric is required beneath the blocks. The outlet will be constructed through a well-maintained grassy slope.

7.09 **Headwalls** - The inlet headwall for the 50-year culvert is designed to be integral with a replacement headwall for two existing precast concrete pipes that have inlets near the new culvert. The headwall is designed as a retaining wall using CRSI design tables with level type "C" soil conditions. It has a total length of 75.5 ft and a height of 9 feet. Slush grouted riprap will be used at the entrance of the culvert instead of a concrete apron. A special headwall will be constructed at entrance of the second set of existing culverts (where a 36-inch corrugated metal pipe and a 36-inch precast concrete pipe cross under Sabin Street). The wingwalls of this headwall will be configured to conform to the right-angle bent in the dike.

7.10 **Real Estate Requirements** - The local sponsor, the Town of Jonesborough, is responsible for all lands, easements, rights-of-way, and relocations (LERRDs) for the project plus the difference in the costs of the 25- and 50-year plans. Before construction, the town of Jonesborough and the government will execute a Project Cooperation Agreement (PCA). There are no relocations under P.L. 91-646. No navigational servitude or federally owned lands are affected by the project.

7.11 The project requires about 0.35 acres of permanent easement and about 1.0 acres of temporary work easement. One private ownership, at the intersection of Sabin and Boone Streets, is affected by the project. A work area easement over 0.04 acres and a pipeline easement over 0.03 acres must be acquired from the Exxon Station. The remaining lands needed for the project (0.96 acres of work area and 0.32 acres of pipeline easement) are now owned in fee by the town of Jonesborough and used as a library, tourist information center, and a public park/playground or dedicated as roads and streets. Jonesborough currently has sufficient interests in these areas to grant a right-of-

None of the alternatives would impact any known endangered species. In addition, no designated wetlands or unique prime farmlands would be adversely impacted.

Cultural Resource Impacts

7.16 Construction of the proposed structural flood control measures (all three alternatives) for the Jonesborough community will be confined to areas almost entirely within the Jonesborough Historic District. The Corps has consulted with the Tennessee State Historic Preservation Officer (SHPO) with the resulting determination that the proposed project will have an effect on the Jonesborough Historic District. Construction will take place; however, in an area that is traversed on the surface by several streets and below the surface by a network of utilities. A small berm or training dike will be constructed at the inlet, and the outlet will require the use of precast, concrete interlocking blocks to prevent scouring by high velocities and turbulent flow. Construction disturbance in the project area will be temporary and, excepting the inlet and outlet of the culverts, surface areas will be returned to their original use and appearance. The Corps and the Tennessee SHPO have concurred in the opinion that any of the three proposed flood control projects for Jonesborough will have an effect on the Jonesborough Historic District, however, that effect will be temporary and not adverse.

7.17 Pursuant to requirement of Section 106 of the National Historic Preservation Act as implemented by regulations at 36 CFR 800, the Corps of Engineers is required to identify properties in project impact areas which are either listed or eligible for listing on the National Register of Historic Places, assess potential effects to those properties, to consult with the State Historic Preservation Officer (SHPO) concerning identified effects, and to seek the comments of the Advisory Council on Historic Preservation (ACHP) should project effects be determined not adverse or adverse. The Tennessee SHPO's no adverse effect determination was provided to the ACHP for their review and comment. The council, by letter dated February 8, 1994, did not object to the no adverse effect determination; therefore, the Corps' responsibilities under Section 106 of the National Historic Preservation Act are concluded.

center parking area. The trench will cross Sabin Street at almost a right angle forcing its closure for several weeks. Testing of the excavated material in the area of the Exxon Station and possible special disposal are also required in this phase. Both Boone and Main Streets should remain open the entire construction period because there is sufficient room to detour traffic around work areas.

7.21 The downstream phase will include the outlet and the trench and culvert below Main Street. During this portion of the project, Spring Street, which is very narrow, will have to be closed between Main and Little Limestone Creek. The closure could last for a month or more. Construction of the outlet channel and bank protection will impact a portion of Mill Springs Park for several weeks.

Table 9 - Project Schedule

Activity	Dates
Submit Report to ORD	3/94
Report Approved & Forwarded to HQ	4/94
Initiate Plans & Specifications	6/94
Execute PCA	8/94
Begin Real Estate Acquisition	8/94
Complete Plans & Specifications	10/94
Real Estate Certification	10/94
Pre-solicitation & Advertisement	11/94
Bid Opening	12/94
Award Construction Contract	1/95
Project Construction	2/95 to 9/95

8.04 The recommendations contained herein reflect the current information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are authorized and/or funded.

J. David Norwood
LTC, Corps of Engineers
Commanding

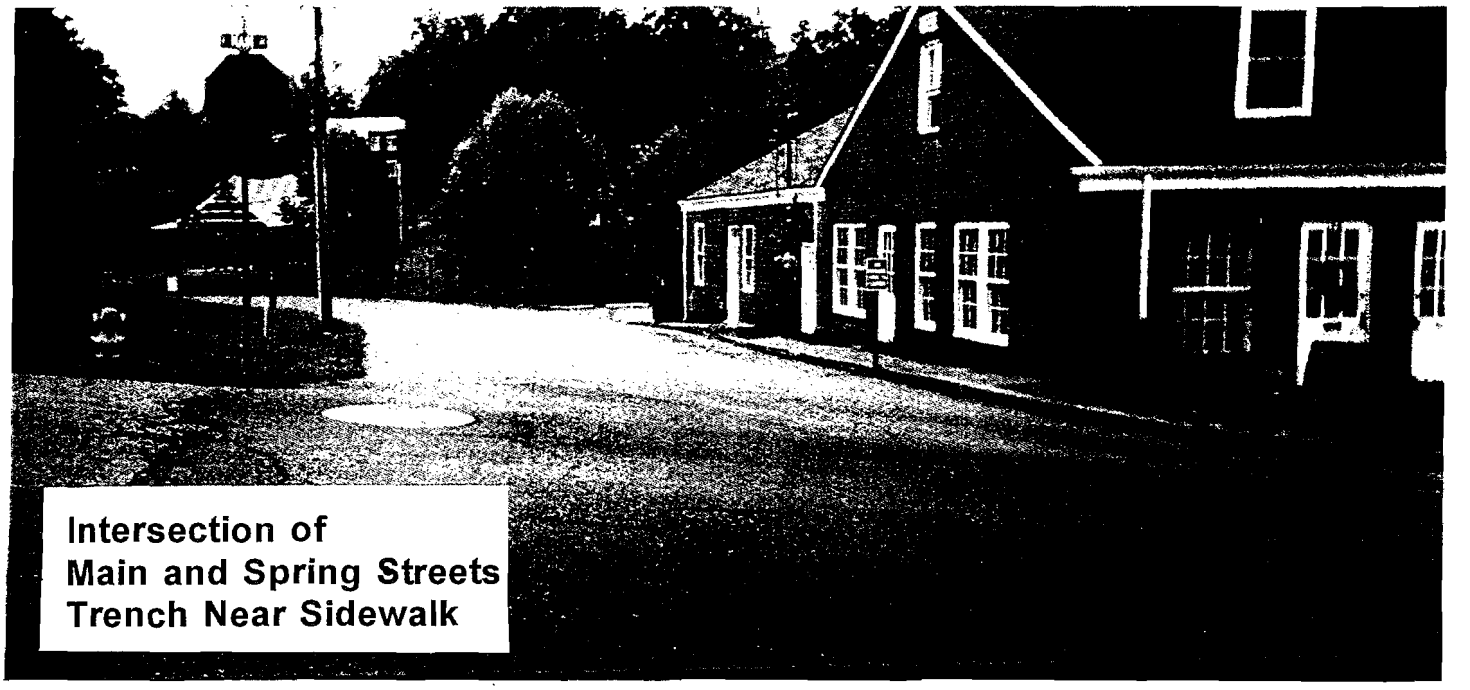
EXHIBITS

Main Street

Typical Floodprone Structures

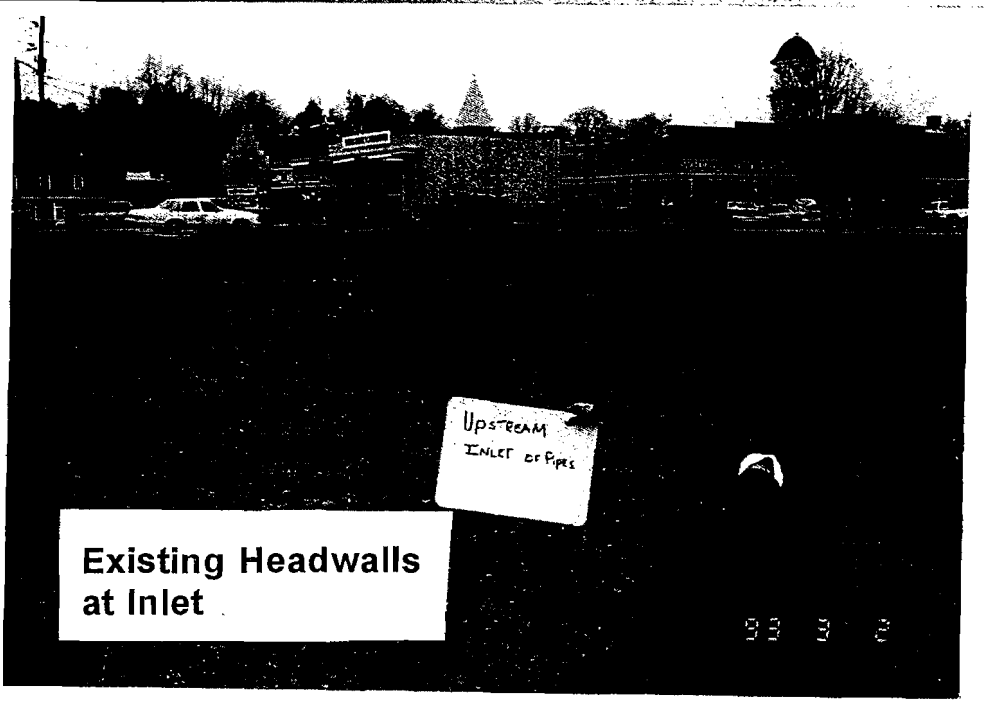
Downtown Jonesborough

Figure 2



Intersection of
Main and Spring Streets
Trench Near Sidewalk

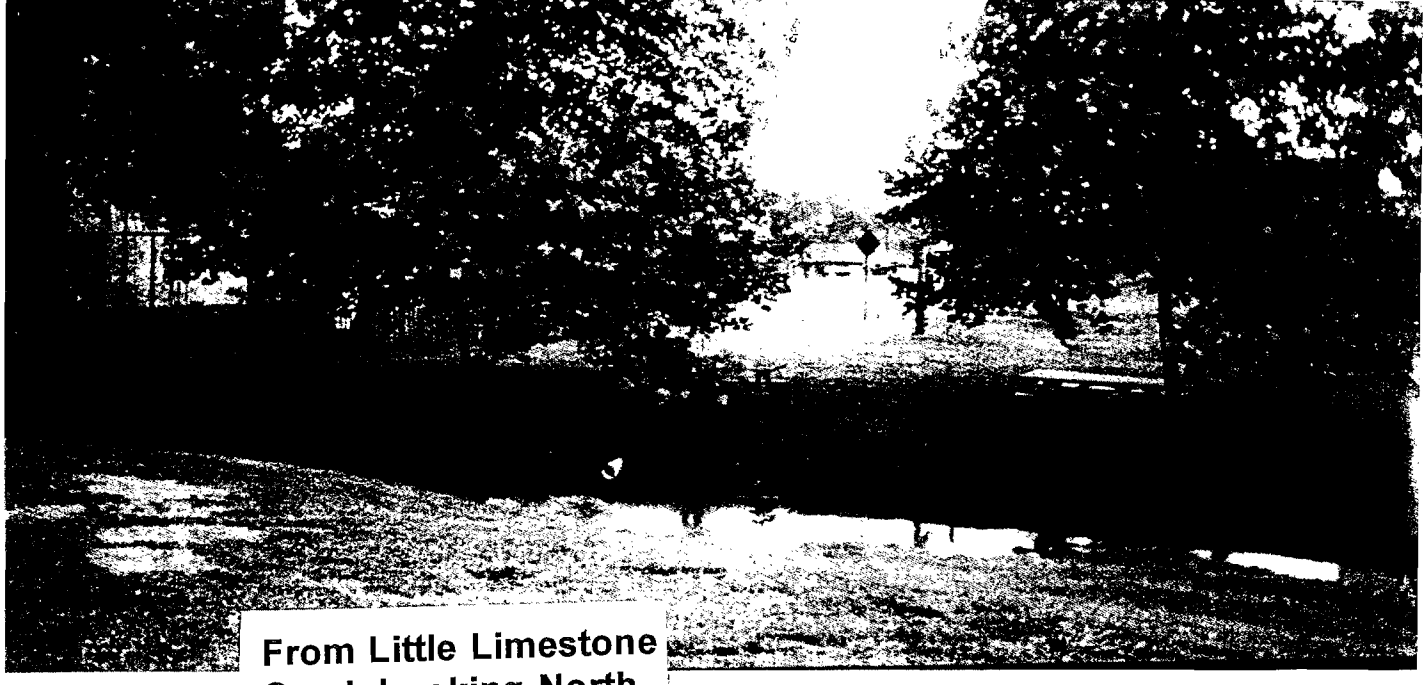
Exxon Station at
Intersection of
Boone and Main Streets



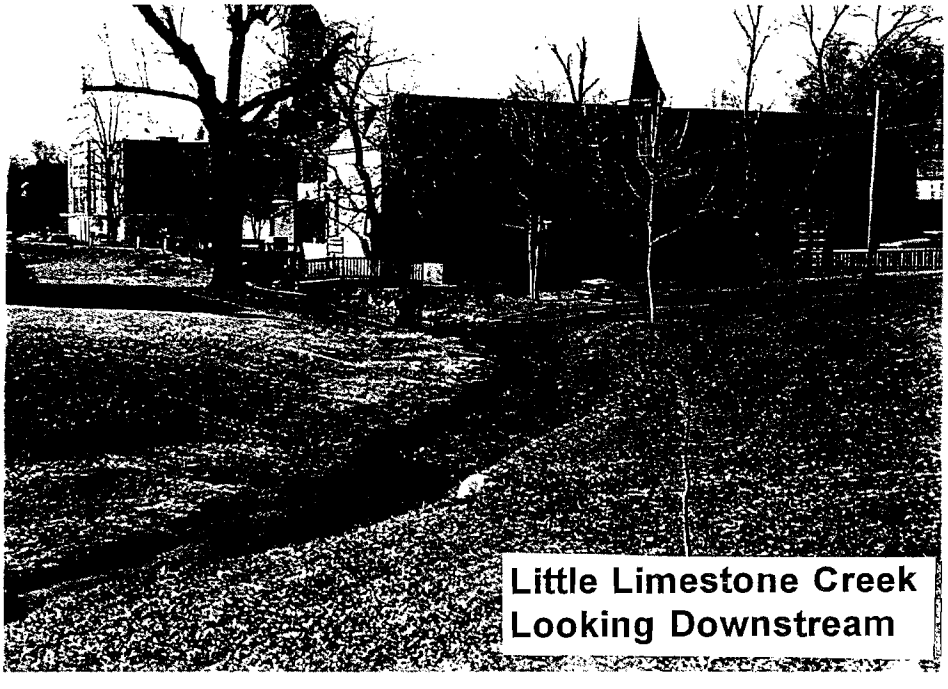
Existing Headwalls
at Inlet

Culvert Alignment

Figure 7



From Little Limestone Creek Looking North Along Spring Street



Little Limestone Creek Looking Downstream

Outlet Location

Figure 9

EXHIBITS

EXHIBIT 1

FEASIBILITY STUDY

COST SHARING

AGREEMENT

AGREEMENT
BETWEEN THE UNITED STATES OF AMERICA
AND
THE TOWN OF JONESBOROUGH, TENNESSEE
FOR THE FLOOD DAMAGE REDUCTIONS IN JONESBOROUGH, TENNESSEE
FEASIBILITY STUDY

THIS AGREEMENT, entered into this 27th day, of August, 1992 by and between the United States of America (hereinafter called the "Government"), represented by the Contracting Officer executing this Agreement, and the Town of Jonesborough, Tennessee (hereinafter called the "Sponsor"),

WITNESSETH, that

WHEREAS, the Congress has authorized the Corps of Engineers to conduct studies of small flood control projects for the prevention of flood damages pursuant to the continuing authority provided by Section 205 of the 1948 Flood Control Act, as amended; and

WHEREAS, the Corps of Engineers, under the authority of Section 205 of the 1948 Flood Control Act, as amended, has conducted a preliminary study of flooding problems on Little Limestone Creek and its Unnamed Tributary in Jonesborough, Tennessee, hereinafter referred to as the "Reconnaissance Phase Study", and has determined that further study in the nature of a "Feasibility Phase Study" (hereinafter called the "Study") is required to complete the determination of the extent of the Federal interest in participating in a solution to the identified problems; and

WHEREAS, the Sponsor has the authority and capability to furnish the co-operation hereinafter set forth and is willing to participate in study cost sharing and financing in accordance with the terms of this agreement; and

WHEREAS, the Sponsor and the Government both understand that entering into this agreement in no way obligates either party to implement a project and that whether a project is supported for authorization and budgeted for implementation depends upon the outcome of this feasibility study and whether the proposed solution is consistent with the Principles and Guidelines and with the budget priorities of the Administration and that at the present time, favorable budget priority is being assigned to projects providing primarily commercial navigation and flood or storm damage reduction outputs; and

WHEREAS, the Water Resources Development Act of 1986 (P. L. 99-662) specifies the cost-sharing requirements applicable to the study;

NOW THEREFORE, the parties agree as follows:

ARTICLE I - DEFINITIONS

For the purpose of this Agreement:

a. The term "Study Cost" shall mean all disbursements by the Government pursuant to this Agreement, whether from Federal appropriations or from funds made available to the Government by the Sponsor, and all Negotiated Costs of work performed by the Sponsor pursuant to this Agreement. Such costs shall include, but not be limited to: labor charges; direct costs; overhead expenses; supervision and administration costs; and contracts with third

grants an exception. If a study is discontinued, it shall be concluded according to Article XII and all data and information shall be made available to both parties.

g. The Sponsor may wish to conclude the Study if it determines that there is no solution in which it has an interest or which is not in accord with its current policies and budget priorities. When such a case exists the study shall be concluded according to Article XII and all data and information shall be made available to both parties.

ARTICLE III - SCOPE OF STUDIES

Appendix A, the Scope of Studies, is hereby incorporated into this Agreement. The parties to this Agreement shall substantially comply with the Scope of Studies in prosecuting work on the Study. The following modifications, to be approved by the Executive Committee, shall require an amendment to this Agreement:

a. Any modification which increases the total Study Costs by more than fifteen (15) percent;

b. Any modification in the estimated cost of a Study work item or any obligation for a Study work item, which changes the total cost of that work item by more than fifteen (15) percent;

c. Any extension of the completion schedule for a Study work item of more than thirty (30) days;

d. Any reassignment of a work item between the Sponsor and the Government.

ARTICLE IV - METHOD OF PAYMENT

a. The Government shall endeavor to obtain during each fiscal year the appropriation for that fiscal year at least in the amounts specified in the Scope of Studies incorporated herein. Subject to the enactment of Federal appropriations and the allotment of funds to the Contracting Officer, the Government shall then fund the Study at least in the amounts specified in the Scope of Studies herein.

b. The Sponsor shall endeavor to obtain during each Government fiscal year the cash contribution for that Government fiscal year at least in the amounts specified in the Scope of Studies incorporated herein and, once it has obtained funds for a cash contribution, shall make such funds available to the Government. The Government shall withdraw and disburse funds made available by the Sponsor subject to the provisions of this Agreement.

c. Funds made available by the Sponsor to the Government and not disbursed by the Government within a Government fiscal year shall be carried over and applied to the cash contribution for the succeeding Government fiscal year; provided, that upon study termination any excess cash contribution shall be reimbursed to the Sponsor after a final accounting, subject to the availability of appropriations, as specified in Article XII herein.

d. Should either party fail to obtain funds sufficient to make obligations or cash contributions or to incur Study Costs in accordance with the schedule included in the Scope of Studies incorporated herein, it shall at

b. Within ninety (90) days upon termination of this Agreement the Study Management Team shall prepare a final accounting of Study Costs, which shall display disbursements by the Government of Federal funds, cash contributions by the Sponsor, and credits for the Negotiated Costs of the Sponsor. Subject to the availability of funds, within thirty (30) days thereafter the Government shall reimburse the Sponsor for the excess, if any, of cash contributions and credits given over fifty (50) percent of total Study Costs. Within thirty (30) days thereafter, the Sponsor shall provide the Government any cash contributions required so that the total Sponsor share equals fifty (50) percent of total Study Costs.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY _____
STEPHEN M. SHEPPARD
LTC, Corps of Engineers
District Engineer
Contracting Officer

THE TOWN OF JONESBOROUGH, TN

BY _____
KEVIN B. MCKINNEY
Mayor
Town of Jonesborough, TN

ATTEST: Laura Hamilton

~~Clerk of Council~~ Recorder
Town of Jonesborough, TN

II - ENGINEERING STUDIES

Engineering studies provide the basis for estimating damage reduction, project costs and effects, and identifying construction details. The following will be undertaken:

a. Surveying - Mapping. Surveying and mapping will be developed in sufficient detail to design and layout the project, and to conduct utility relocations and real estate assessments.

The remainder of this work task involves development of stream cross-sections and topographic mapping for hydraulic studies. Any required cross-sections or mapping will be developed from field surveys. Actual measurements will be taken for all bridges and/or culverts.

b. Hydrologic and Hydraulic (H&H) Studies. This includes:

(1) Writing a generalized area description.

(2) Conducting a data search and compiling meteorological and climatological information.

(3) Compute frequency discharges for use in backwater modeling.

(4) Update the HEC-2 backwater model; test various culvert capacities to optimize hydraulic performance, minimize environmental and neighborhood impacts; and provide existing and projected future condition flood profiles.

(5) Develop exhibits for selected plan:

* Site Plan and Index
* Alignment Data and Typical Sections
* Plan and Profile

(6) Evaluate a complementary flood warning system, and investigate other non-structural protection measures for damage areas not benefitting from the primary plan-of-action.

(7) Prepare written documentation for the feasibility report.

c. Geotechnical Study. To complete this work task, the following will be necessary:

(1) Determine general geological basin characteristics.

(2) Determine nature of materials to be excavated and borrow areas required.

(3) Prepare written documentation.

TASK RESPONSIBILITY

Task/Activity	Estimated Cost	Responsible Party COE	Responsible Party Jonesborough
I. ECONOMIC STUDIES			
a. Flood Damage Evaluations	$ 2,000	X	
b. Existing & Projected Conditions	6,000	X	
	8,000*		
II. ENGINEERING STUDIES			
a. Surveying & Mapping	5,000	X	
b. Hydrology & Hydraulics	15,000	X	
c. Geotechnical	6,000	X	
d. Cost Estimating	12,000	X	
e. Relocations Determinations	4,000	X	
f. HTRW Innvestigation	10,000	X	
	52,000*		
III. ENVIRONMENTAL STUDIES			
a. Environmental Assessment	1,000	X	
b. Evaluate Effects	1,000	X	
c. Fish & Wildlife Coordination	2,000	X	
d. Cultural Resources Survey	4,000	X	
	8,000*		
IV. REAL ESTATE STUDIES	5,000*	X	
V. STUDY/PROJECT COORDINATION	5,000	X	
VI. PLAN FORMULATION	2,000	X	
VII. STUDY MANAGEMENT AND REPORT PREPARATION	15,000	X	
VIII. TRAVEL	1,000	X	
IX. REVIEW	4,000	X	
SUBTOTAL	100,000		
X. CONTINGENCIES (10%)	10,000		
TOTAL	$110,000**		

* Includes travel costs to support this task

** Includes $55,000 non-Federal cash contribution, of which 50% may be in-kind services

EXHIBIT 1/9

SECTION 205

FEASIBILITY STUDY SCHEDULE

JONESBOROUGH , TENNESSEE

ACTIVITY	CALENDAR MONTHS FROM START
BEGIN STUDY	0
Establish team members	
Surveying	
Evaluate alternative(s)	
Develop preliminary costs	
MEET WITH SPONSOR	4.5
Select plan	
Develop selected plan	
MEET WITH SPONSOR	7
Develop final costs	
Report preparation	
Internal review	
Print report	
DIVISION SUBMITTAL	13
Sponsor review	
Division review	
Revisions	
DIVISION APPROVAL	18

EXHIBIT 2

LETTER

OF

LOCAL

SUPPORT

MAYOR
KEVIN B. McKINNEY

ALDERMEN
HOMER G'FELLERS
R.I.C. HAWLEY
W. HAL KNIGHT
HUBERT C. MILLER

HISTORIC JONESBOROUGH 1779

TOWN ADMINISTRATOR
ROBERT E. BROWNING

TOWN RECORDER
LAURA J. HAMILTON

Town of Jonesborough

March 23, 1994

LTC J. David Norwood
District Commander
Nashville District
P.O. Box 1070
Nashville, TN 37202-1070

Dear LTC Norwood:

The Town of Jonesborough has reviewed the draft detained project report and understands the findings. The Town of Jonesborough is willing to provide all items of local cooperation as set forth in the draft Project Cooperation Agreement. The Town of Jonesborough believes that the 50-year plan is the wisest investment choice considering the historic and cultural value of the structures being protected.

The Town of Jonesborough is willing to pay the additional costs of $76,000.00 to construct the 50-year plan.

If we need to do anything else, please call me at 615-753-6128.

Sincerely,

Kevin B. McKinney
Mayor

KBM/vc

JONESBOROUGH, the OLDEST TOWN in TENNESSEE
123 BOONE STREET JONESBOROUGH, TENNESSEE 37659 (615) 753-6128
FAX NUMBER (615) 753-6129

EXHIBIT 2

EXHIBIT 3

PUBLIC

WORKSHOP

MEMORANDUM

ORNEP-P

3 February 1994
Ferguson/Bonds/5225

MEMORANDUM FOR RECORD

SUBJECT: Town Meeting, Jonesborough, TN

1. On January 31, 1994 the Town of Jonesborough held a Town Meeting. The Corps was asked to give a presentation of our Draft Detailed Project Report. Local and Corps officials attending the board meeting are listed below:

Bob Browning, Administrator
Kevin McKinney, Mayor
Laura Hamilton, Recorder
Judson Thronton, Town Attorney
John LaFon, COE, Chief Special Studies Section
Sue Ferguson, COE, Study Manager
LaNita Bonds, COE, Special Studies Section
Daphne Jackson, COE, Geotechnical Engineer

Alderman Hal Knight
Alderman Homer G'Feller
Alderman R.I.C. Hawley
Alderman Hubert Miller

2. Dr. William Kennedy, President, Jonesborough Historical Commission, also attended the meeting. The City had asked Dr. Kennedy to give an evaluation of the Corps' recommendation and methods of determining costs of repairing historic structures. Dr. Kennedy provided copies of his consultation report to the board. A copy is attached.

3. Several Jonesborough residents and business owners also attended the meeting to ask questions and comment on the plans. Their questions and comments and our responses are included in paragraph 5.

4. The Board voted to accept the Corps' draft report, but requested that the 50-year plan be implemented. They are fully aware that they will be obligated to pay all additional project costs.

5. Comments and Responses.

1. **Comment** - Why couldn't the existing culvert be increased instead of installing an entire new culvert?

Response - With the existing culvert, Sabin Street is overtopped at about the 2-year event. The draft report stated that the pipe would have to be doubled to carry the 2-year event and more than tripled to carry the 10-year event. This is not entirely accurate. The report will be revised to state that the capacity of the existing culvert is less than the 2-year event. The existing culvert would have to be more than doubled to accommodate the 10-year event.

the outlet of the channel. That is why the interlocking pavers are included on both upstream and downstream of the outlet on both banks of Little Limestone Creek.

9. **Comment** - What will the topography of the park look like with the outlet? The park's setting will be destroyed by bringing the channel outlet through it. The recommended plan should mesh with the function of the park.

Response - The use of interlocking blocks is intended to mesh with the park setting. However, during plans and specifications we will obtain additional survey information and look more closely at the outlet channel. We will consider alternatives to the current design and present them to the city. An artist's rendering of the best option will also be done.

10. **Comment** - During normal flow will water be flowing in the new channel? Is there constant flow of water in the park?

Response - The new culvert has a lower inlet elevation and as currently designed, water will flow into the new culvert first. A berm will be added with an elevation of about the 1-year flood to divert flows below that to the existing culvert.

11. **Comment** - Can the base of the outlet channel be lined with stone or can the interlocking blocks be made to simulate stone? Are the stream slopes safe for mowing or for visitors at the park?

Response - There are other types of interlocking blocks that look more like stone and could be used to line the channel. As stated in comment 9, we will explore other options during the preparation of plans and specifications. Contrary to the response given at the public meeting, the 1.5H:1V slopes on the outlet channel will are not gentle enough to mow. We can either reduce the slope (and impact more land) or pave the sides of the outlet channel.

12. **Comment** - If the channel cannot be made to complement the park can the culvert be extended all the way to Little Limestone Creek?

Response - This option can also be explored.

13. **Comment** - Will the culvert at 6x6 or 6x8 feet be a safety hazard to children? Children will be enticed by the large opening and will want to play inside the culvert.

Response - The culvert is typical of many found under highways and may indeed attract children. However, blocking access with bars and such may create a more dangerous situation by trapping them inside.

14. **Comment** - Can the Board request the Corps to select the larger 50-yr plan?

Response - Yes, the Board could request the Corps to recommend the 50-year plan. However, approval to deviate from the NED plan must come from the Assistant Secretary of the Army and based upon experience with other projects, approval is unlikely. In any event it would definitely add time to the planning process. They can buy up to the 50-year plan without adding significantly to the process.

EXHIBIT 4

FINANCIAL STATEMENT AND ATTORNEY'S REPORT

FINANCIAL CAPABILITY DISCLOSURE

The Town of Jonesborough, hereby submits the following information for fiscal year 92-93 as assurance of its financial capability to provide the necessary non-Federal contribution with which to cooperate in a Flood Control Project with the United States as may be required by Public Law 99-662. The total non Federal share is currently estimated to be $238,000.00

1. Pursuant to PL 99-662 at least 5 percent of the total implementation costs will be tendered in cash, pursuant to an agreement to be executed before construction begins. This cash contribution is currently estimated to be $125,700.00. The source of this contribution will be:

ACCOUNT, FUND, TAX SOURCE	BALANCE
General Fund	See Audit Report

2. Monies necessary to acquire all lands, easements, rights-of-way, dredged material disposal areas and perform all relocations and alterations of buildings, utilities, highways, railroads, bridges, sewers, and related and special facilities as may be required by subsequent agreement entered into by the Federal Government and Town of Jonesborough will be acquired with funds from the following sources:

ACCOUNT, FUND, TAX SOURCE	BALANCE
General Fund	See Audit Report

EXHIBIT 4/1

3. Additionally, if the value of the contributions provided in numerical paragraph 2 above represents less than 25 percent of the total implementation costs the Town of Jonesborough agrees to make additional cash contributions in an amount necessary to make the total non-Federal contributions equal to 25 percent of total implementation costs. In such an event, the Town of Jonesborough assures that these additional funds are available from the following accounts:

ACCOUNT, FUND, TAX SOURCE	BALANCE
General Fund	See Audit Report

The Town of Jonesborough certifies that these funds are obligated for this project and will be appropriated as may be necessary to meet future contractual obligations for construction of Flood Control Project.

Respectfully Submitted

Laura Hamilton

Laura Hamilton
Town Recorder

EXHIBIT 4/2

ATTORNEY CERTIFICATION

I, Judson D. Thornton, do hereby certify that I am the Attorney for the Town of Jonesborough; that the Town of Jonesborough is a legally constituted public body with full authority and legal capability to enter into a contract with the Federal Government to construct the proposed project, to furnish the above-mentioned items of local cooperation, and to pay damages, if necessary, in the event of its failure to perform.

§
DATED 3/24/94

NAME
Attorney for Town of Jonesborough

EXHIBIT 4/3

CEORN-RE-A 29 March 94

MEMORANDUM FOR RECORD

SUBJECT: Proposed Project Cooperation Agreement with the Town of Jonesborough

1. The Town of Jonesborough wishes to enter into a Project Cooperation Agreement with the Corps of Engineers to construct a 25-year culvert training dike and outlet improvements on the unnamed tributary and Little Limestone Creek. In order to enter into such a contract with the Government, a non-Federal interest must meet the requirements of PL 91-611 and EP 405-1-2 by being a:

a. legally constituted
b. financially capable
c. public body

2. The Town of Jonesborough is a legally constituted body as provided in Tennessee Code, Chapter 135, Acts of 1903 and Senate Bill 210, and has the powers enumerated therein, including the power to operate and maintain public works projects, to acquire, hold, and dispose of real estate, and to enter into contracts related thereto, and to issue bonds or impose and collect taxes to finance such projects, if necessary.

3. A copy has been provided of an attorney's certificate as to Jonesborough's legal capability to enter into a contract, a financial capability disclosure statement and financial statements with auditor's report. The Town of Jonesborough is financially capable of performing the terms of the proposed Project Cooperation Agreement.

Bonnie S. Baggott

Bonnie S. Baggott
Attorney, Acquisition Branch
Real Estate Division

EXHIBIT 4/4

APPENDIX A

PROJECT ECONOMICS

ENVIRONMENTAL ASSESSMENT

Coordination. Scoping letters were sent on July 22, 1991 to the agencies listed on page EA-11. Responses were received from the U.S. Fish and Wildlife Service and the Tennessee Department of Environment and Conservation.

Environmental Setting. The training dike and inlet to the new culvert are to be constructed on the road right of way for Sabin Street and Boone Street. This area is bounded by streets with an open grassed area lying to the north toward the Public Library. The alignment for the trench which would be excavated to build the box culvert is through a paved parking lot and down Boone Street. A small end wall for the terminus for the box culvert will be in the road right of way at a turn in Boone Street. The outlet channel for the remaining 65 feet between the culvert and the Little Limestone Creek will be excavated through a well maintained grassed area. The proposed impact area is largely disturbed and mostly under pavement or part of a road right of way. The remaining sections proposed to be disturbed are in grass and are surrounded by development. These areas offer little value to wildlife. The only portion of this project subject to any adverse impact potential is the area nearest the Little Limestone Creek.

The aquatic habitat of the Little Limestone is generally considered good with a diversity of substrates and favorable sinuosity index. The lack of streamside vegetation and the abundance of development within the study reach make the riparian zone less desirable for terrestrial species and reduce the overall quality of the aquatic system at this specific site.

Endangered Species. A literature search and coordination with the U.S. Fish and Wildlife Service and Tennessee Department of Environment and Conservation Ecological Services have not revealed the presence of endangered or threatened species that would be impacted by the proposed project.

Cultural Resource Compliance Requirements. Pursuant to requirement of Section 106 of the National Historic Preservation Act as implemented by regulations at 36 CFR 800, the Corps of Engineers is required to identify properties in project impact areas which are either listed or eligible for listing on the National Register of Historic Places, assess potential effects to those properties, to consult with the State Historic Preservation Officer (SHPO) concerning identified effects, and to seek the comments of the Advisory Council on Historic Preservation (ACHP)

should project effects be determined not adverse or adverse. The Tennessee SHPO's no adverse effect determination was provided to the ACHP for their review and comment. The Council, by letter of February 8, 1994, did not object to the no adverse effect determination; therefore, the Corps' responsibilities under Section 106 of the National Historic Preservation Act are concluded.

Historical Setting. In 1969 the National Park Service officially announced that the Jonesborough Historic District had been determined eligible for listing on the National Register of Historic Places and was the first district so designated in the State of Tennessee. Chartered by the State of North Carolina in 1779, Jonesborough was the first planned community west of the Appalachians and served as a center of urban life on the Tennessee frontier. Among its more notable architectural treasures are the Chester Inn (1797), Sister's Row (1820), and the log Christopher-Taylor Cabin which once housed as a boarder the young frontier lawyer named Andrew Jackson. Jonesborough was at one time the home of President Andrew Jackson and was visited by many other presidents. It was here in the Washington County courthouse that Andrew Jackson was admitted to the bar, and a few years later, presided as judge. A walk through the downtown historic district presents one with a mix of historical events and a blend of architectural styles. The roots of Tennessee and America as a nation are deeply embedded in the mountainous terrain of the area known as the "First Tennessee." Its rich heritage and significant role in the settlement of the Southwest Territory make Jonesborough and the Upper East Tennessee region a unique resource for historians, preservationists, and the restoration community.

Environmental Impacts.
The no action alternative would not have an effect on the environment. No action would also not provide a solution to the flooding problem which has many socioeconomic impacts.

Impacts to terrestrial wildlife species would be minimal since the proposed alternative passes primarily through paved lots, roads, and a "backyard" type of environment. The proposed alternative of building a training dike and constructing a new culvert does not have long term adverse impacts to the environment. The training dike would be built along the road right of way from material obtained from the trench and outlet excavation. An invert at the inlet will have to be excavated to allow proper drainage into the new culvert, and this material will also be used in the training dike. The work along Little Limestone Creek is above headwaters. Impacts from these activities have no significance and have been previously permitted for purposes of 404 under Department of Army Nationwide

Permit effective January 21, 1992 [33 CFR 330 (26)]. A 404 (b) (1) evaluation was prepared to provide necessary information to Tennessee Division of Water Pollution Control. An Aquatic Resource Alteration Permit from the Tennessee Division of Water Pollution Control was issued to the local sponsor for this work on March 28, 1994. The proposed project would not impact any known endangered species. No designated wetlands or unique prime farmlands would be adversely impacted by the proposed project.

Cultural Resource Impacts. Proposed structural flood control measures for the Jonesborough community will be confined to areas almost entirely within the Jonesborough Historic District. The Corps has consulted with the Tennessee SHPO with the resulting determination that the proposed project will have an effect on the Jonesborough Historic District. Construction will take place; however, in an area that is traversed on the surface by several streets and below the surface by a network of utilities. A small berm will be constructed at the inlet, and the outlet will require the use of interlocking concrete blocks to prevent further erosion along Little Limestone Creek. Construction disturbance in the project area will be temporary and, excepting the inlet and outlet of the culverts, surface areas will be returned to their original use and appearance. The Jonesborough flood control project will result in the protection of valuable and irreplaceable historic structures within the Jonesborough Historic District. The Corps and the Tennessee SHPO have concurred in the opinion that the proposed flood control project for Jonesborough will have an effect on the Jonesborough Historic District, however, that effect will be temporary and not adverse.

SECTION 404 (b) (1) EVALUATION
SECTION 205 FLOOD CONTROL PROJECT
FOR LITTLE LIMESTONE CREEK, JONESBOROUGH
WASHINGTON COUNTY, TENNESSEE

1. **PROJECT DESCRIPTION.**

A. Location. The project area is located primarily on an unnamed tributary and its confluence with the Little Limestone Creek at mile 12.6 in Jonesborough, Tennessee. Refer to figure 1 for the general location map.

B. General Description. Jonesborough experiences flooding when runoff exceeds the capacity of the culvert which carries the unnamed tributary beneath downtown Jonesborough. The unnamed tributary has a watershed of 1.24 square miles and the Little Limestone Creek's watershed is 4.21 square miles at mile 12.6. At the inlet, two pairs of 36" culverts cross under Sabin Street and intersect at the head of a 370' box culvert. The unnamed tributary emerges from the box culvert to travel approximately 125' before it joins Little Limestone Creek.

The proposed project features a training dike at the inlet to help direct flow. The four existing 36" culverts will be extended through the levee and concrete headwalls will be constructed at the inlet of these extensions and the new culvert. A concrete headwall would be constructed at the outlet of the new culvert. The outlet would be connected to the Little Limestone Creek by an open trapezoidal channel. The base width of the channel would be 8 feet and the side slopes 1.5H:1V. The outlet channel and a limited area around its mouth would be protected with interlocking blocks to protect these areas from scouring by high velocity, turbulent flow. About 1,900 interlocking blocks and 2,113 square feet of filter fabric would be in the outlet channel and 1050 of these interlocking blocks would be on the bank of the Little Limestone Creek below ordinary high water. The culvert and its associated materials and activities are above ordinary high water and will not be further addressed in this 404(b)(1) evaluation.

C. Authority and Purpose. The assessment was done within the scope and authority of Section 205 of the 1948 Flood Control Act, as amended, and the National Environmental Policy Act of 1969, as amended. In addition, it is a response to a request from the Mayor of Jonesborough, Tennessee. The primary purpose of this project is to reduce flood damages.

D. General Description of the Dredged or Fill Material. The outlet channel would require excavation of about 210 cubic yards. The excavated material will be used for the training dike construction. Approximately 1900 blocks of interlocking blocks and 2,113 square feet of geotextile would be placed in the outlet channel and about 1050 of these would be on the banks of the Little Limestone Creek. The interstices of the conlock can be backfilled and planted with grasses for good erosion control with a more natural appearance. The total linear feet along the Little Limestone is 110 feet.

E. Description of the Proposed Discharge Site. The project site is located on the right bank of the Little Limestone Creek. The natural soils in this location are largely comprised of residual soils and alluvium. The area is generally grassed top of bank with an occasional tree.

F. Description of the Disposal Method. Sound environmental and engineering practices would be followed during all phases of project construction. About 210 cubic yards of excavation, and minimal clearing and grubbing will be necessary. Overburden from the excavation will be used to construct the training dike. The Contractor would remove and dispose of any other material in accordance with local ordinances and the Contracting Officer. Silt fences and other methods to protect the area from runoff will be incorporated into the plans and specifications. The conlock and filter fabric will be placed as quickly as possible and impact areas revegetated as soon as practicable to minimize adverse impacts.

2. FACTUAL DETERMINATIONS.

"Factual Determinations" as required by 230.11 of the EPA Final Guidelines of 24 December 1980 include the following:

A. Physical Substrate Determinations. Changes to the physical substrate would be insignificant. The work would be accomplished primarily on the creek bank with little or no changes to the streambed.

B. Water Circulation, Fluctuation, and Salinity Determinations.

Water chemistry, odor, taste, dissolved oxygen levels, nutrients, and eutrophication would not be significantly affected by the operations. Any minor effects would stabilize to preconstruction ranges quickly when construction activities were complete. Current patterns, creek flow and velocity and hydrologic regime would be only locally affected to the extent necessary to reduce shoreline erosion. There would be no discernable fluctuation of pool level and no significant project-induced effects during high water periods. Salinity is not a consideration.

C. Suspended Particulate and Turbidity Determinations. Turbidity levels would be elevated only locally during rain events while construction activities are taking place. Following these activities, turbidity levels should return to preconstruction levels. The effect on the chemical and physical properties of the Little Limestone Creek would be insignificant.

D. Contaminant Determinations. The stone fill would be obtained from a clean, native source and would present no contamination problems.

E. Aquatic Ecosystem and Organism Determination. The shallow, aquatic ecosystem near the bank would be temporarily disturbed. The trophic levels of the aquatic system would not be significantly affected. Within the area proposed for fill and nearby, no Federally-listed endangered species of mussels was found.

F. Proposed Fill Site Determination. Economic, engineering, and environmental concerns resulted in the selection of the preferred site and methods evaluated here. Placement of the fill materials would not violate Tennessee water quality standards. There would be no effect on municipal water supplies; no significant recreational fishery would be adversely affected.

G. Determination of Cumulative Effects on the Aquatic Ecosystem. No adverse cumulative effects to the aquatic ecosystem of the Little Limestone Creek can be attributed to the disposal of fill materials associated with the construction of the proposed project. Localized beneficial effects are expected to occur.

H. Determination of Secondary Effects on the Aquatic Ecosystem.

No significant adverse secondary effects to the aquatic ecosystem can be identified from the proposed placement of fill materials.

3. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE.

A. Adaptation of the Section 404(b)(1) Guidelines to this Evaluation. No adaptations were made.

B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site Which Would Have Less Adverse Impact on the Aquatic Ecosystem. Construction of an outlet for a new culvert and protecting it with riprap was considered the most practical alternative. Various sizes of culverts in different locations were investigated in the course of study. The area was restricted by development, however, the preferred alternative fulfills the economic, engineering, and environmental requirements associated with project evolution under the applied authority.

C. Compliance with Applicable State Water Quality Standards. The preferred alternative complies with all current water quality standards.

D. Compliance with Applicable Toxic Effluent Standard or Prohibition Under Section 307 of the Clean Water Act. The fill operations would not violate Section 307 of the Clean Water Act.

E. Compliance with Endangered Species Act of 1973, as amended. There are no known adverse affects to any endangered or threatened species.

F. Compliance with Specified Protection Measures for Marine Sanctuaries Designated by the Marine Protection, Research, and Sanctuaries Act of 1972. Not applicable.

G. Evaluation of Extent of Degradation of the Waters of the United States. The proposed placement of fill material would not result in any significant adverse impacts on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton,

shellfish, wildlife, and endangered species. Life stages of aquatic and terrestrial species would not be adversely affected. No significant adverse effects on aquatic ecosystem diversity, productivity, and stability would occur. Recreational, aesthetic, and economic values would not be adversely affected. There would be no adverse effect on wetlands in the area.

H. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem. Appropriate steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem of the Little Limestone Creek include sound engineering design. In addition, the Contractor's placing of the fill material would be governed by detailed contract specifications to prevent pollution and damage to the aquatic system as a result of construction operation and fill placement. Vegetation in impact areas would be established as quickly as possible once construction activities were complete.

4. EVALUATION RESPONSIBILITY.

Based on this evaluation, it is my finding that the proposed disposal site for the discharge of fill material are specified as complying with the requirements of the 404(b)(1) Guidelines.

Date: _____

_____
J. David Norwood
LTC, Corps of Engineers
District Engineer

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Division of Water Pollution Control
401 Church Street 6th Floor L&C Annex
Nashville, TN 37243 1534

Certified Mail Return Receipt # P 008 515 869

March 28, 1994

Town of Jonesborough
c/o Mr. Robert Browning, Town Administrator
123 Boone Street
Jonesborough, TN 37659

Re: General Permit for Bank Stabilization Activities
General Permit for Alteration of Wet Weather Conveyances
Little Limestone Creek, rm 13.7, Jonesborough, Washington County

Dear Mr. Browning:

In response to your application for an Aquatic Resource Alteration Permit, the Division of Water Pollution Control advises you that stream alterations associated with bank stabilization activities require a permit in accordance with the Tennessee Water Quality Control Act (T.C.A. 69-3-101 et seq.). The Division has regulations which establish terms and conditions for certain bank stabilization activities. These activities may be accomplished by authorization of Rule 1200-4-7-.09, General Permit for Bank Stabilization Activities. If you can proceed in compliance with the conditions of the enclosed general permit, the work is hereby authorized and an individual permit will not be required. All disturbed areas must be vegetated or otherwise stabilized upon completion of construction.

This authorization does not obviate the need for any other required Federal, State, or local permits. If there are any questions or you are unable to proceed with your project in compliance with the conditions of the general permit, please call me at (615) 532-0678 and we will begin processing an individual permit.

Sincerely,

Bill Duffel

Bill Duffel
Natural Resources Section
Division of Water Pollution Control

enclosure

CHAPTER 1200-4-7 RULES OF THE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
TENNESSEE WATER QUALITY CONTROL BOARD
AQUATIC RESOURCE ALTERATION

1200-4-7-.09 GENERAL PERMIT FOR BANK STABILIZATION ACTIVITIES

(1) Bank stabilization activities are permitted by this Rule provided the activity is done in accordance with the terms and conditions of this Rule and provided:

(a) an individual permit is not required;

(b) the activity is necessary to repair or prevent bank erosion;

(c) no portion of the activity is located in wetlands;

(d) no portion of the activity is located in a component of the National Wild and Scenic River System or a State Scenic River, or streams within the property boundaries of public lands administered by the National Park Service, the National Forest Service, the Tennessee Department of Environment and Conservation and the Tennessee Wildlife Resources Agency;

(e) no portion of the activity is located in any waterway which is identified by the Department as having contaminated sediments;

(f) the activity will not permanently disrupt the movement of aquatic life; and,

(g) no portion of the activity is located in a known habitat of State or Federally listed threatened or endangered species.

(2) This general permit will expire August 1, 1996.

(3) Terms and Conditions.

(a) Persons proposing to conduct streambank stabilization activities in waters of State shall notify the Department by submission of an application which includes the following minimum information:

1. a map showing the exact location of the proposed construction site; and

2. a single copy of construction plans which includes specifications for proposed stream channel alterations and pollution control methods or structures.

(b) Stream alteration activities shall not commence until the Commissioner issues written notification that the proposal may proceed in accordance with the terms of this Rule or issues an individual permit.

(c) Stream bank disturbance associated with stabilization shall be limited to the minimum needed for abatement and prevention of stream bank erosion.

(d) Material may not be placed in such location or manner so as to impair surface water flow into or out of any wetland area.

(e) Materials used in stabilization shall include clean shot rock, rip rap or anchored trees or other non-erodable materials found in the natural environment. Stabilization materials shall not include gravel, sand, sediments, chert, soil, or other unconsolidated materials. Materials to be discharged shall be free of contaminants, including toxic pollutants, hazardous substances, waste metal, construction debris, organic materials, etc.

(f) Streams shall not be used as transportation routes for heavy equipment. Crossings must be limited to one point and erosion control measures must be utilized where the stream banks are disturbed. Where the stream bed is not composed of rock, a pad of clean rock must be used at the crossing point. All temporary fill must be completely removed after the work is completed.

(g) Vegetation and debris disturbed by activity at the construction site shall be removed from the site to such a location so as to prevent reentry into the waterway.

(h) Clearing, grubbing and other disturbance to riparian vegetation shall be limited to the minimum necessary for slope construction and equipment operations. Unnecessary vegetation removal is prohibited. All disturbed areas shall be properly stabilized as soon as practicable.

(i) Upon achievement of final grade, all disturbed areas must be stabilized and re-vegetated within 30 days by sodding or seeding and mulching. Seed to be utilized shall include a combination of annual grains and grasses, legumes, and perennial grasses. Lime and fertilizer shall be applied as needed to achieve a vegetative cover.

(3) For the purpose of this rule, bodies of water defined as navigable pursuant to Section 10 of the Rivers and Harbors Act of 1899 are subject to different restrictions than all other waters regarding the scope and type of bank stabilization activities authorized under this general permit. Where the activity is located in waters which are not navigable pursuant to 10, the following special conditions apply:

(a) Removal of living trees and other riparian vegetation which help comprise the integrity of the stream bank or which help provide canopy or shade to the waters or the placement of fill which would otherwise injure or damage stream side vegetation is not authorized by this rule.

(b) Grading, sloping, dredging or reshaping of the stream banks or bed is not authorized by this rule.

(c) The discharge of stabilization materials is limited to 200 linear feet of stream bank.

(4) Where the activity is located in waters defined as navigable pursuant to 10 of the Rivers and Harbors Act of 1899, the following special conditions apply:

(a) the discharge of materials is limited to less than an average of one cubic yard per running foot placed along the bank;

(b) the activity may be up to 500 feet in length.

Rulemaking Authority: T.C.A. 69-3-105(b) and 4-5-201 et seq.
Substantive Authority: T.C.A. 69-3-101 et seq.

RULES
OF
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
WATER QUALITY CONTROL BOARD
DIVISION OF WATER POLLUTION CONTROL

CHAPTER 1200—4—7
AQUATIC RESOURCE ALTERATION

1200—4—7—.06 GENERAL PERMIT FOR THE ALTERATION OF WET WEATHER CONVEYANCES.

Wet weather conveyances are defined in rule 1200—4—3—.04 of the Rules of Tennessee Department of Environment and Conservation. Rule 1200—4—3—.02(7) requires that waters designated as wet weather conveyances shall be protective of wildlife and humans that may come in contact with them and maintain standards applicable to all downstream waters. No other use classification or criteria apply to these waters. Activities which result in the alteration of wet weather conveyances are permitted by this rule provided the activity does not result in the discharge of waste or other substances which may be harmful to humans or wildlife, and that erosion and sedimentation and other pollution control mechanisms are employed to maintain the quality of downstream waters. This general permit will expire August 1, 1996.

Mailing List

Tennessee State Plng Office
307 John Sevier Building
500 Charlotte Avenue
Nashville, TN 37219-5082

Tennessee Wildlife Resources Agency
P. O. Box 40747
Nashville, TN 37204

U. S. Fish and Wildlife Service
Division of Ecological Services
446 Neal Street
Cookeville, TN 38501

Tennessee Conservation League
300 Orlando Avenue
Nashville, TN 37209

Mr. Herbert Harper, SHPO
Tennessee Historical Commission
701 Broadway
Nashville, TN 37219-5237

U.S. Environmental Protection Agency
Region IV
345 Courtland St.
Atlanta, GA 30365

TN Dept of Environment & Conservation
Division of Water Pollution Control
6th Floor L&C Tower
401 Church Street
Nashville, TN 37243-1534

State Conservationist
Soil Conservation Service
Room 675 U.S. Courthouse
801 Broadway
Nashville, TN 37203

Mr. Donald Walker
ASCS, State Executive Director
579 US Courthouse
Nashville, TN 37203

Mr. Paul Schmeirbach
Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, TN 37902

William M. Christie
TN Dept. of Environment & Conservation
Division of Ecological Services
8th Floor L&C Tower
401 Church Street
Nashville, TN 37243-0447

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO
Environmental Resources Branch

22 July 1991

To Whom It May Concern:

Under the authority of Section 205 of the 1948 Flood Control Act, as amended, the Nashville District Corps of Engineers has initiated an investigation of flooding at Jonesborough in Washington County, Tennessee.

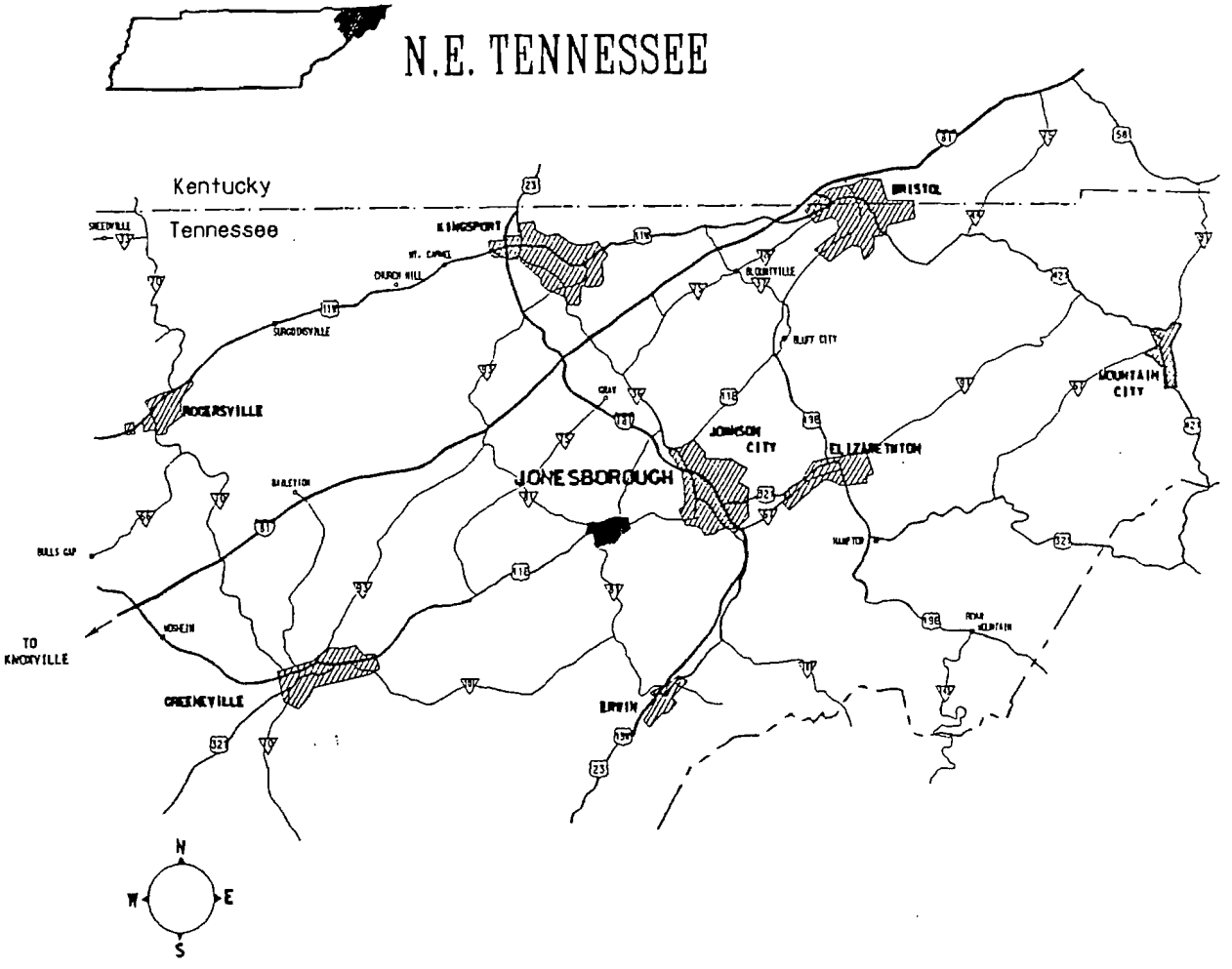
At this stage in the study, no action, a dry-bed detention basin on Little Limestone Creek, and improving the drainage system from the mouth of an unnamed tributary of Little Limestone Creek up to Sabin Street, mile 0.09 appear to be the most likely alternatives.

Any information or comments concerning this study will be appreciated. Maps of the study area are enclosed. If you have questions or desire any further information, please contact Patty Coffey, Biologist of my staff, at (615) 736-5028. Please provide your comments before August 16, 1991.

Sincerely,

R. J. Connor, P.E.
Chief, Engineering-Planning
Division

Enclosures



JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY

REGIONAL MAP

FIGURE A-i

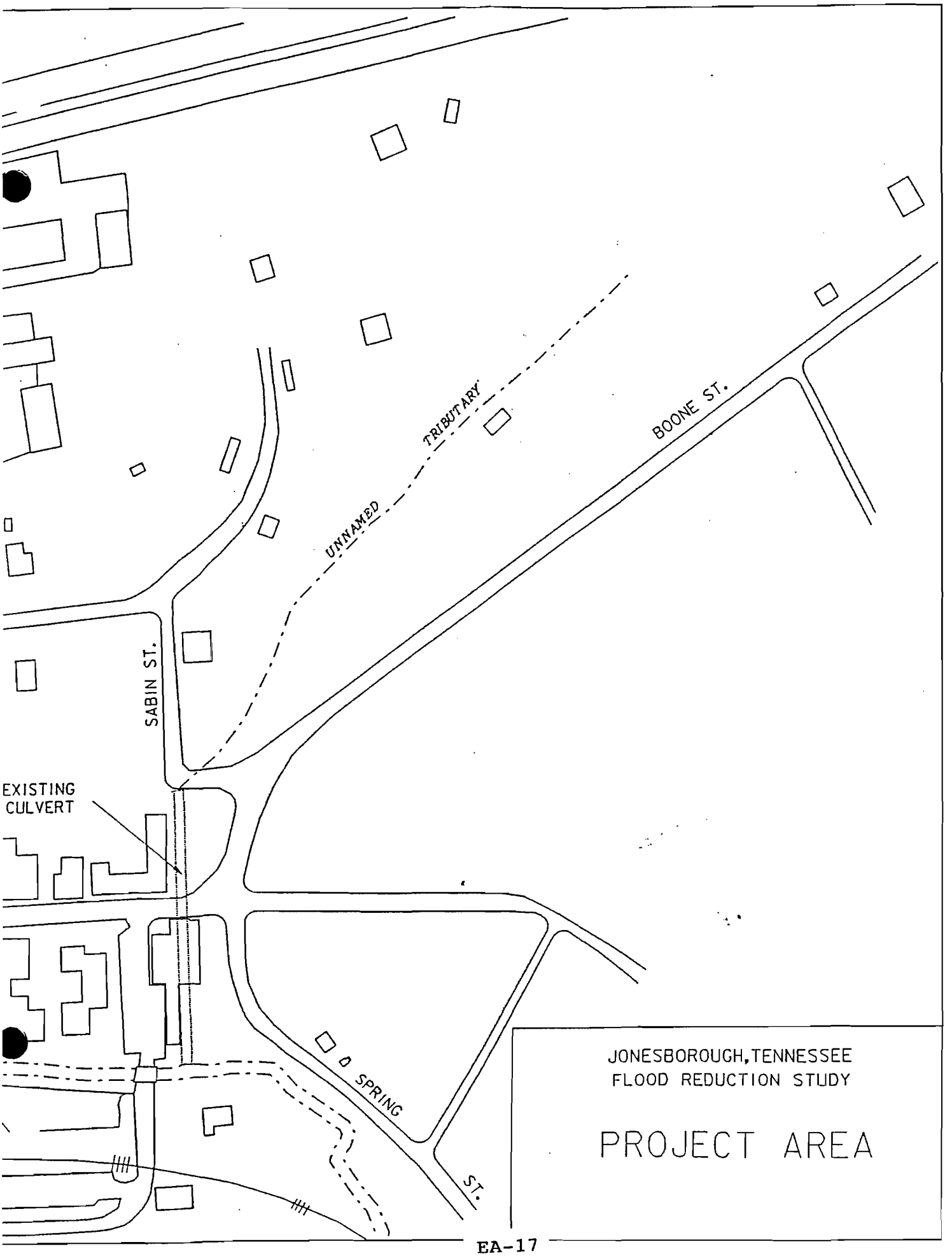

UNNAMED TRIBUTARY
BOONE ST.
SABIN ST.
EXISTING CULVERT
SPRING ST.
JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
PROJECT AREA

FIGURE A-3

D Patty
D Rob

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
NASHVILLE, TENNESSEE 37243-0435

NED McWHERTER
GOVERNOR

J. W. LUNA
COMMISSIONER

December 14, 1993

CTS 12/27/93

Mr. R. J. Connor
Corps of Engineers-Nashville District
Post Office Box 1070
Nashville, Tennessee 37202-1070

Re: COE-N, FLOOD CONTROL PROJECT, JONESBORO, WASHINGTON COUNTY,

Dear Mr. Connor:

Pursuant to your request, this office has reviewed your correspondence plus additional documentation relative to the above-referenced undertaking. Based on available information, we concur that the project as currently proposed will not adversely affect properties eligible for or listed in the National Register of Historic Places.

Unless project plans change, this office has no objection to the implementation of this project. You are now obliged to seek the comment of the Advisory Council on Historic Preservation prior to project implementation. Please enclose a copy of this determination along with all support documentation delineated at 36 CFR Part 800. Until such time as the Council has rendered a final comment on this project, your Section 106 obligation under federal law has not been met.

Should project plans change, please contact this office to determine what additional action, if any, is necessary. Questions and comments may be directed to Joe Garrison (615)532-1559. Your cooperation is appreciated.

Sincerely,

J. W. LUNA, Commissioner
State Historic Preservation Officer

JWL/jyg

Advisory Council On Historic Preservation

The Old Post Office Building
1100 Pennsylvania Avenue, NW, #809
Washington, DC 20004

FEB 8 1994

Mr. R. J. Connor, P.E.
Chief, Engineering-Planning Division
Department of the Army
Nashville District, Corps of Engineers
P.O. Box 1070
Nashville, TN 37202-1070

REF: Proposed Flood Control Project
Jonesboro, Washington County, Tennessee

Dear Mr. Connor:

On January 18, 1994, the Council received your determination, supported by the Tennessee State Historic Preservation Officer (SHPO), that the referenced undertaking will have no adverse effect upon the Jonesboro Historic District, a property included in the National Register of Historic Places. Pursuant to Section 800.5(d)(2) of the Council's regulations, "Protection of Historic Properties" (36 CFR Part 800), we do not object to your determination. Therefore, you are not required to take any further steps to comply with Section 106 of the National Historic Preservation Act other than to implement the undertaking as proposed and consistent with any conditions you have reached with the Tennessee SHPO.

Thank you for your cooperation.

Sincerely,

Don L. Klima
Director
Eastern Office of Review

STATEMENT OF FINDINGS
AND
FINDING OF NO SIGNIFICANT IMPACT

Section 205, Flood Damage Reduction
Jonesborough, Washington County, Tennessee

1. Under the authority of Section 205 of the 1948 Flood Control Act, as amended, the Nashville District has evaluated flooding in Jonesborough, Tennessee. The principal sources of flooding in Jonesborough are Little Limestone Creek and an unnamed tributary to Little Limestone Creek. Much of Jonesborough's development has occurred in the floodplain of these two watersheds. The recommended plan consists of constructing a training dike, a box culvert, and a culvert outlet into the Little Limestone Creek. Several culvert sizes and alignments were considered, as was the "No-action" alternative.

2. In accordance with ER 200-2-2, Policy and Procedures for Implementing NEPA, a Detailed Project Report/Environmental Assessment (DPR/EA) has been prepared and circulated with the main report to other agencies and groups for review. The EA indicates no significant adverse environmental impacts would result from the proposed work. The proposed work would create a beneficial socioeconomic impact by reducing flood damages to historic Jonesborough. A cultural resource assessment of the proposed project was conducted in accordance with the District's responsibilities under Section 106 of the National Historic Preservation Act. Construction of the Jonesborough project would take place within the National Register property; however, that effect would not be adverse. Revegetation and preservation of some existing trees would minimize future erosion and aesthetic impacts. The work along the Little Limestone and the unnamed tributary is above headwaters. Impacts from these activities have no significance and have been previously permitted for purposes of 404 under Department of Army Nationwide Permit effective January 21, 1992 [33 CFR 330 (26)]. The proposed work is not expected to affect any Federally-listed endangered or threatened species or prime farmland.

3. I have reviewed the DPR/EA for Flood Damage Reduction, Jonesborough, Tennessee, and responses to its review. In addition, although not required, I have prepared a Section 404(b) evaluation to provide information to the Tennessee division of Water Pollution Control in its evaluation of the work. On March 28, 1994 an Aquatic Resource Alteration Permit was issued by the Tennessee Division of Water Pollution Control for this work. In light of the general public interest, I have determined that the work would not constitute a major federal action significantly

affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969. Accordingly, I have concluded that an Environmental Impact Statement covering the proposed work is not required. Further, having weighed the potential benefits that may be accrued as a result of implementing the recommended plan against the reasonable foreseeable detrimental effects, I conclude that the flood damage reduction project at Jonesborough, Tennessee would be in the public interest.

Date: 30 March 1994

J. David Norwood
LTC, Corps of Engineers
District Engineer

APPENDIX A

PROJECT ECONOMICS

APPENDIX A
ECONOMICS
PRELIMINARY DRAFT
DETAILED PROJECT REPORT
JONESBOROUGH, TENNESSEE
FLOOD DAMAGE REDUCTION STUDY

APPENDIX A - ECONOMICS

Paragraph	Description	Page
Section 1	JONESBOROUGH AND THE PRESENT SITUATION	
1.0	Introduction	A-3
1.1	Historical Significance	A-3
1.2	Archetictural Significance	A-3
1.3	Historical Preservation Programs	A-3
1.4	Regional Preservation Programs	A-3
1.5	Regional Attractions	A-3
1.6	Justification of Study	A-4
1.7	Report Methodology	A-4
1.8	Legal Mandate for Preservation of Historical Sites	A-4
Section 2	SOCIO-ECONOMICS	
2.0	Location	A-4
2.1	Population	A-5
2.2	Employment	A-5
2.3	Transportation	A-5
Section 3	ECONOMICS	
3.0	Prelude	A-5
3.1	General	A-5
3.2	Average Annual Benefits	A-5
3.3	Structure File	A-6
3.4	Depth Damage Relationships	A-6
3.5	Profiles	A-6
3.6	Damages and Benefits	A-6
3.7	Number of Structures Innundated	A-6
3.8	Summary Analysis	A-7
Section 4	ADDITIONAL BENEFITS	
4.0	Intangible Benefits	A-7
4.1	Unclaimed Benefits	A-7
4.2	Intensification	A-7
4.3	Educational	A-7
4.4	Regional Benefits and Tourism	A-8
4.5	Visitation	A-8
4.6	Closing Comment	A-8

SECTION 1 - Jonesborough and the Present Situation

1.0 Introduction - In 1969, the National Park Service officially announced that the Jonesborough Historic District was recorded in the National Register of Historic Places and was to be the first district so designated in the state of Tennessee. Jonesborough, located in the northeastern corner of Tennessee, possesses some of the richest historic ground in America. Today, much of the architectural styles of the past can be seen throughout the town. Because of the District's historical significance and in order to preserve some of our Nation's heritage, a flood damage reduction project in this area has special value and importance.

1.1 Historical Significance - Jonesborough was the first planned community in the United States, West of the Appalachians. It was at one time the home of President Andrew Jackson and visited by many other Presidents. It was here in the Washington County courthouse that Andrew Jackson was admitted to the bar, and, a few years later, he presided as judge. Jonesborough's residents also included such legendary figures as Daniel Boone, Davy Crockett, President Andrew Johnson, and John Sevier. A walk through the downtown district presents one with a mix of historical events and a blend of architectural styles handed down through the years.

1.2 Architectural Significance - Chartered by the state of North Carolina in 1779, this small town was once the center of urban life on the Tennessee frontier. Among its treasures are the Chester Inn (1797), Sister's Row (1820), and the Christopher-Taylor log cabin which once housed as a boarder the young frontier lawyer named Andrew Jackson. Jonesborough appeals to both leisure and commercial travelers, as they are delighted with its Bed & Breakfast homes and its many craft, gift and antique shops.

1.3 Historic Preservation Programs - The northeast Tennessee region was recently selected, by the National Trust for Historical Preservation and the Tennessee Department of Tourist Development, to participate in a three-year Heritage Tourism Program to develop long-range preservation and marketing plans. Jonesborough played an important role in the application process, and hosted a Public Hearing Reception to educate the community on the program. This early historic preservation program will serve as a model to other towns in the pilot program, which consists of only four states - Tennessee, Texas, Indiana, and Wisconsin.

1.4 Regional Preservation Programs - In recent years, NAPPS (National Association for the Preservation and Perpetuation of Storytelling) has established Jonesborough as the Nations center for story telling. This has boosted the economy of the community as people come in from all over the nation to participate and take-in the story telling activities. The Tennessee Historical Commission has recently funded 1.5 million dollars for restoration of structures in Jonesborough. Other monies from private sources are being spent to restore other historically valuable homes in Jonesborough.

1.5 Regional Attractions - The roots of Tennessee and America as a Nation are deeply embedded in the mountainous terrain of the area known as "First

terrain and natural setting gives the opportunity for a highly diversified life-style.

2.1 Population - Washington County's population was over 91,000 in 1987. Population within a 300 mile radius is approximately 33,500,000.

2.2 Employment - Total employment for Washington County reached 51,850 through 1987, a 33 percent increase from 1970. The state of Tennessee's total employment increased 29 percent from 1970 to 1987. Manufacturing and service industries each comprise approximately 20 percent of the total work force in the county. Washington County's unemployment rate averaged 6.0 and 5.5 percent in 1987 and 1988 respectively. The state of Tennessee's unemployment rate averaged 5.8 percent for 1988.

2.3 Transportation - Washington County, Jonesborough, and Johnson City all have adequate transportation facilities that tie in with other counties in the area. Interstate 75 and numerous U.S. and state highways along with various county roads provide excellent transportation. The county's air traffic needs are served by the Tri-City Regional Airport which is located just north of Johnson City. This network of transportation facilities provides easy access to any attractions within the region.

SECTION 3 - ECONOMIC ANALYSIS

3.0 Prelude - In the following analysis, conventional flood control benefits have been computed; while the cultural and historical benefits are evaluated in Section 4. Conventional benefits alone support the selected plan without the addition of any cultural benefits. Still, considerable weight should be placed on the fact that there are cultural and historical benefits that would be preserved for the future generations to learn from and enjoy.

3.1 General - This economic analysis determined economic efficiencies associated with alternative plans as part of the plan selection process and determined the benefit to cost ratios (BCR) which are used in the "ability to pay" determinations. These damages were calculated through the use of a computer program that compared the first floor, elevations, river mile location and depth-damage relationships of each structure with the associated hydraulic profiles. A database management system was also used to group data and aggregate totals for specific sets of conditions. Benefits were determined in accordance with Principal and Guidelines dated 10 March 1983 and ER 1105-2-100 dated 28 December 1990. All costs were calculated as described elsewhere in this report. Specific methodologies and findings are discussed in the following paragraphs.

3.2 Average Annual Benefits - Average annual benefits are the difference of average annual damages or costs with and without the proposed flood control measures. These values are the area under the damage-frequency curve. Mechanically, they are produced through integration of the structure file, depth-damage relationships, and hydraulic profiles. The Nashville District's DIRB (Damage Inundation Reduction Benefit) computer

while Tables A-7 through A-12 illustrate the the proposed 25, 50, and 100 year culvert alternatives.

3.8 Summary Analysis - Along the tributary of Litte Limestone Creek, there are numerous structures which benefit from the 100-year, 50-year and 25-year culvert designs. All the alternatives reduced the number of structures damaged and primary damages at the lower event frequencies, (see Tables A-3 through A-14). However, the 25-year culvert enlargement proposal produces the most net benefits at $25,000 and the highest benefit cost ratio of 1.44 (see Table A-2).

SECTION 4 - ADDITIONAL BENEFITS

4.0 Intangible Benefits - In addition to the flood control benefits, the cultural and historical benefits have been evaluated. These benefits and a detailed explanation as to the nature of these benefits is listed below. These benefits are similar to those presented in the "Hannibal Missouri" local flood protection report.

4.1 Unclaimed Benefits - Extending the life of very old historical structures in the floodplain with a proposed plan: These old and fragile buildings that experience basement water damage in low frequency floods are slowly decaying away. Many of these antique masonary structures have been weakened in their foundations by low frequency events. Through the years, flooding has dissolved much of the lime in the mortar thus producing costly repairs. These foundation damages to much older buildings are not being claimed. It would not be cost effective to undertake the analysis. With a project in place the repair and demolition costs of structures with failing foundations and superstructures is eliminated.

4.2 Intensification - By protecting structures, more desirable businesses are established and higher rents and values follow. Also, buildings vacant because of high flood risk are now safe with a project in place and are open for business prospect. By protecting this historical area and taking it out of a flood threatened situation, more novel business opportunity would develop that would not develop elsewhere. In other words, novelty shops associated with the Jonesborough theme would rather be located in the downtown historical district.

4.3 Educational - Jonesborough, Tennessee's oldest town and the first capitol of the Lost State of Franklin, makes a wonderful day trip for school groups in this region. In the 1989-90 school year 2,711 school children came to Jonesborough for numerous scheduled activities and learning experiences. Total visitation to the visitors center and museum was 56,000 in the same period. However, this total represents only those who signed the register at the museum. With time and improvements to this historical area, visitation is anticipated to increase. Flooding problems will not only endanger this visitation but will also endanger personal property and lives.

4.4 Regional Benefits and Tourism - A tremendous commitment to historical preservation exist among the people of this area. Jonesborough is the centerpiece of historical preservation in this region. This town plays an

TABLE A-1

AVERAGE ANNUAL STRUCTURAL DAMAGES AND BENEFITS
EXISTING AND WITH PROJECT CONDITIONS

ALTERNATIVES	AVERAGE ANNUAL DAMAGES	AVERAGE ANNUAL BENEFITS
EXISTING CONDITIONS		
Little Limestone Creek	$9,340	N/A
Tributary	$85,922	N/A
25 YEAR CULVERT	$3,993	$81,930
50 YEAR CULVERT	$2,142	$83,780
100 YEAR CULVERT	$1,787	$84,135

TABLE A-2

ECONOMIC ANALYSIS
JONESBOROUGH, TENNESSEE
(OCTOBER, 1993 DOLLARS, I=8%, N=50 YEARS)

COSTS AND BENEFITS:	**25-YEAR CULVERT**	**50-YEAR CULVERT**	**100-YEAR CULVERT**
REAL ESTATE	$45,100	$45,100	$45,100
OTHER COST	$601,254	$677,704	$803,737
TOTAL PROJECT COST	$646,354	$722,804	$848,837
INTEREST DURING CONSTRUCTION	$13,903	$15,388	$17,836
TOTAL INVESTMENT WITH IDC	$660,257	$738,192	$866,673
ANNUAL INVESTMENT COST	$55,526	$62,080	$72,885
ANNUAL O&M COST	$1,200	$1,387	$1,495
TOTAL ANNUAL COST	$56,726	$63,467	$74,380
AVERAGE ANNUAL BENEFITS	$81,930	$83,780	$84,135
BENEFIT COST RATIO (BCR)	**1.44**	**1.32**	**1.13**
NET BENEFITS	**$25,204**	**$20,313**	**$9,755**

TABLE A-5
NUMBER OF STRUCTURES RECEIVING DAMAGE
BY EVENT AND STRUCTURE TYPE
EXISTING CONDITIONS

Tributary to Little Limestone Creek

Type of Structure	2 Year Flood Event	5 Year Flood Event	10 Year Flood Event	25 Year Flood Event	50 Year Flood Event	100 Year Flood Event	500 Year Flood Event
RESIDENTIAL	1	1	2	2	2	2	2
AUTOMOBILE	1	1	1	1	1	1	1
COMMERCIAL	8	8	9	10	10	10	10
TOTAL	9	9	11	12	12	12	12

*Excluding Automobiles

TABLE A-6
DAMAGE BY EVENT AND STRUCTURE TYPE ($)
EXISTING CONDITIONS

Tributary to Little Limestone Creek

Type of Structure	2 Year Flood Event	5 Year Flood Event	10 Year Flood Event	25 Year Flood Event	50 Year Flood Event	100 Year Flood Event	500 Year Flood Event
RESIDENTIAL	1033	2671	3187	4031	4968	6351	8724
AUTOMOBILE	143	379	437	542	689	932	1339
COMMERCIAL	37748	52822	57274	65843	73587	81629	95639
CONTENT	47438	61148	65048	72928	79374	86143	103168
TOTAL	86362	117020	125946	143344	158618	175055	208870

TABLE A-9
NUMBER OF STRUCTURES RECEIVING DAMAGE
BY EVENT AND STRUCTURE TYPE
50-YEAR CULVERT PLAN

Tributary to Little Limestone Creek

Type of Structure	2 Year Flood Event	5 Year Flood Event	10 Year Flood Event	25 Year Flood Event	50 Year Flood Event	100 Year Flood Event	500 Year Flood Event
RESIDENTIAL	0	0	0	0	1	1	1
AUTOMOBILE	0	0	0	0	1	1	1
COMMERCIAL	0	0	0	3	4	5	9
TOTAL	0	0	0	3	5	6	10

*Excluding Automobiles

TABLE A-10
DAMAGE BY EVENT AND STRUCTURES TYPE ($)
50-YEAR CULVERT PLAN

Tributary to Little Limestone Creek

Type of Structure	2 Year Flood Event	5 Year Flood Event	10 Year Flood Event	25 Year Flood Event	50 Year Flood Event	100 Year Flood Event	500 Year Flood Event
RESIDENTIAL	0	0	0	0	45	342	4164
AUTOMOBILE	0	0	0	0	6	46	595
COMMERCIAL	0	0	0	3762	13001	28283	69362
CONTENT	0	0	536	3268	10127	39326	76338
TOTAL	0	0	536	7030	23179	67997	150459

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B
HYDROLOGY & HYDRAULICS

CLIMATOLOGICAL DATA. The average temperature for Jonesborough, TN, is approximately 56 degrees Fahrenheit (F). The highest recorded temperature was 102 degrees F while the lowest recorded was minus 15 degrees F. The average annual precipitation is 41.5 inches. The month with the highest average monthly precipitation is July with 4.98 inches while October has the lowest average precipitation of 2.25 inches.

SUMMARY OF FLOOD SITUATION. The principal sources of flooding in Jonesborough are Little Limestone Creek and an unnamed tributary to Little Limestone Creek herein referred to as Unnamed Tributary. Much of Jonesborough's development has taken place in the floodplain of these waterways. Little Limestone Creek originates approximately two miles east of Jonesborough and flows through the heart of the town. The drainage area of Little Limestone Creek at the State Highway 81 bridge (RM 12.6) and at the mouth of Unnamed Tributary (RM 13.7) is 4.21 and 1.53 square miles, respectively. The drainage area of Unnamed Tributary above its mouth is 1.24 square miles. The average width of the basin is about three miles. The upper reaches of the watershed are characterized by steep valleys and sharp ridges. Elevations range from 1880 in the headwaters to 1660 near the southwestern edge of the corporate limits. From the headwaters to the mouth of Unnamed Tributary, Little Limestone Creek has an average slope of 60 feet per mile and downstream of Unnamed Tributary the slope flattens out to approximately 21 feet per mile. Unnamed Tributary has a fairly uniform slope of about 50 feet per mile.

Rapid runoff from the drainage basin is due to the steep, urbanized, and largely unforested valleys which characterize the area. The largest flood known to have occurred on Little Limestone Creek since May 1901 was the flood of June 1928, with a recurrence interval of approximately 110 years. The flood of May 1958 was the highest flood in recent years, with a recurrence interval of approximately 100 years, and caused heavy damage for some 20 businesses.

The August 1977 flood demonstrates that the flooding problems in Jonesborough can be caused by localized storms, usually in the summer. These summer type thunderstorms can cause flooding in some areas and totally or partially bypass another adjacent drainage basin. **Table B-1** lists some of the large floods that have occurred in Jonesborough. This table was extracted from a flood damage reduction study for Jonesborough produced for TVA by Lamar Dunn and Associates, Inc., under subcontract from Russell and Axon, Engineers-Planners-Architects, Inc.

HYDROLOGIC ANALYSIS. The hydrologic information gathered in the earlier reconnaissance study was reviewed and adopted for this feasibility study. Peak discharges for the 10, 50, 100, and 500 year events were developed by TVA for FEMA's Jonesborough FIS, completed in March 1982, and were determined from frequency curves developed using procedures outlined in the U.S. Water Resources Council's Bulletin 17A, including adjustments for historical information where available. From a discharge-frequency plot of this data, the peak discharges for the 2, 5, and 25 year events were determined. The chance of the 2, 5, 10, 25, 50, 100, or 500 year event occurring in any one year is 50%, 20%, 10%, 4%, 2%, 1%, or 0.2%, respectively. Frequency discharges for Little Limestone Creek and Unnamed Tributary are given in the following table for selected events.

Table B-2 Summary of frequency discharges.

	PEAK DISCHARGES (cfs)						
LOCATION	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	500 YR
LITTLE LIMESTONE CREEK							
mile 12.6	470	700	860	1,020	1,320	1,500	2,100
mile 14.6	80	170	260	360	450	550	820
UNNAMED TRIBUTARY							
mouth	190	290	370	490	610	740	1,050
mile 0.6	120	220	300	420	510	630	900

HYDRAULIC ANALYSIS. A hydraulic analysis was performed using the HEC-2 models of Little Limestone Creek and Unnamed Tributary developed by TVA for the FIS. (See **Figure B-1** for site map.) The model of Little Limestone Creek extended between river miles 8.60 and 13.76. The model of Unnamed Tributary was broken into two reaches: over the existing culvert (RM 0.04 to 0.09), and upstream of the existing culvert (RM 0.09 to 0.65). These models were used to develop water surface profiles for the various frequency discharges considered for the existing conditions (see **Figures B-2** and **B-3**) and for proposed alternatives.

THE EXISTING CULVERT. The existing culvert carrying Unnamed Tributary beneath downtown Jonesborough has evolved in a piece-meal fashion over the years. At the inlet, two pairs of 36" culverts cross under Sabin Street and intersect at the head of a box culvert which runs beneath the alley between the Exxon station and White's Auto Parts. The box culvert crosses under Main Street and runs beneath a concrete block structure adjacent to the old fire station building (now divided into shops), ending at the downstream wall. Unnamed Tributary then flows in an open channel behind the 10-Plex Apartments before emptying into Little Limestone Creek at river mile 13.68. Both the cross-sectional shape and area of the culvert change abruptly and often along its length of approximately 370 feet. Piers and cables bisect the culvert and a portion of the box culvert beneath the old fire

in **Figure B-6**. **Figure B-7** provides a discharge rating curve at the culvert inlet (RM 0.09) for this alternative.

Alternative B. Designing for the 50 year event, a single RCBC 8 feet wide by 6 feet high (with inlet and outlet invert elevations of 1685.75 and 1682.00, respectively) along with a levee with a crest elevation of 1694.5 would be required in addition to the existing culvert. Overflow through downtown Jonesborough would be eliminated for all events up to the 50 year event while overflow for the 100 and 500 year events would be reduced by about 81% and 57%, respectively. The resulting water surface profiles are given in **Figure B-8**. **Figure B-7** provides a discharge rating curve at the culvert inlet for this alternative.

Alternative C. Designing for the 25 year event, a single RCBC 6 feet wide by 6 feet high (with inlet and outlet invert elevations of 1685.75 and 1682.00, respectively) along with a levee with a crest elevation of 1694.5 would be required in addition to the existing culvert. Overflow through downtown Jonesborough would be eliminated for all events up to the 25 year event while overflow for the 50, 100, and 500 year events would be reduced by about 75%, 68%, and 43%, respectively. The resulting water surface profiles are given in **Figure B-9**. **Figure B-10** provides a discharge rating curve at the culvert inlet for this alternative.

Alternative D. For events with a 10% or greater chance of exceedance in any one year (the "10 year" event), a single RCBC 8 feet wide by 6 feet high would be required in addition to the existing culvert. No inlet-control levee would be required for this alternative. (Due to the low level of protection provided by this alternative, it was designed such that it could later be upgraded to a higher level of protection by adding an inlet-control levee and making some minor alterations to the existing storm drainage system.) There would be no overflow through downtown Jonesborough for the 2, 5, and 10 year events while overflow for the 25, 50, 100, and 500 year events would be reduced by 80%, 58%, 33%, and 25%, respectively. The resulting water surface profiles are given in **Figure B-11**. **Figure B-10** provides a discharge rating curve at the culvert inlet for this alternative.

Other Alternatives Considered. Reinforced concrete pipe (RCP) and polyethylene pipe (PEP) were also considered for this project. Precast RCP is more economical than large RCBC which must be constructed at the site while PEP is cheaper to transport and place than either RCP or RCBC due to its light weight and flexibility, while RCBC generally provide a larger discharge capacity compared with RCP or PEP which will fit into the same size of excavation. At the Jonesborough site, it was found that major utilities (most notably the telephone trunk lines which are extremely expensive to relocate and/or reconstruct) and building

in the water surface elevation on Unnamed Tributary were found to have no significant adverse effect for any alternative for the events considered.

For the economic analysis, structures were assigned a river mile based on the waterway which most affected them. Structures between Little Limestone Creek and Main Street were assigned to Little Limestone Creek. While Unnamed Tributary begins overflowing the culvert at between the 5 and 10 year events for existing conditions, Little Limestone Creek begins affecting structures in the flow path soon after and, therefore, it is expected that damages in this area are due primarily to flooding from Little Limestone Creek. Structures between Main and Sabin Streets were assigned to the overflow reach of Unnamed Tributary. Flooding of these structures by Little Limestone Creek was accounted for by adjusting starting water surface elevation of the Unnamed Tributary's overflow model to reflect the water surface elevation on Little Limestone Creek where necessary or, for events which do not produce overflow during project condition runs, by setting the water surface elevation in the overflow reach equal to the water surface elevation on Little Limestone Creek. (The Little Limestone Creek water surface elevation at the upper end of this reach was input first to identify structures susceptible to this type of flooding and it was found that only structures corresponding to this river mile were affected.) Structures upstream of Sabin Street were assigned to Unnamed Tributary.

Since small variations in water surface elevations were felt to have a significant impact on the economic analysis of the alternatives, a sensitivity analysis of the water surface profiles was conducted. The FEMA FIS study indicated that water surface elevations were computed with an accuracy of 0.5 feet. In an attempt to break this generalized figure down on a reach basis, the models' sensitivity to changes in discharge was tested. From the U.S. Geological Survey's Bulletin 17A, the standard error in calculating discharges using the regression equations for the Jonesborough, TN, area is 45%. Based on this, profiles were calculated for discharges +/- 22.5% of the 10 year and 50 year discharges using the existing condition models. Overland flow on Unnamed Tributary was determined based on flow distribution curves provided by TVA. The resulting water surface profiles were compared to the profiles for the corresponding event. It was found that the Little Limestone Creek model is accurate to within about 0.50 feet between river miles 13.00 and 13.76, with respect to discharge uncertainty. The model for the Unnamed Tributary was found to be accurate within about 0.25 feet between river miles 0.04 and 0.39, 1.00 feet between river miles 0.39 and 0.45, and 0.50 feet between river miles 0.45 and 0.65, with respect to discharge uncertainty. Thus, it appears that the model is the least sensitive to errors in discharge in the overflow reach where the project has the most effect.

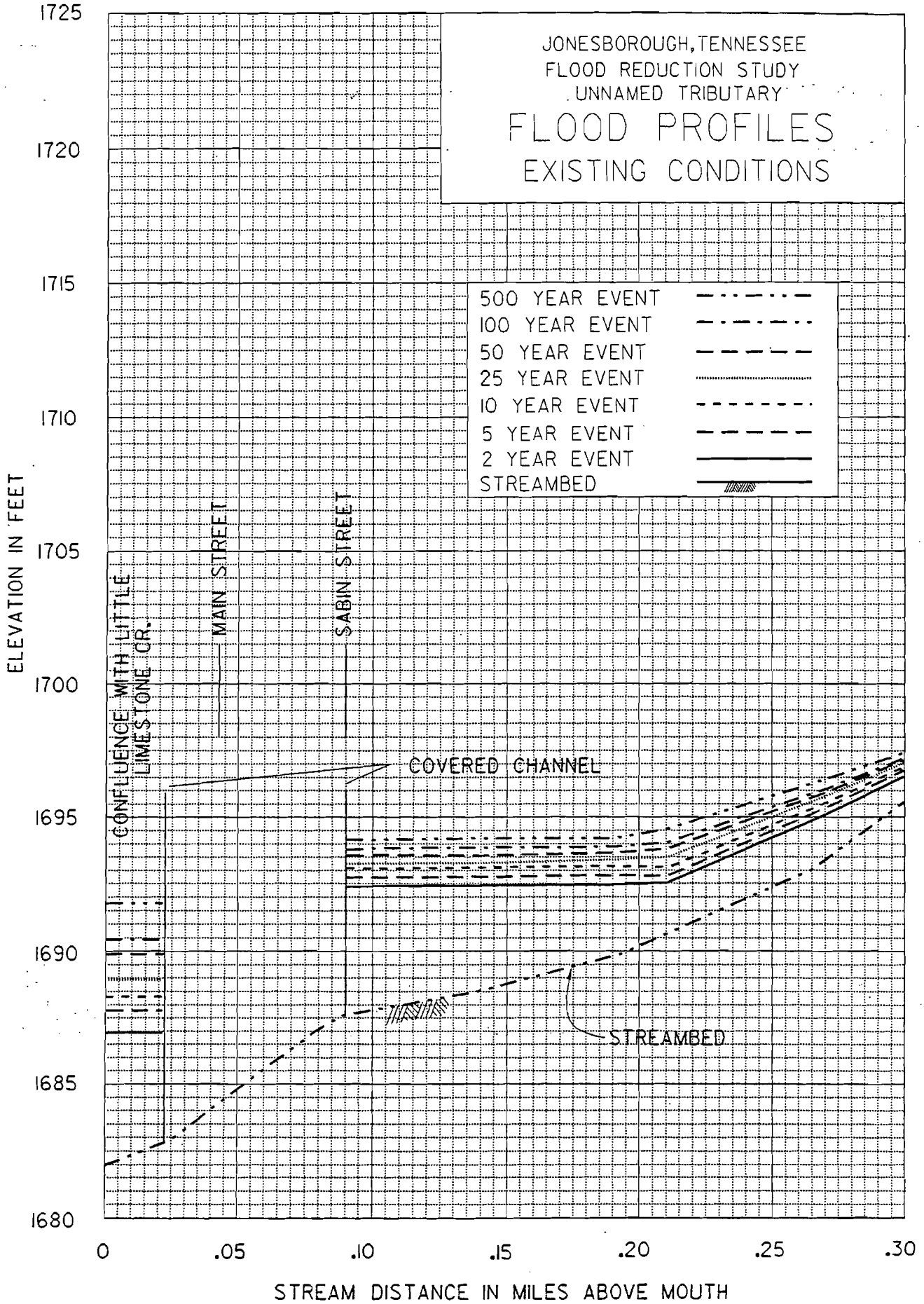

JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
FLOOD PROFILES
EXISTING CONDITIONS
500 YEAR EVENT
100 YEAR EVENT
50 YEAR EVENT
25 YEAR EVENT
10 YEAR EVENT
5 YEAR EVENT
2 YEAR EVENT
STREAMBED
ELEVATION IN FEET
1725
1720
1715
1710
1705
1700
1695
1690
1685
1680
CONFLUENCE WITH LITTLE LIMESTONE CR.
MAIN STREET
SABIN STREET
COVERED CHANNEL
STREAMBED
0
.05
.10
.15
.20
.25
.30
STREAM DISTANCE IN MILES ABOVE MOUTH

FIGURE B-3

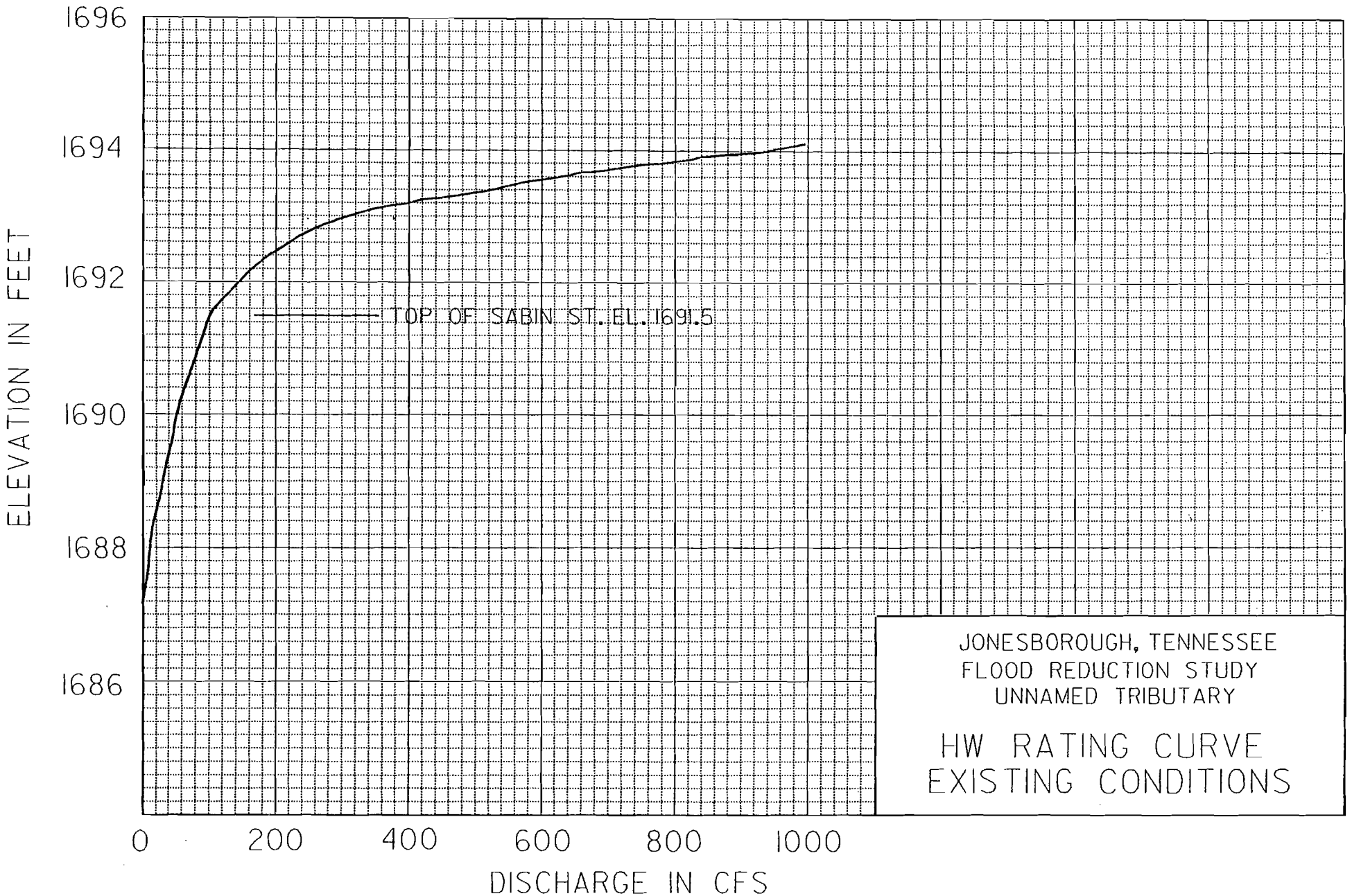

1696
1694
1692
1690
1688
1686
ELEVATION IN FEET
TOP OF SABIN ST. EL. 1691.5
0
200
400
600
800
1000
DISCHARGE IN CFS
JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
HW RATING CURVE
EXISTING CONDITIONS

FIGURE B-4

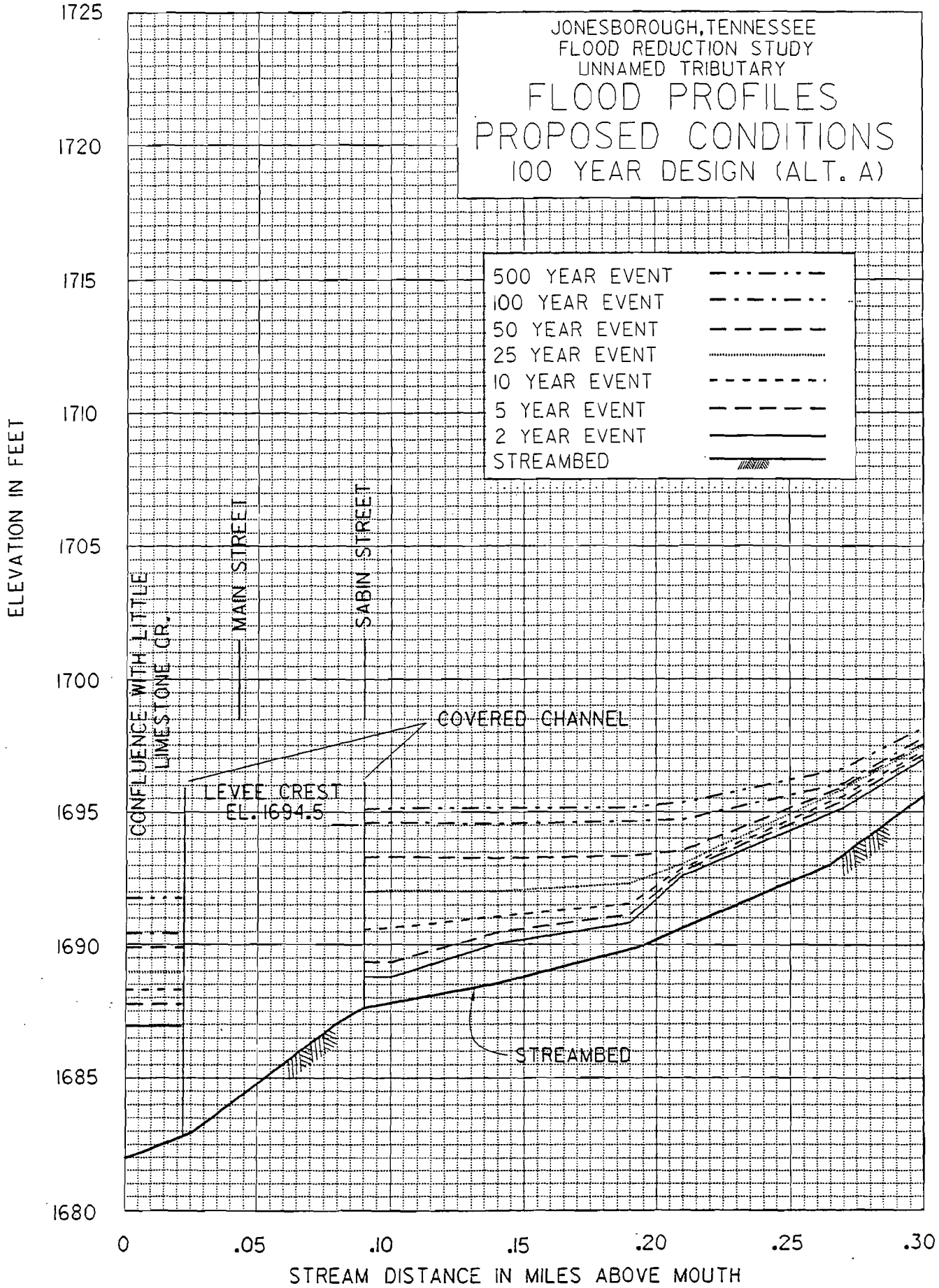
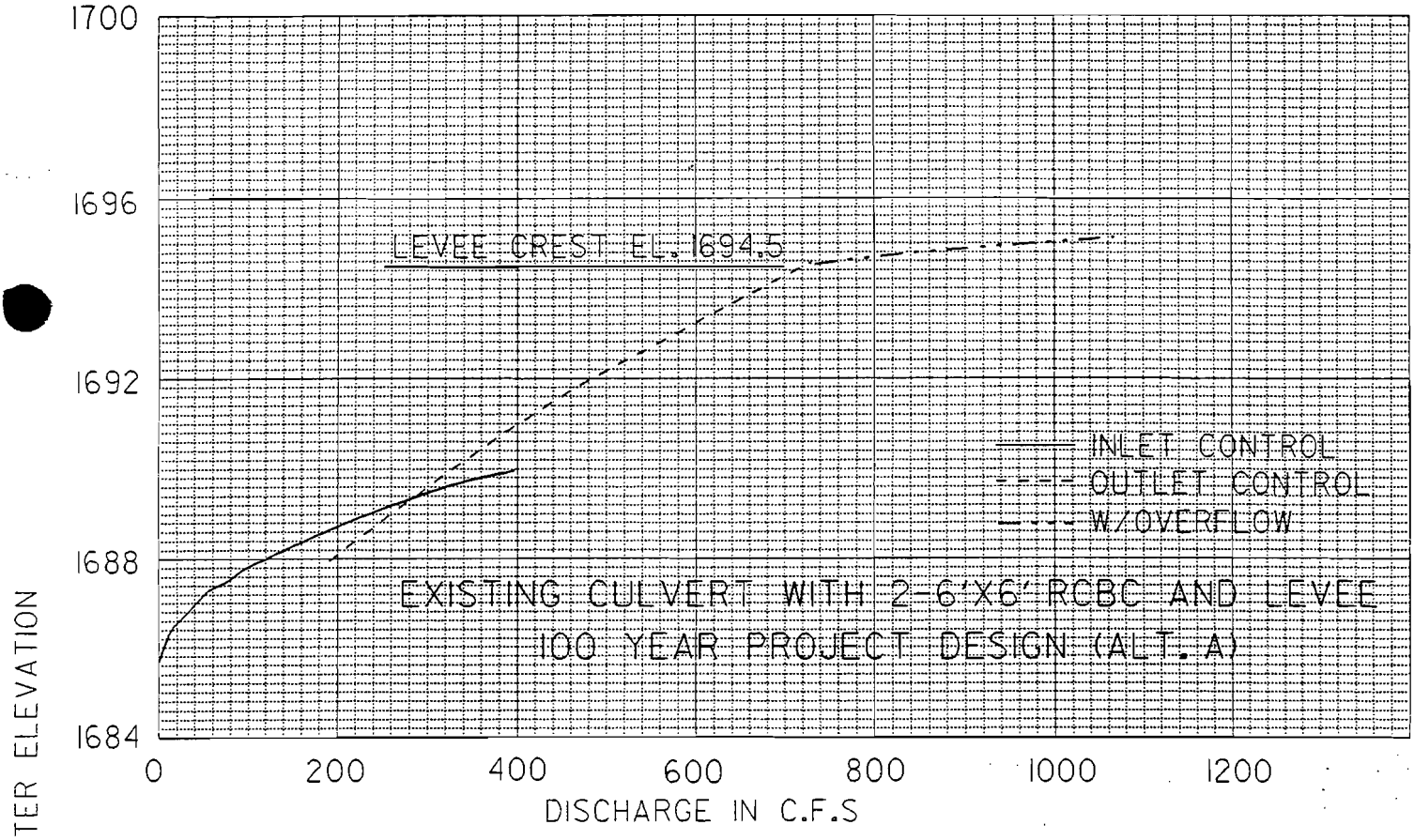
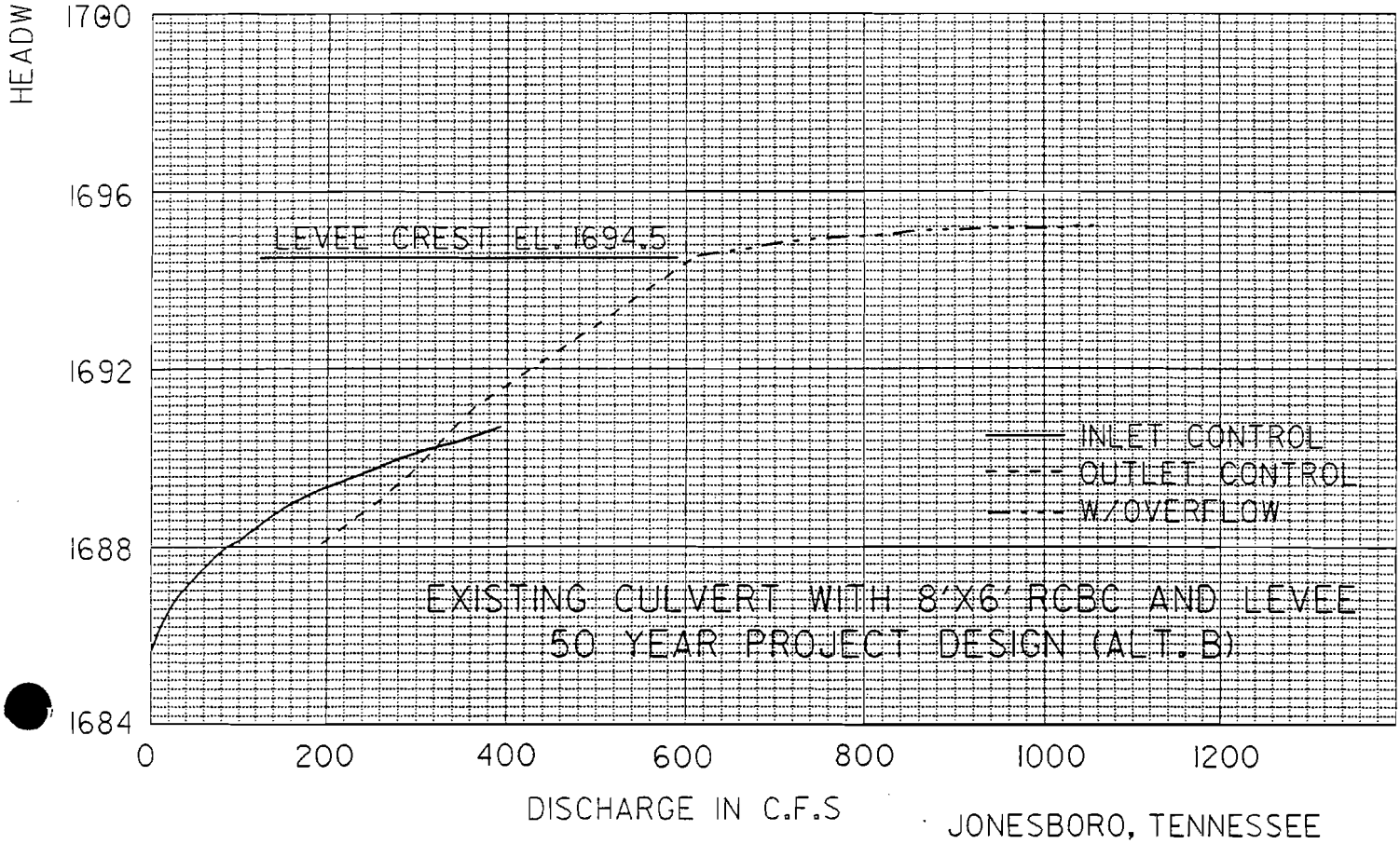

JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
FLOOD PROFILES
PROPOSED CONDITIONS
100 YEAR DESIGN (ALT. A)
500 YEAR EVENT
100 YEAR EVENT
50 YEAR EVENT
25 YEAR EVENT
10 YEAR EVENT
5 YEAR EVENT
2 YEAR EVENT
STREAMBED
ELEVATION IN FEET
1725
1720
1715
1710
1705
1700
1695
1690
1685
1680
CONFLUENCE WITH LITTLE LIMESTONE CR.
MAIN STREET
SABIN STREET
COVERED CHANNEL
LEVEE CREST
EL. 1694.5
STREAMBED
0
.05
.10
.15
.20
.25
.30
STREAM DISTANCE IN MILES ABOVE MOUTH

FIGURE B-6





JONESBORO, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
HW RATING CURVE @ RM 0.09

FIGURE B-7

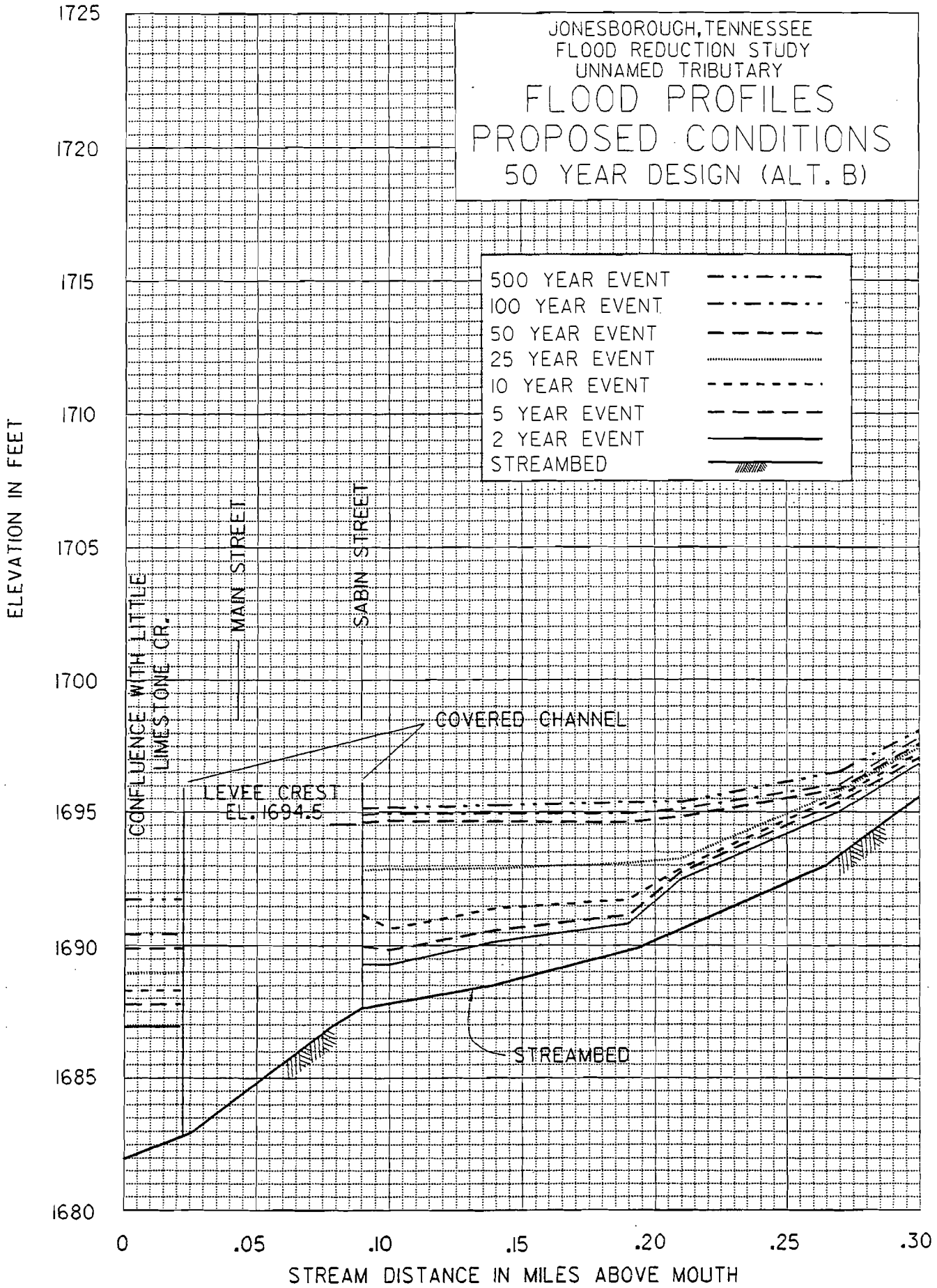

JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
FLOOD PROFILES
PROPOSED CONDITIONS
50 YEAR DESIGN (ALT. B)
500 YEAR EVENT
100 YEAR EVENT
50 YEAR EVENT
25 YEAR EVENT
10 YEAR EVENT
5 YEAR EVENT
2 YEAR EVENT
STREAMBED
ELEVATION IN FEET
1725
1720
1715
1710
1705
1700
1695
1690
1685
1680
CONFLUENCE WITH LITTLE LIMESTONE CR.
MAIN STREET
SABIN STREET
COVERED CHANNEL
LEVEE CREST EL. 1694.5
STREAMBED
0
.05
.10
.15
.20
.25
.30
STREAM DISTANCE IN MILES ABOVE MOUTH

FIGURE B-8

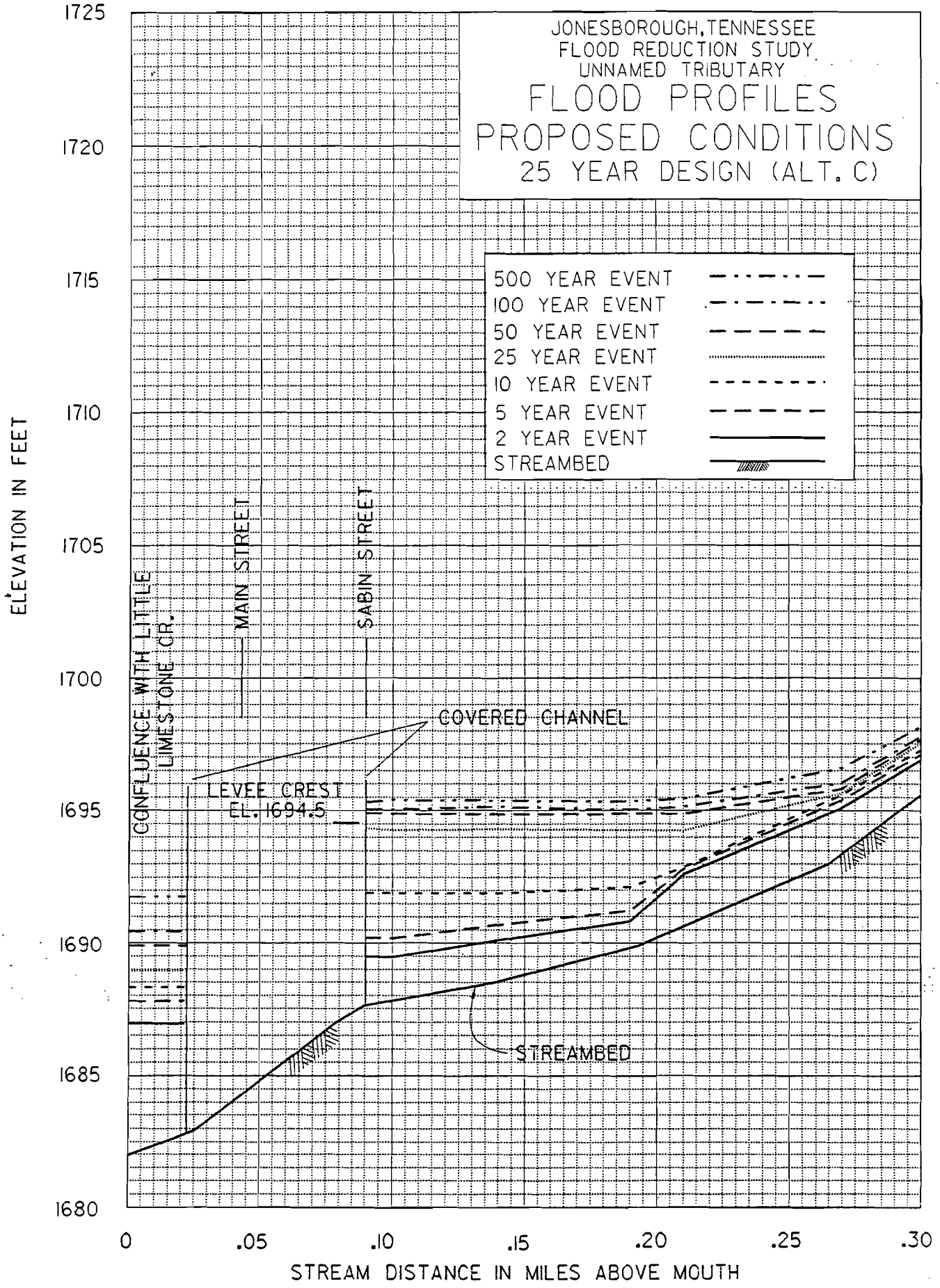
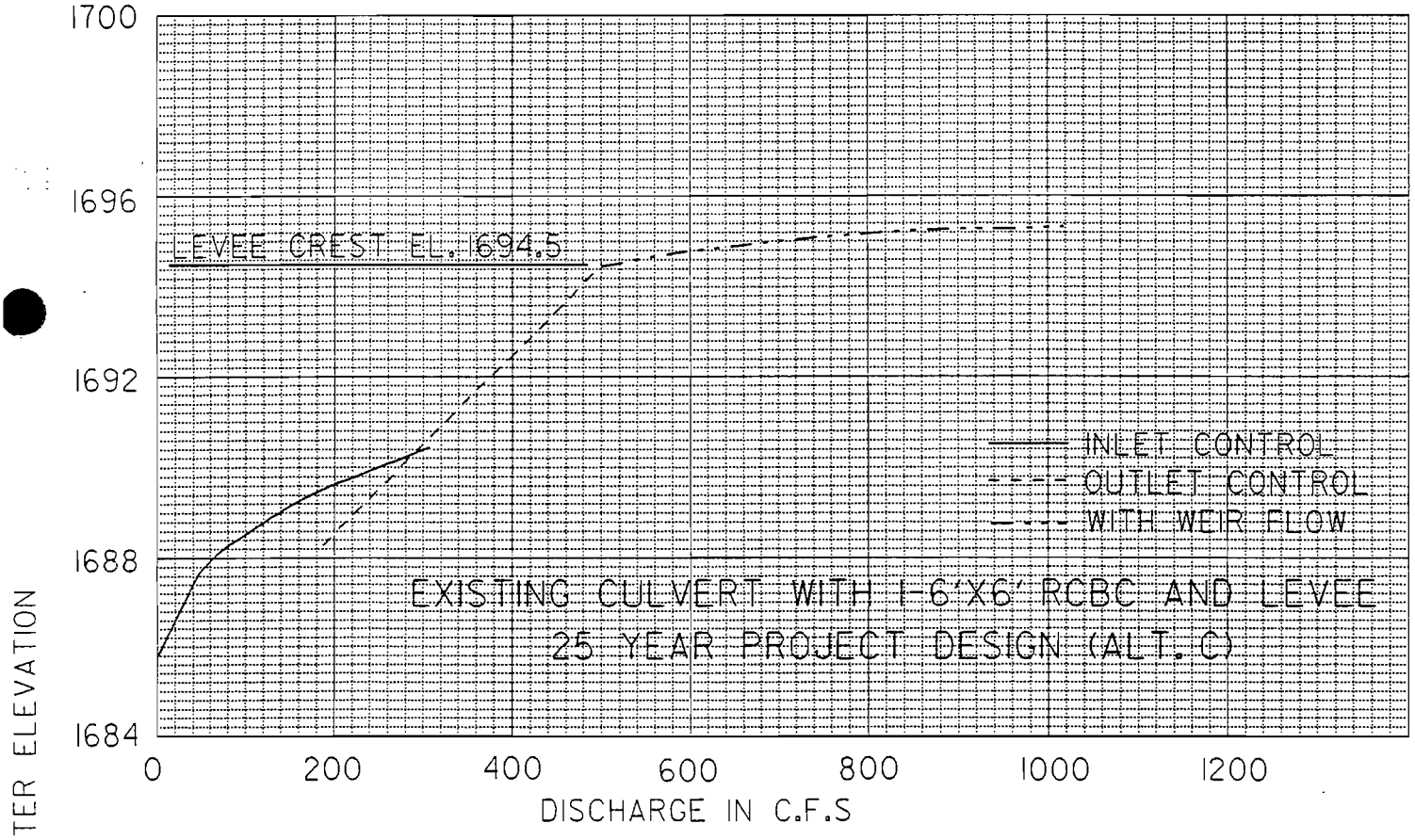
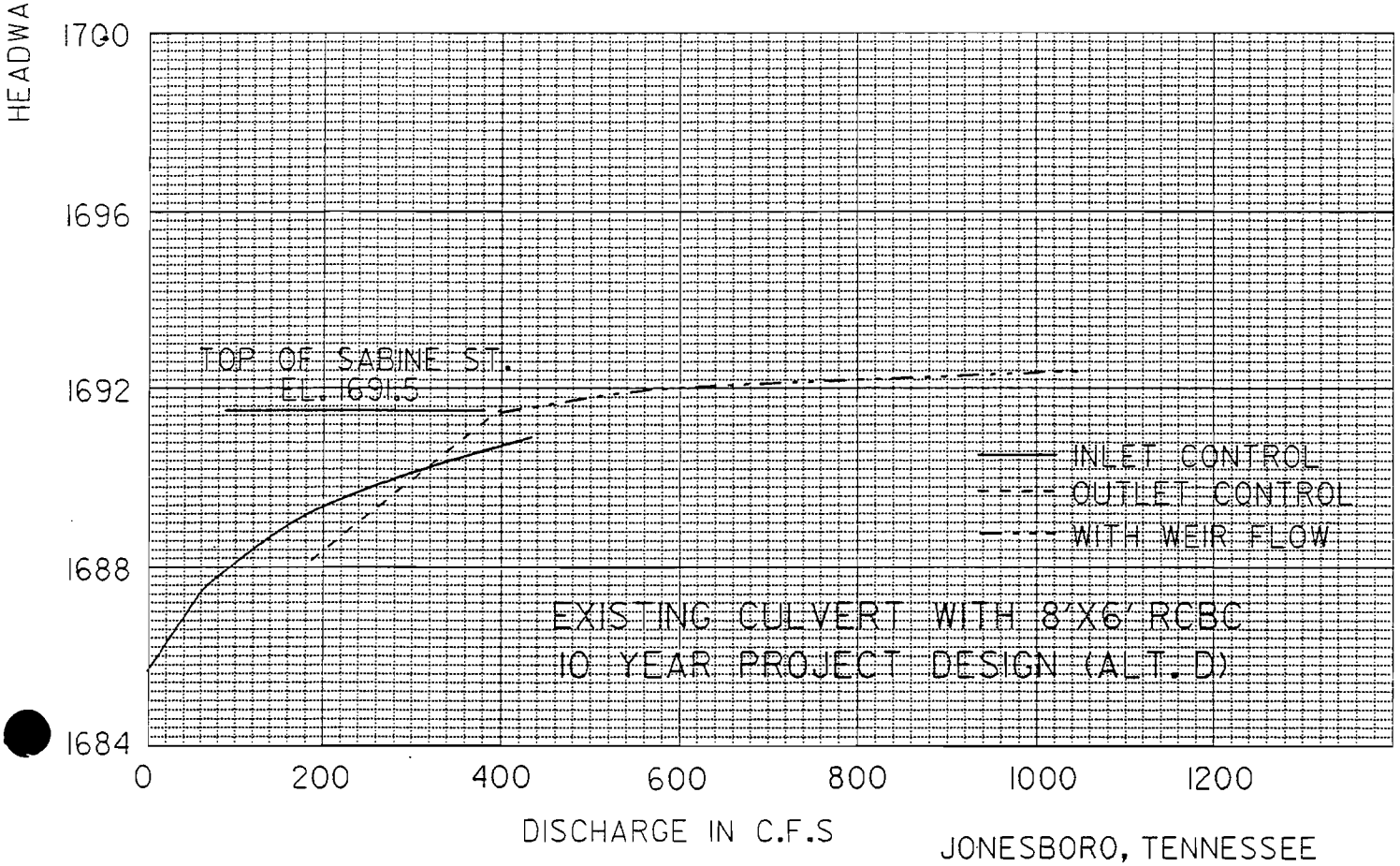

JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
FLOOD PROFILES
PROPOSED CONDITIONS
25 YEAR DESIGN (ALT. C)
500 YEAR EVENT
100 YEAR EVENT
50 YEAR EVENT
25 YEAR EVENT
10 YEAR EVENT
5 YEAR EVENT
2 YEAR EVENT
STREAMBED
ELEVATION IN FEET
1725
1720
1715
1710
1705
1700
1695
1690
1685
1680
CONFLUENCE WITH LITTLE LIMESTONE CR.
MAIN STREET
SABIN STREET
COVERED CHANNEL
LEVEE CREST
EL. 1694.5
STREAMBED
0
.05
.10
.15
.20
.25
.30
STREAM DISTANCE IN MILES ABOVE MOUTH

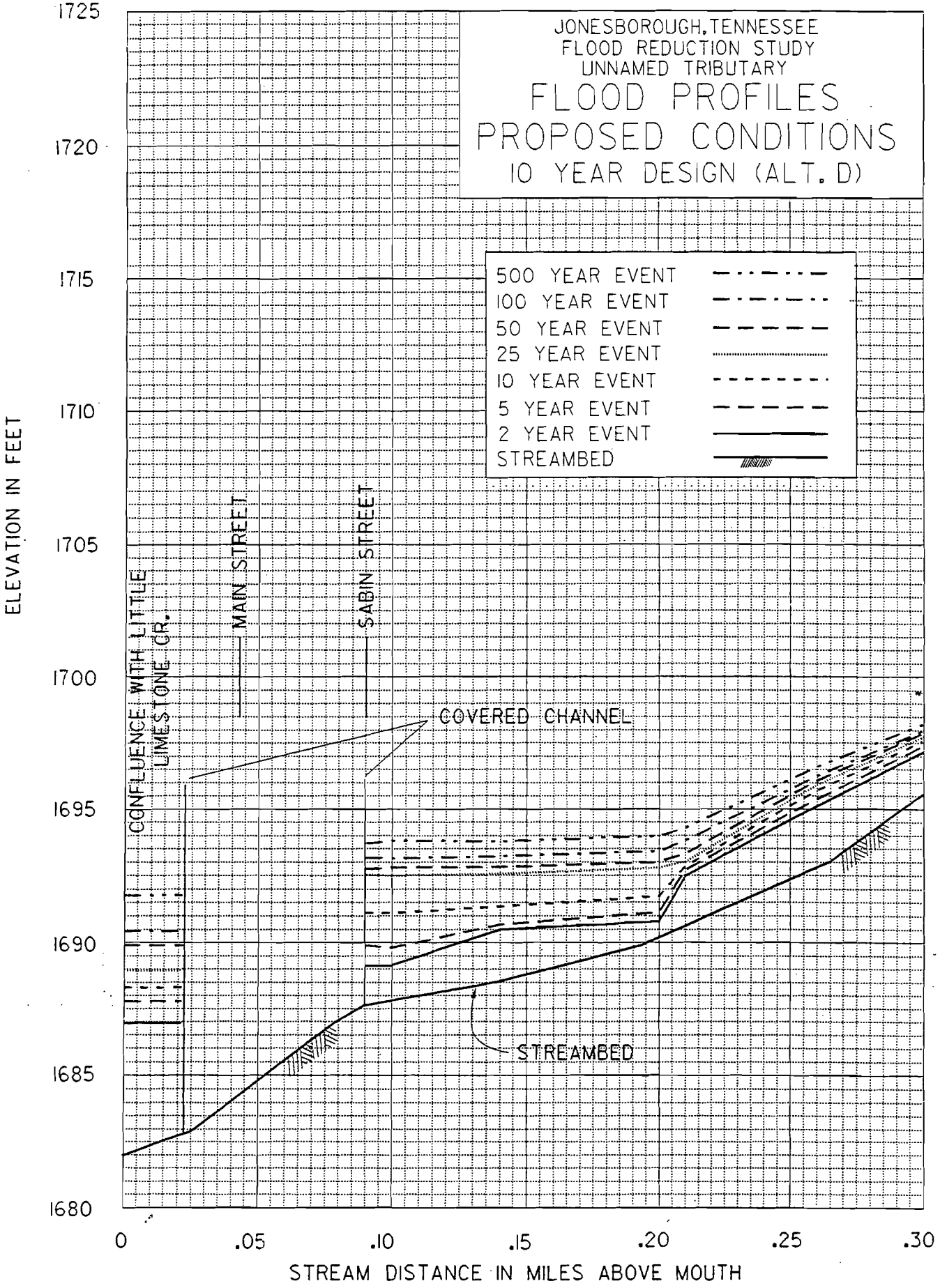
FIGURE B-9





JONESBORO, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
HW RATING CURVE @ RM 0.09

FIGURE B-10


JONESBOROUGH, TENNESSEE
FLOOD REDUCTION STUDY
UNNAMED TRIBUTARY
FLOOD PROFILES
PROPOSED CONDITIONS
10 YEAR DESIGN (ALT. D)
500 YEAR EVENT
100 YEAR EVENT
50 YEAR EVENT
25 YEAR EVENT
10 YEAR EVENT
5 YEAR EVENT
2 YEAR EVENT
STREAMBED
ELEVATION IN FEET
1725
1720
1715
1710
1705
1700
1695
1690
1685
1680
CONFLUENCE WITH LITTLE LIMESTONE CR.
MAIN STREET
SABIN STREET
COVERED CHANNEL
STREAMBED
0
.05
.10
.15
.20
.25
.30
STREAM DISTANCE IN MILES ABOVE MOUTH

APPENDIX C

GEOTECHNICAL

ASSESSMENT

APPENDIX C

GEOTECHNICAL ASSESSMENT

Geology of the Jonesborough Area.

Physiography. Jonesborough is located in Washington County in northeast Tennessee, within the Valley and Ridge physiographic province. The Valley and Ridge province is an area of northeast to southwest trending, parallel valley lowlands and narrow ridges which extends over 1200 miles, from the St. Lawrence valley to Alabama. In Tennessee its average width is about 40 miles.

Stream courses are closely related to the structure and composition of the underlying rocks. A fault trellis drainage pattern, a system of subparallel streams aligned along the strike of the rock formations, has developed in the area. Most of the smaller streams are located in the northeast to southwest trending valleys.

The Jonesborough area is drained by Little Limestone Creek. From it's origin about one mile north of Jonesborough, Little Limestone Creek flows generally southwest for a distance of about 12 miles, before joining the Nolichucky River.

Bedrock Structure. The Valley and Ridge province is underlain almost entirely by sedimentary rocks deformed by folding and faulting which occurred at the end of the Paleozoic era, about 230 to 260 million years ago. A series of parallel thrust faults has brought together alternating bands of strong and weak rock. The resulting surface outcrop is a repetitive sequence of essentially parallel belts which strike northeast to southwest.

Bedrock Stratigraphy. Bedrock is Upper Cambrian and Lower Ordovician carbonate rocks of the Knox Group. The Knox is composed of interbedded bluish-gray limestone and dolomite containing varying amounts of sand and clay. Beds range from a few inches to several feet in thickness and generally dip to the southeast at 15 to 40 degrees. Local variations occur where the strata have been folded or overturned by thrust faulting.

Overburden. Overburden is comprised of residual soils and alluvium. A mantle of red, clayey, residual soil exceeds 150 feet in some places. In addition to the soil formed in place by the decay of rocks, streams from the nearby Appalachian mountains have left alluvial deposits which are up to 50 feet thick in some areas. These unconsolidated deposits are not differentiated from bedrock on geologic maps of the area.

excavation to prevent failure of the foundation. The remainder of the trench will be supported with standard plank shoring. It is estimated that the quantity of excavation will be 4500 cubic yards for the 100-yr alternative, which requires a 20 feet trench width; 3000 cubic yards for the 50-yr alternative, requiring a 16 feet trench width, and 2000 cubic yards for the 25-yr alternative requiring an 11 feet trench width. The trench depth varies from 8 to 19 feet. It is assumed that the excavated material will be 80 percent alluvium (gravelly clay) and approximately 20 percent rock. Any rock that is encountered will be removed without blasting. This will be unsuitable for construction of the training dike due to the lack of clay material, however it may be used for backfill of the trench itself.

DIKE CONSTRUCTION. A training dike at the inlet will be constructed to help direct flow. Shaping of the invert area will also be required to insure proper flow into the culvert. The material for the construction of the training dike will be compacted clay. The total fill needed is estimated at 400 cubic yards of material. Excavation from the invert area and the outlet area will supply the necessary material for dike construction. The training dike will vary in height from less than 1 foot to just under 7 feet. The average height will be 3 feet and the top width will be 1 foot. The estimated length is 325 feet. The design of the training dike is at a 3H:1V to accommodate maintenance mowing.

OUTLET. The proposed outlet of the box culvert will be a channel protected by precast interlocking concrete blocks which exits into the Little Limestone Creek. Excavation and shaping of the channel area will be necessary to obtain the required volume for the computed flow. There will also be some shaping of Little Limestone Creek for placement of blocks. This excavated material will be used for the training dike construction.

APPENDIX D

RELOCATIONS

APPENDIX D
RELOCATIONS

1. The following text is a summary description of the relocations necessary for construction of the Jonesborough Flood Control Project:

2. The abundance of existing underground utilities made it imperative that the culvert alignment be designed to avoid as many of the utilities as possible. The existing utilities extending down and across Boone Street and Spring Street include overhead electric and telephone lines and underground sanitary sewers, storm severs, telephone lines, electric lines, natural gas lines, and water lines. Underground telephone lines running down Boone Street were found to be particularly costly to relocate and were deemed to be essential to avoid.

3. Utilities required to be relocated by construction of the culvert are shown below. All lengths are approximate. Sizes of utilities are based upon field collected data unless noted otherwise.

50 feet of 4-inch natural gas lines
125 feet of 2-inch natural gas lines
70 feet of 8-inch sanitary sewer line
80 feet of 18-inch sanitary sewer line
3 sanitary sewer manholes
10 feet of 12-storm sewer
35 feet of 18-inch storm sewer (approximate size)
2 gate valves and 2 flap gates
100 feet of 3/4-inch water line
25 feet of 1-inch water line
195 feet of 6-inch water line
4 six-inch valves
155 feet of 200 pair underground telephone lines
70 feet of underground electric lines

4. Costs for relocating water lines, sanitary sewer lines and manholes, storm sewers, and natural gas lines were based upon "Means Construction Cost Data". Telephone and electric relocations costs were obtained from United Telephone and Johnson City Power Board, respectively. Temporary traffic control during construction of the project was estimated using labor rates with overhead and profit for two flag persons during critical construction periods.

APPENDIX E

STRUCTURAL

DESIGN

APPENDIX E
STRUCTURAL DESIGN

General. This section covers the structural designs included in the flood reduction studies for Jonesborough. Concrete box culverts and concrete headwalls were designed for the 25 year, 50 year and 100 year protection plans. For this study, all structures were sized using designs from state highway standards, the Concrete Reinforcing Steel Institute (CRSI) handbook, and previously used designs. The concrete strength will be 3500 psi and the reinforcing steel will be Grade 60.

Culverts. The 100 yr. protection plan has a 450 ft. double 6 ft. x 6 ft. cast in place reinforced concrete box culvert. The double 6 ft. by 6 ft. box culvert designed for the Harlan Clover Fork gravity outlet was used to determine quantities for this culvert. The 50 yr. protection plan has a 450 ft. long 8 ft.(h) x 6 ft.(v) cast in place reinforced concrete box culvert. The 25 yr. protection plan has a 450 ft. long 6 ft.(h) x 6 ft.(v) cast in place reinforced concrete box culvert. The Illinois Dept. of Transportation Culvert Manual was used to determine member sizes and quantities for both the 50 yr. culvert and the 25 yr. culvert.

Headwalls. The inlet headwalls for the 100 yr., 50 yr. and 25 yr. protection culverts were designed to be integral with replacement headwalls for two existing precast concrete pipe which have inlets near the new culverts. The headwall were designed as retaining walls using CRSI design tables with level type "C" soil conditions. Since the levee height does not change for the two different levels of protection, both headwalls will have the same height. The 100 yr. headwall will have a total length of 78.1 ft. The 50 yr. headwall will have a total length of 75.5 ft. and the 25 yr. headwall will have a total length of 74.5 ft. Slush grouted riprap will be used at the entrance instead of a concrete apron. The outlet headwalls for the culverts were laid out and sized using the Harlan Clover Fork outlet headwall as a go by. The double headwall which will replace an existing headwall for two 36" precast concrete pipe was sized using Kentucky Bureau of Highways standard drawings.

APPENDIX F

REAL ESTATE

APPENDIX F
REAL ESTATE PLAN
JONESBOROUGH, TENNESSEE

Subject	Page
1.01 SCOPE	F-2
1.02 PROJECT COOPERATION AGREEMENT	F-2
1.03 REAL ESTATE ACQUISITION	F-2
1.04 GENERAL DESCRIPTION OF THE AREA	F-2
1.05 PROJECT SPECIFIC NARRATIVE	F-3
1.06 RELOCATION ASSISTANCE - PUBLIC LAW 91-646	F-3
1.07 ENVIRONMENTAL CONSIDERATIONS	F-4
1.08 TOTAL PROJECT COST	F-4

APPENDIX F
REAL ESTATE PLAN
LITTLE LIMESTONE CREEK
JONESBOROUGH, TENNESSEE

1.01 SCOPE: The scope of this Real Estate Plan (REP) includes estimating structure and land values and acquisition cost for inclusion in the Jonesborough Detailed Project Report (DPR). The real estate information is based on a field inspection by real estate personnel and on information furnished by the Nashville District Planning-Engineering Division. This Appendix is a draft of the Real Estate Plan (REP) and is based on early planning data which will be refined as more detailed information becomes available.

1.02 PROJECT COOPERATION AGREEMENT: Jonesborough, Tennessee and the United States of America will enter into an appropriate Project Cooperation Agreement (PCA) containing Section 221 provisions. A copy of the signed Feasibility Cost Sharing Agreement is included in the main report as Exhibit 1. The final PCA will be submitted as a stand alone document with the final DPR. The draft PCA is included as Exhibit 3 of the main report .

1.03 REAL ESTATE ACQUISITION: The local sponsor is responsible for all lands, easements, rights-of-way, and relocations (LERRDS), necessary for the project. The Town of Jonesborough will be the local sponsor.

No navigational servitude or federally owned lands are to be affected by the project. Most of the land in the project is owned by the Town of Jonesborough, Tennessee.

1.04 GENERAL DESCRIPTION OF THE AREA: This is the feasibility level of the Little Limestone Creek Project. Project area is located in the historic business district of Jonesborough, Tennessee. Jonesborough is located in upper east Tennessee and is the county seat of Washington County. The population of Jonesborough is about 3,500.

Flooding has been recorded in Jonesborough since 1901. The worst flood in recent history was in May 1958; some 20 businesses suffered heavy damage. Substantial flood damages have occurred in the town of Jonesborough and will

1.06 RELOCATION ASSISTANCE - PUBLIC LAW 91-646: There will be no relocation under 91-646 in the project. No structure will be affected or removed.

1.07 ENVIRONMENTAL CONSIDERATIONS: The only concern identified was an Exxon Service Station in close proximity to the proposed excavation. In 1988 three UST's were closed in place and three more were replaced. There are no records or signs which indicate a high probability that leakage has occurred. It has been Division policy to deal with Underground Storage Tanks (USTs) during construction rather than expend investigation funds up front. This is a relatively small, low cost project with a local cost share partner which we feel cannot support the estimated $65,000 cost it would take to investigate this possibility. It has been recommended by District Environmental Restoration Division that no Phase II investigations be completed for this project; however, no acquisition will begin until all NEPA and NHPA requirements are complied with.

1.08 TOTAL PROJECT COST: As stated above, all real estate will be furnished by the local sponsor. The estimate for this project is based on only four (4) tracts and two (2) ownerships.

Perpetual pipeline, temporary work area easements, and the estimated value for the required real estate is as follows:

Perpetual Pipeline Easement	$21,300.00
Temporary Work Area Easement	3,650.00
Contingency	5,000.00
Administrative Cost (Federal)	3,100.00
Administrative Cost (Local Sponsor)	3,000.00
Total Estimate Value (rounded)	$36,100.00

APPENDIX G

PROJECT COSTS

Little Limestone Creek
Jonesborough, Tennessee
Detailed Project Report
Cost Estimate

Designed By: Nashville District, Engr Div.
Estimated By: Nashville District, Cost Engr Br

Prepared By: Tram N. Pollock

Date: 10/04/93
Est Construction Time: 180 Days

M C A C E S G O L D E D I T I O N
Composer GOLD Copyright (C) 1985, 1988, 1990, 1992
by Building Systems Design, Inc.
Release 5.20J

10. Actual field location of underground utilities will affect cost.

11. Contingency included.

12. Low level of design.

13. % of project cost.

14. Contractor's overhead and profit are included due to abstracted or quoted items.

DETAILED ESTIMATE DETAIL PAGE

08. 15" RCP Storm Sewer.....9
09. Plug End of Abandoned Pipes.....9
10. Backflow Valves.....9
11. Remove Existing CBIs.....9
30. Planning, Engineering and Design
01. Planning Branch.....11
02. Design Branch.....11
03. Environmental Restoration Div.....11
04. Environmental Resource Branch.....11
05. H & H Branch.....11
06. Geotech Branch.....11
07. Engineering Support Branch
01. Relocations.....11
02. A/E Contract.....11
03. Specifications.....11
08. Cost Engineering Branch.....11
31. Construction Management
01. Construction Management @ 6%.....12
02. H & H Branch.....12
2. Alternative 2 - 50 yr
01. Lands and Damages
01. Project Planning.....13
02. Acquisitions.....13
05. Appraisals.....13
18. Real Estate Land Payments.....13
20. LERRD (Sponsor's Admin Cost).....13
02. Relocations
03. Cemeteries, Utilities, & Struct.
13. Traffic Control.....14
18. Utilities
15. Mechanical.....14
16. Electrical.....15
17. Telephone Cable.....15
09. Channels and Canals
01. Channels
01. Mobilization and Demobilization.....16
13. Traffic Control.....16
15. Culvert
01. Excavation, Unclassified.....16
02. Excavation, Rock.....17
03. Shoring.....17
04. Backfill.....17
05. Headwalls.....17
06. Cast in Place 8x6 Culvert.....18
07. 4" Fin. Granular Fill Mat'l.....18
08. Exc. & Dispose Contaminated Matl.....18
30. Bank Stabilization and Dikes
01. Stripping.....19
02. Training Dike.....19
03. Ditch, Inlet @ Outlet Excavation.....19
04. Seeding.....19

DETAILED ESTIMATE DETAIL PAGE

07. 4" Fin. Granular Fill Mat'l.....29
08. Exc. & Dispose Contaminated Matl.....29
30. Bank Stabilization and Dikes
01. Stripping.....30
02. Training Dike.....30
03. Ditch, Inlet @ Outlet Excavation.....30
04. Seeding.....30
05. Bank Stabilization.....31
99. Associated General Items
01. Safeloading Abandoned Pipes.....31
02. Replace Exist. Pavement.....31
03. Remove Existing Pavement.....31
06. Drop Box Inlet, Type 3.....32
07. Curb Box Inlet, Type A.....32
08. 15" RCP Storm Sewer.....32
09. Plug End of Abandoned Pipes.....32
10. Backflow Valves.....32
11. Remove Existing CBIs.....32
30. Planning, Engineering and Design
01. Planning Branch.....33
02. Design Branch.....33
03. Environmental Restoration Div.....33
04. Environmental Resource Branch.....33
05. H & H Branch.....33
06. Geotech Branch.....33
07. Engineering Support Branch
01. Relocations.....33
02. A/E Contract.....33
03. Specifications.....33
08. Cost Engineering Branch.....33
31. Construction Management
01. Construction Management @ 6%.....34
02. H & H Branch.....34

BACKUP REPORTS BACKUP PAGE

CREW BACKUP.....1
LABOR BACKUP.....6
EQUIPMENT BACKUP.....7

* * * END TABLE OF CONTENTS * * *

JONESBORUGH,TN DETAILED PROJECT REPORT
OMRR&R SUMMARY - 25-YEAR PLAN

		TOTAL		COST
ITEM	**DESCRIPTION**	**COST**	**FREQUENCY**	**PER YEAR**
1	REHAB BLOCKS	5702.30	10	570.23
2	RECAULK CULVERT	853.64	10	83.56
3	CLEAN CULVERT	182.07	1	182.07
4	CLEAN DBI &CBI	182.07	1	182.07
5	ANNUAL INSPECTION	182.07	1	182.07
	TOTAL			**1200.00**

OMRR&R SUMMARY - 50-YEAR PLAN

		TOTAL		COST
ITEM	**DESCRIPTION**	**COST**	**FREQUENCY**	**PER YEAR**
1	REHAB BLOCKS	6756.90	10	675.69
2	RECAULK CULVERT	1652.28	10	165.23
3	CLEAN CULVERT	182.07	1	182.07
4	CLEAN DBI &CBI	182.07	1	182.07
5	ANNUAL INSPECTION	182.07	1	182.07
	TOTAL			**1387.13**

OMRR&R SUMMARY - 100-YEAR PLAN

		TOTAL		COST
ITEM	**DESCRIPTION**	**COST**	**FREQUENCY**	**PER YEAR**
1	REHAB BLOCKS	6756.90	10	675.69
2	RECAULK CULVERT	2735.43	10	273.54
3	CLEAN CULVERT	182.07	1	182.07
4	CLEAN DBI &CBI	182.07	1	182.07
5	ANNUAL INSPECTION	182.07	1	182.07
	TOTAL			**1495.44**

APPENDIX H

HTRW PHASE I ENVIRONMENTAL SITE ASSESSMENT

CEORN-ER-H (200-1c) 2 Nov 93

MEMORANDUM FOR CEORN-EP-P (Attn. Ferguson)

SUBJECT: Little Limestone Creek, Jonesborough, TN

1. Enclosed is the Phase I Environmental Site Assessment for the subject project.

2. The only concern identified was an Exxon Service Station in close proximity to the proposed excavation. In 1988 three USTs were closed in place and three more were replaced. There were no records kept of these closures which opens the possibility of past leakage into a portion of the proposed excavation. However we are recommending no Phase II investigations for this project. We base this recommendation on the following:

a. There are no records or signs which would indicate a high probability that leakage has occurred.

b. It has been Division policy to deal with USTs during construction rather than expend investigation funds up front as outlined in ORD Policy Memorandum #14 dated 19 March 1992.

c. This is a relatively small, low cost project with a local cost share partner which we feel cannot support the estimated $65,000 it would take to investigate this possibility.

3. We recommend some contingency be built into the construction cost estimate for special handling of the contaminated material should such be encountered. Without investigations, this estimate will naturally be based upon a reasonable assumption as to quantities.

Enclosure

MICHAEL F. ZOCCOLA
Acting Chief, HTRW Design Branch

CF:
CEORN-ER-M (McClanahan, wo/encls)

PHASE I ENVIRONMENTAL SITE ASSESSMENT
FOR
SECTION 205 FLOOD CONTROL PROJECT
JONESBOROUGH, WASHINGTON COUNTY, TENNESSEE

(2 November 1993)

PHASE I ENVIRONMENTAL SITE ASSESSMENT
FOR
SECTION 205 FLOOD CONTROL PROJECT
JONESBOROUGH, WASHINGTON COUNTY, TENNESSEE

1.0 INTRODUCTION

The Hazardous Toxic and Radiological Waste (HTRW) Branch of the Nashville District Corps of Engineers has completed a Phase I Site Assessment for the Section 205 Flood Control Project for Jonesborough, Tennessee. The purpose of the site assessment was to determine if further investigation into possible recognized environmental contamination is necessary. This report summarizes the findings of the Phase I Assessment.

2.0 SITE BACKGROUND

Flooding has been recorded in Jonesborough since 1901. The worst flood in recent history was in May 1958 when some 20 businesses suffered heavy flood damage. The principal sources of flooding in Jonesborough are the Little Limestone Creek (LLC) and an unnamed tributary to LLC (herein referred to as Unnamed Tributary). Flooding is possible all year, but is more common in Spring and Summer months due to local high-intensity thunderstorms. Much of Jonesborough's development has been on the flood plains of the Unnamed Tributary and LLC. Little Limestone Creek originates approximately 2 miles east of Jonesborough and flows through the heart of the town. The steep slopes on both streams can cause flash floods during intense rainfall. Flooding on LLC is no longer a major problem as the town removed several channel constrictions and obstructions that had a significant effect on flood heights in the downtown area. At present the inadequate capacity of the existing culvert system carrying the Unnamed Tributary beneath downtown Jonesborough causes the most flooding. The culvert system has evolved in a piece-meal fashion over the years and carries the stream from mile 0.09 downstream to mile 0.026. The culvert system overflows at its inlet of four 36" diameter culverts at Sabin Street flooding several shops along Main Street and an auto parts building on Sabin Street.

Based on the results of a reconnaissance report (dated Jan 1991) improvement of the existing culvert system was shown to be impractical. The proposed Section 205 Flood Control Project recommends construction of a new culvert. In addition a small levee at the inlet, upstream of Sabin Street, would be constructed to increase the capacity of the culvert systems. The alignment of the new culvert was designed to minimize the cost of utility relocation without compromising the hydraulic efficiency.

The new culvert will be 450 feet long. Once the upstream levee is constructed, the four existing 36" culverts will be extended

The review of the EPA records revealed that the subject property was not on the CERCLIS, NPL, FINDS, RCRA, or ERNS lists, nor were any sites listed in the vicinity of the project area. This indicates that the EPA has not investigated, reviewed, or been made aware of any regulated environmental problems within a one-mile radius of the Exxon station and project area.

4.2 State Environmental Record Sources

State environmental records reviewed include the following Tennessee records:

1. Tennessee State Superfund List. Dan Hawkins of the Superfund Knoxville area office stated that there is no superfund site within one and a half miles of the project site.

2. UST Facility Information for notifications, closures, and inspections. Review of files at the Tennessee Division of Underground Storage Tanks provided the following information:

   a. The Jonesborough Exxon station (Facility # 1-900116) is presently owned by Dogwood Oil Company Inc., Exxon Products, 205 Crown Street, Johnson City, TN 37601. The previous owner was B.R. Foster who sold the business on July 9, 1986.

   b. The Exxon station originally had six USTs in operation. On December 21, 1988, three 550 gallon USTs were filled with foam. One had been used for slop oil, one for heating oil, and one for kerosene (see Attachment C).

   c. Three USTs approximately 20 years old are currently being used for gasoline. One tank has a 6000 gallon capacity, and the other two are 5000 gallon tanks (See Attachment C).

   d. The last inspection, conducted by Environmental Specialist Katie L. Rudd, was dated October 10, 1992, and the registration certificate is valid until September 30, 1993. There is no report or indication of any leakage from the tanks.

4.3 Jonesborough City Manager Interview

Robert Browning, Jonesborough City Manager, said there were no reports of any spills on the Exxon site. He also said there were no environmental problems reported.

environmental contamination.

4. The Exxon Station property has contained USTs for at least 20 years and possibly 40 years.

   a. Three USTs were filled with foam in December 1988.

   b. According to the station manager, three new USTs were installed in 1988. These USTs are tight-tested annually as per EPA regulations. The most recent test revealed no indications of leakage.

6.2 Conclusions

It is recommended that no Phase II investigation of the proposed excavation material be conducted. The only concern identified during the Phase I assessment was the Exxon Station and the possibility that past leakage from USTs might have infiltrated the material to be excavated for the culvert construction. While past leakage is a possibility, there are no records or signs which would suggest a high probability that leakage has occurred. Thus, we do not feel an expenditure of funds is warranted to address this possibility. Rather, some contingency based upon reasonable assumptions should be added to the project cost estimate in order to address the possibility of encountering UST leakage contaminated soils.

7.0 REFERENCES

7.1 "Reconnaissance Report: Section 205 Flood Control Project for Jonesborough, Washington County, Tennessee", U.S. Army Corps of Engineers, Nashville District, Jan 1991.

7.2 "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process", ASTM E 1527-93, May 1993.

7.3 "Standard Practice for Environmental Site Assessments: Transaction Screen Process", ASTM E 1528-93, May 1993.

ASTM E 1528 Screen Questionnaire

Description of Site: Address:
Jonesborough Exxon
Main Street + Boone
Jonesborough, TN 37659

Question	Owner	Occupants	Observed
1. Is the property or any adjoining property used for industrial use?	Yes No Unk	Yes No Unk	Yes (No) Unk
2. To the best of your knowledge, has the property or any adjoining property been used for an industrial use in the past?	Yes No Unk	Yes (No) Unk	Yes No Unk
3. Is the property or any adjoining property used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard, or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?	Yes No Unk	(Yes) No Unk	Yes No Unk
4. To the best of your knowledge has the property or adjoining property been used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?	Yes No Unk	(Yes) No Unk	Yes No Unk
5. Are there currently, or to the best of your knowledge have there been previously, any damaged or discarded automotive or industrial	Yes No Unk	Yes (No) Unk	Yes No Unk

Question	Owner	Occupants	Observed
11. Are there currently, or to the best of your knowledge have there been previously any vent pipes, fill pipes, or access ways indicating a fill pipe protruding from the ground on the property or adjacent to any structure located on the property?	Yes No Unk	Yes No Unk	Yes No Unk
12. Are there currently, or to the best of your knowledge have there been previously, any flooring, drains, or walls located within the facility that are stained by substances other than water or are emitting foul odors?	Yes No Unk	Yes No Unk	Yes No Unk
13. If the property is served by a private well or non-public water system, have contaminants been identified in the well or system that exceed guidelines applicable to the water system or has the well been government environmental/health agency?	Yes No Unk	Yes No Unk N/A	Yes No Unk
14. Does the owner or occupant of the property have any knowledge of environmental liens or governmental notification relating to past or recurrent violations of environmental laws with respect to the property or any facility located on the property?	Yes No Unk	Yes No Unk	Yes No Unk
15. Has the owner or occupant of the property been informed of the past or current existence of hazardous	Yes No Unk	Yes No Unk	Yes No Unk

Question	Owner	Occupants	Observed
20. Is there a transformer, capacitor, or any hydraulic equipment for which there are any records indicating the presence of PCBs?	Yes No Unk	Yes No Unk	Yes No Unk

This questionaire was completed by:

Name LYNN M. VAN BEEK

Title CIVIL ENGINEER

Firm U.S. ARMY CORPS of ENGINEERS

Address P.O. Box 1070, Nashville, TN

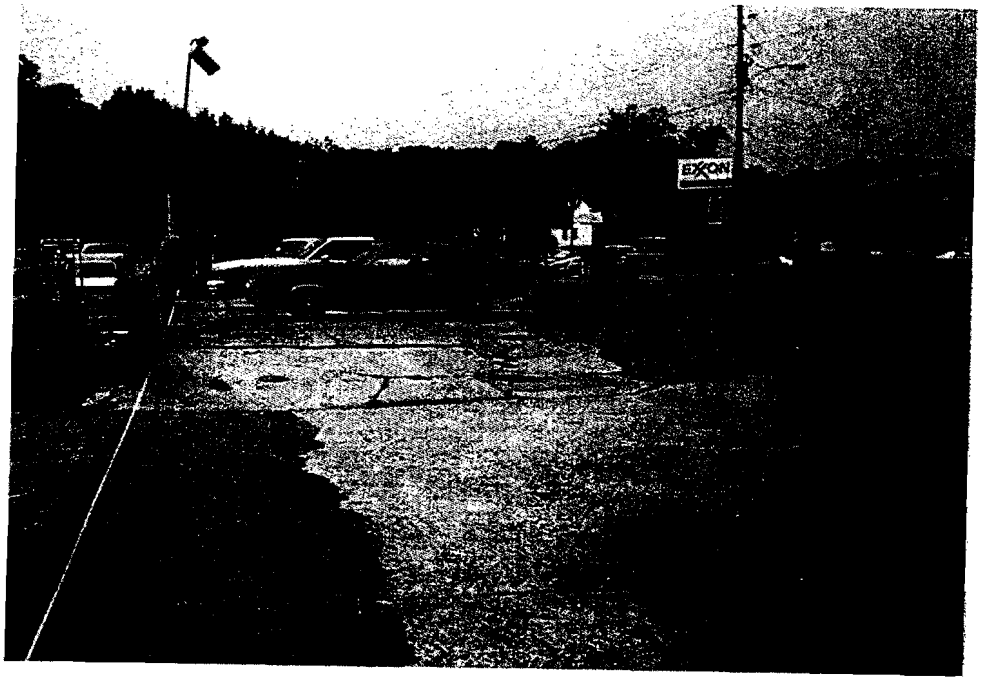
Date July 19, 1993 37202-1070

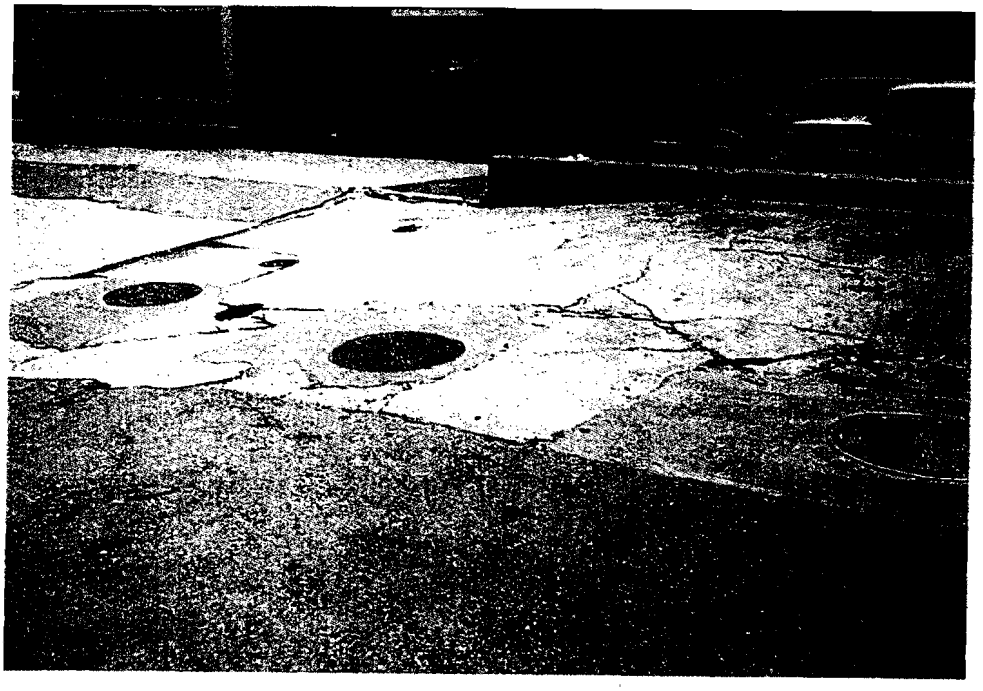
Attachment B

PHOTOGRAPHS OF SITE

Service pit which was filled with concrete and 550 gallon UST which was filled with foam in 1988

550 gallon UST which was filled with foam on December 21, 1988





Three Underground Storage Tanks currently used for gasoline. One Tank has a capacity of 6000 gallons, the other two are 5000 gallon tanks.

Transformer on Power Pole at Exxon Station

550 gallon UST for slop oil which was filled with foam on December 21, 1988

Attachment C

SITE PLAN

CITY OF JOHNSON CITY
FLOOD PLAIN STUDY

DOWNTOWN DRAINAGE STUDY
JOHNSON CITY, TENNESSEE

Prepared for:
City of Johnson City
Tennessee

Under Work Order #1 of
MSA dated 7 February 2008

Submitted by:
AMEC Earth & Environmental, Inc.
Knoxville, Tennessee

August 20, 2008

IMPORTANT NOTICE

This report was prepared exclusively for the City of Johnson City by AMEC. The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in AMEC's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Johnson City only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

CONTENTS

1.0 PURPOSE AND BACKGROUND 3
2.0 PRELIMINARY STRUCTURAL EVALUATION OF THE OLD BRUSH CREEK CULVERT 6
3.0 MODELLING METHOD 6
3.1 Model Updating 6
3.2 Survey 7
3.3 Model Refinement 7
4.0 PUBLIC WORKS CONCEPT MODELLING AND RESULTS 9
5.0 ADDITIONAL CONCEPT MODELLING AND RESULTS 11
5.1 Concept 1 11
5.2 Concept 2 12
5.3 Concept 3 13
5.4 Concept 4 14
5.5 Concept 5 15
6.0 EVALUATION OF PUBLIC WORKS AND ADDITIONAL CONCEPTS 16
7.0 REDEVELOPMENT CONCEPT 16
8.0 DOWNTOWN REDEVELOPMENT CONCEPT MODELLING 18
9.0 DOWNTOWN REDEVELOPMENT CONCEPT RESULTS 19
10.0 DOWNTOWN REDEVELOPMENT CONCEPT COSTS AND BENEFITS 21
11.0 CONCLUSIONS AND FUTURE ACTIONS 23
12.0 REFERENCES 25

FIGURES

Figure 1: Existing Drainage Infrastructure 3
Figure 2: Flooding Flow Paths 4
Figure 3: Public Works Concept 5
Figure 4: King Street/Brush Creek Culvert Junction Photos 6
Figure 5: As-Is Model Refinement 8
Figure 6: Revised Public Works Concept 9
Figure 7: Additional Concept 1 11
Figure 8: Additional Concept 2 12
Figure 9: Additional Concept 3 13
Figure 10: Additional Concept 4 14
Figure 11: Additional Concept 5 15
Figure 12: Redevelopment Concept Stormwater Conveyance 17
Figure 13: Regional Detention Pond Locations 19
Figure 14: As-Is Structures Flooded for 50-year storm 20
Figure 15: Redevelopment Concept Phase III Structures Flooded for 50-year storm 21
Figure 16: Structure Depth-Damage Function 22
Figure 17: Contents Depth-Damage Function 22

APPENDICES

A: Preliminary Structural Evaluation Report A-1
B: Redevelopment Concept B-1
C: Redevelopment Concept Graphics C-1
D: Cost Estimates D-1
E: FEMA Cost-Benefit Analysis E-1
F: Compact Disc Containing Project Files F-1

1.0 PURPOSE AND BACKGROUND

The downtown drainage improvement project was performed to determine whether a relatively minor capital improvement project could help to alleviate some of the flooding problems that have plagued the downtown area since the late 1800s. Flooding occurs downtown due to the development of structures in the floodplain. The existing culverts and their ages are shown in Figure 1 below.

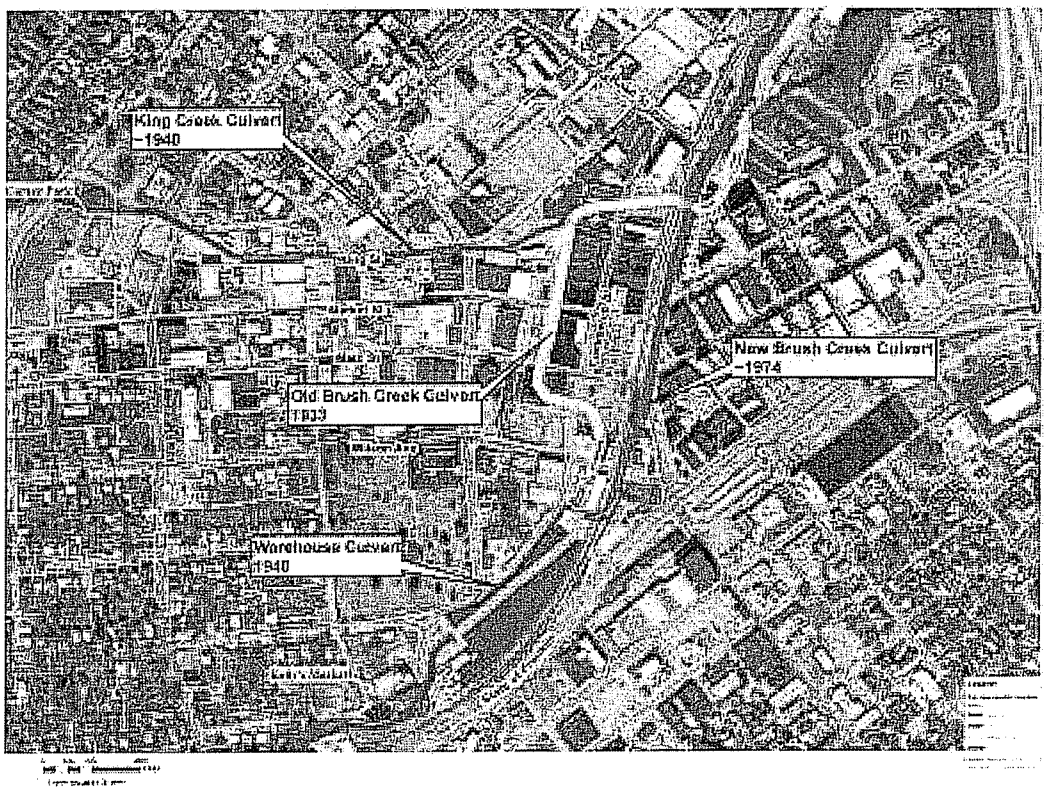


Figure 1: Existing Drainage Infrastructure

Flooding downtown is caused by overflow from Brush Creek and King Creek. Flow from these creeks enters the downtown area when the Brush Creek and King Creek culverts are overtopped. The King Creek culvert is overtopped at its inlet. Overland flow from King Creek flows down King Street and enters the downtown area via Montgomery, Boone and McClure Streets.

The Brush Creek culvert is overtopped at its inlet near the old tobacco warehouse. Brush Creek also overtops the Watauga Street culvert. After overtopping, the overland

flow travels down State of Franklin Road/Water Street and the railroad right of way. This flow finally enters downtown by crossing over the railroad tracks at Market and Main Streets.

Flow from Brush and King Creeks combine in the downtown area and pond until the Brush Creek culvert can dewater the downtown. The flowpaths described above can be seen in Figure 2 below.

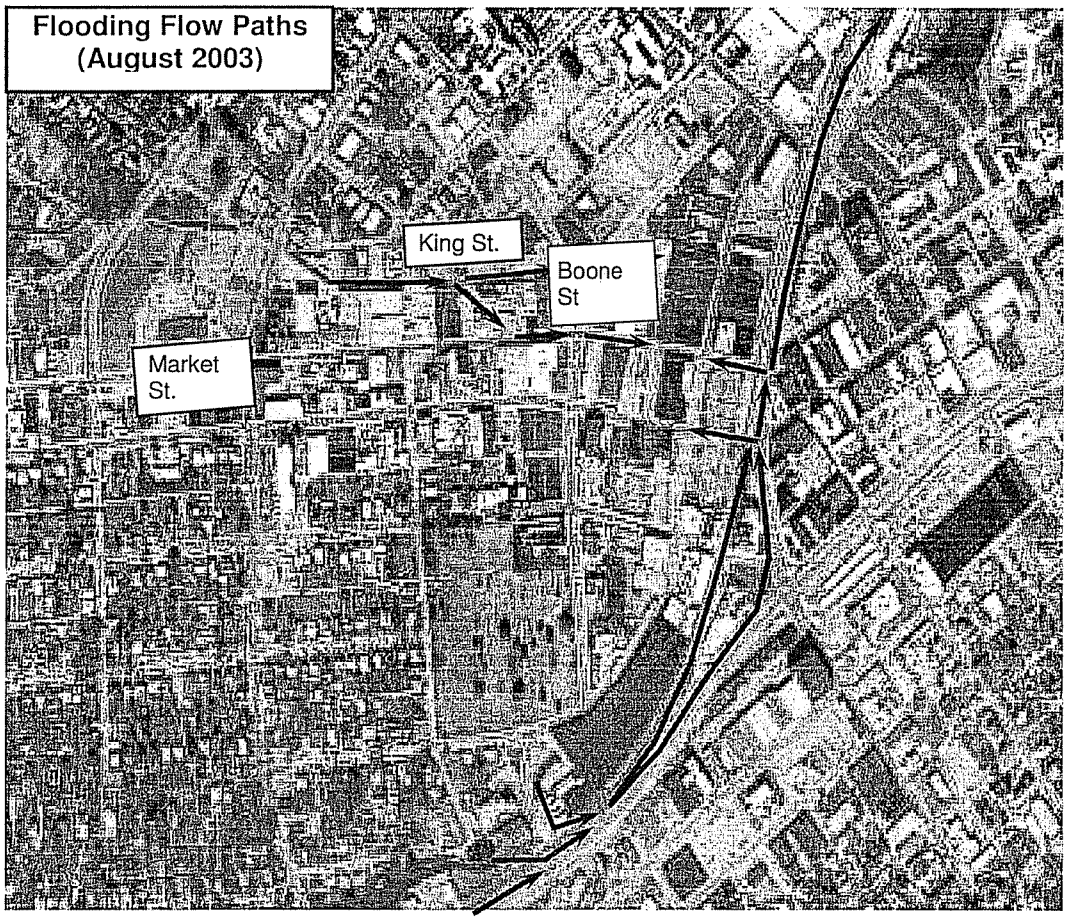


Figure 2: Flooding Flow Paths

A previous study (CDM, 2003) showed that a major project would be necessary to provide flood relief for the downtown during large storms. AMEC was tasked by Johnson City (the City) to determine whether the Public Works Concept (Figure 3) of a small local collection system in the Market and Boone Street area could help alleviate flooding for small storms. The Public Works Concept would take advantage of the currently unused Old Brush Creek Culvert to drain the downtown. Should this concept fail, AMEC was tasked to work with the City to choose and evaluate additional alternatives for alleviating flooding for small storms.

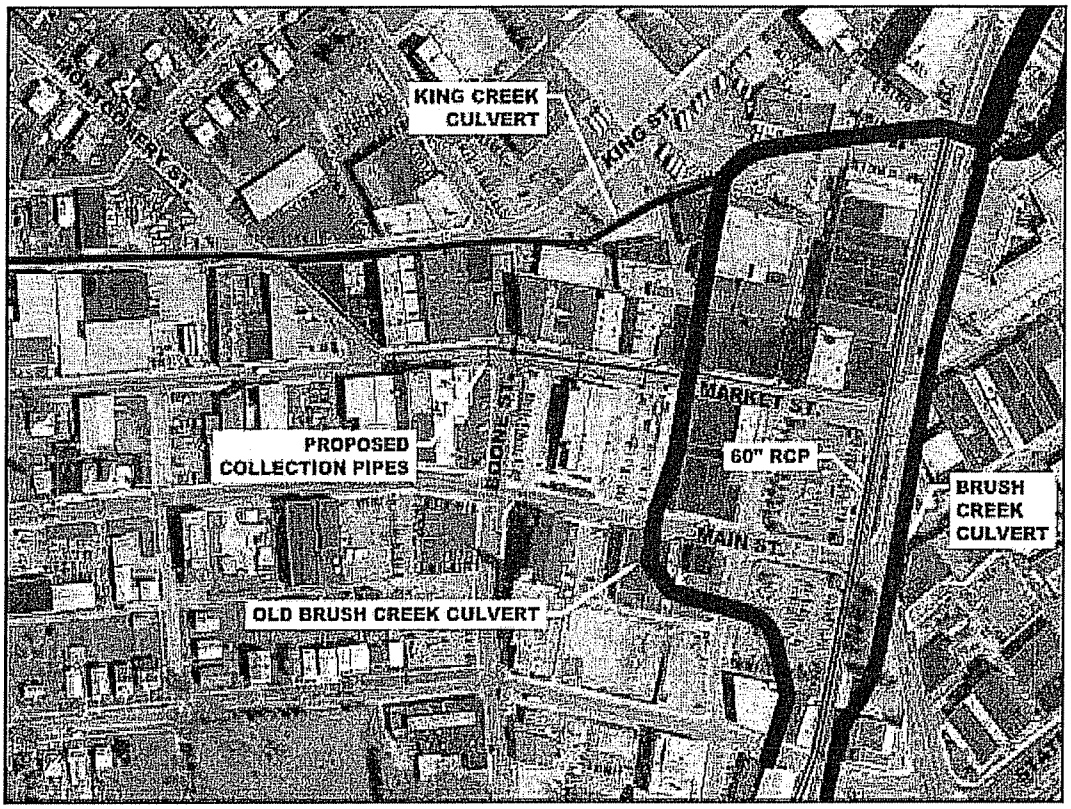


Figure 3: Public Works Concept

In order for the Public Works Concept to be successful, the Old Brush Creek Culvert that drains the new system would have to be:

- structurally sound
- able to dewater downtown fast enough to prevent flooding

AMEC's first task was to determine whether both conditions could be met; the results of these analyses follow.

2.0 Preliminary Structural Evaluation of the Old Brush Creek Culvert

AMEC's subcontractor, Hodge Engineering, performed an evaluation of the Old Brush Creek Culvert over several days in March 2008. The investigating engineers found that the oldest part of the Old Brush Creek culvert is failing severely, especially at the junction of the Old Brush and King Creek culverts. Severe undercutting at this location has caused one of the culvert walls to begin toppling. The effect of this can be seen underground and at the surface in Figure 4 below.

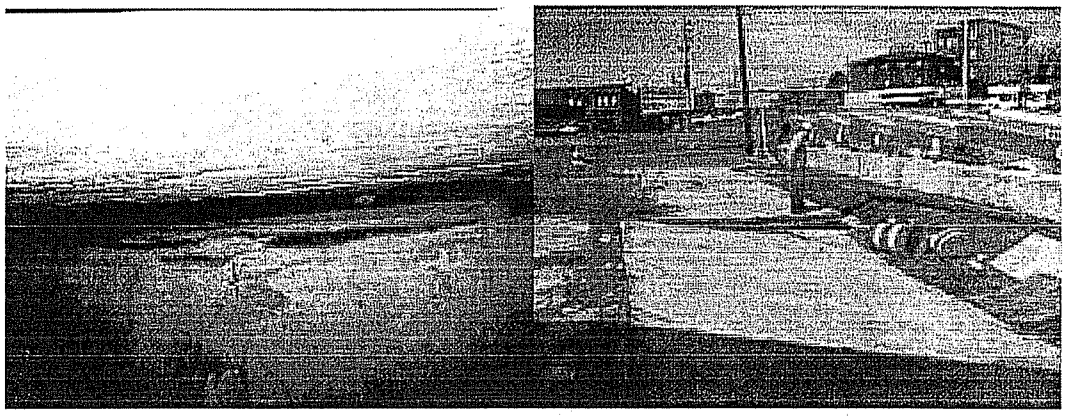


Figure 4: King Street/Brush Creek Culvert Junction Photos

Undercutting, footer failure, top slab failure, poor concrete condition and poor reinforcing steel condition were found in several places along the culvert. Culvert structural problems were also detected under several of the buildings on top of the Old Brush Creek culvert. We recommend that Johnson City work to remedy these problems. The Public Works Concept is not feasible due to the poor condition of the Old Brush Creek Culvert. The full structural evaluation report can be found in Appendix A.

3.0 Modelling Method

3.1 Model Updating

AMEC analyzed the downtown flooding problems from a hydraulic perspective concurrently with the structural evaluation. The first task was to update the existing hydrologic and hydraulic model of the watershed to the newest version (5.0.013) of the Storm Water Management Model (SWMM). The existing model was created by CDM and found to be suitable for this study. Please refer to the CDM report for information on the watershed and hydrologic modelling of the watershed. AMEC made no

substantial changes to the hydrologic components of the model or any of the hydraulic components outside the project area.

During model updating, minor edits were made to ensure compatibility with the new version of the software and to match flood peaks to the elevations reported by CDM as closely as possible. Rainfall distributions were obtained by applying the SCS type II rainfall distribution to the 24-hour rainfall totals provided by the City.

3.2 Survey

Ground survey was performed in the downtown area in order to provide the detailed inputs necessary to accurately model the overland flow and storage of water during storm events. AMEC's subcontractor Michael Brady Inc. (MBI) surveyed flow cross sections, culvert geometries and finished floor elevations for input to the SWMM models and flood damage analysis.

3.3 Model Refinement

Considerable detail was added to the as-is model in order to accurately depict the flow and storage of water in the downtown area. Several portions of King, Market, Main, McClure, Montgomery, Boone, and Commerce Streets act as overland flow channels for flow that has overtopped the King and Brush Creek culverts. These flowpaths were modelled as irregular channels using surveyed cross sections. Vertical channel walls were added at building locations, to ensure that no flow or storage is considered within the existing buildings.

The minor drainage system was modelled as pipes with orifice connections to the overflow system at street level. Where necessary, several adjacent inlets were modelled as a single inlet. An existing 60" RCP line paralleling State of Franklin Road was added to the model, due to its exclusion by the CDM model.

The Brush Creek channel downstream of the downtown was surveyed and modelled in detail in order to provide a more reliable tailwater condition.

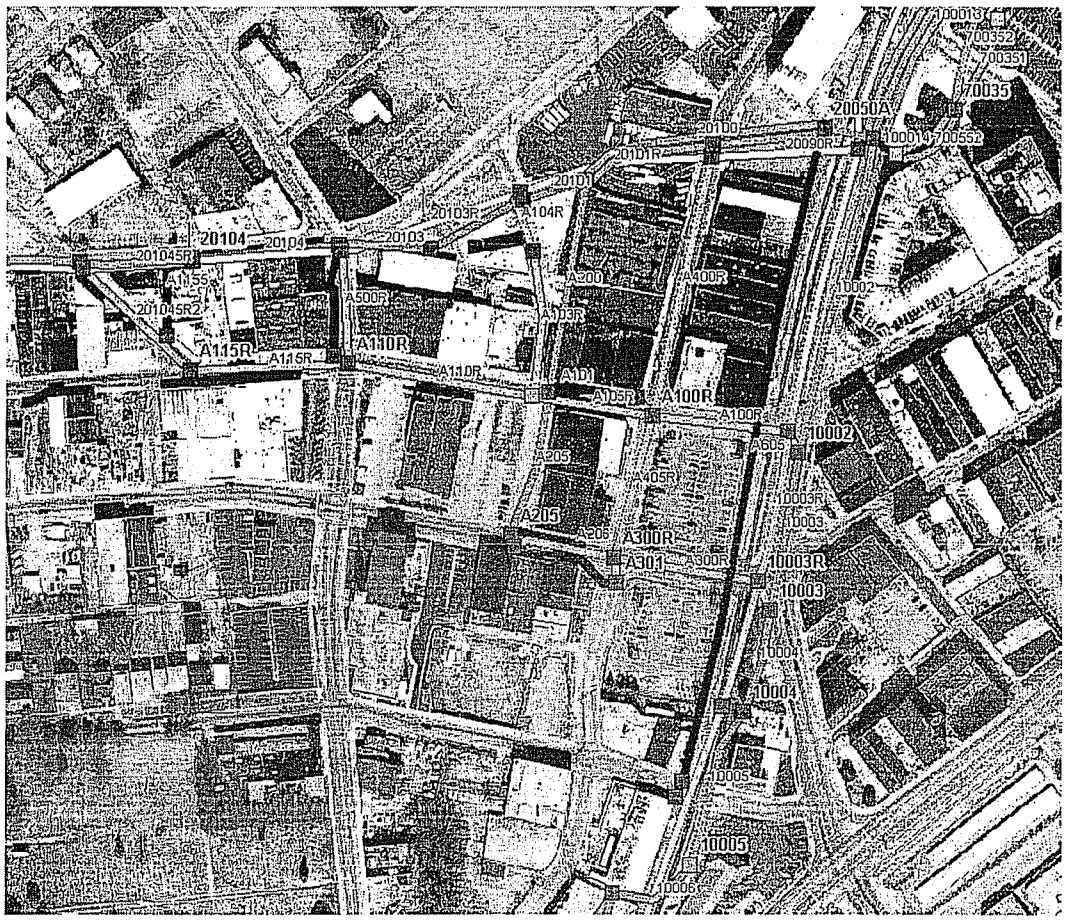


Figure 5: As-Is Model Refinement

Several storage nodes were used in the CDM model to simulate flood storage in the depression of downtown. AMEC's more detailed modelling of the downtown as a series of large channels made these storages unnecessary and they were removed. An example schematic of the model refinements is shown in Figure 5.

The flood elevations produced by the As-Is model, run with the rainfall distribution of the August 2003 storm, were compared with eyewitness accounts of flood elevations and found to be reasonably similar. This correspondence helped to validate the As-Is model and provide a sound basis for continuing on to the flood abatement models.

4.0 Public Works Concept Modelling and Results

The Public Works Concept Model was created from the As-Is model by adding new drainage pipes beneath Market and Boone Streets per the Public Works Concept drawing provided by the City. The new pipes were fed into the Old Brush Creek Culvert. Inlets draining the flooded area of downtown were modelled as orifices. A large number of high capacity inlets were modelled. These inlets would be necessary to efficiently capture the overland flow and transfer it into the new culverts. Please refer back to Figure 3 for the layout of the Public Works Concept.

The Public Works Concept model showed very little benefit to flood levels. This disappointing result was due to the backwater being applied to the Brush Creek culvert from the culverts and open channel downstream of it. The Old Brush Creek culvert has very little remaining flow capacity at storms as small as the 2-year storm due to the backwater filling it up. Installing the number of inlets necessary to capture the overflow from Brush and King Creeks would also be difficult.

A Revised Public Works Concept was also created in an attempt to direct overland flows into the Old Brush Creek Culvert more easily. A pond was modelled at the junction of the Old Brush and King Creek culverts as shown in Figure 6 below. This pond would serve as a sump to more efficiently capture the water flowing into downtown from the overtopping culverts.

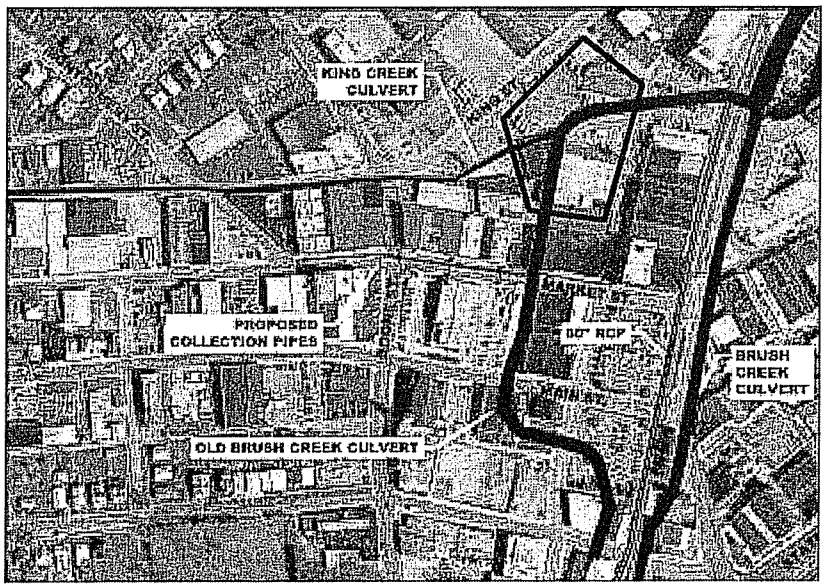


Figure 6: Revised Public Works Concept

The revised Public Works Concept model showed minor improvement in flood levels downtown due to the more efficient capture of overland flows. However, the backwater problem was not resolved and flooding in the downtown still resulted during small storms.

The failure of the Public Works Concepts led the City to request the modelling of several additional concepts, with the hope of finding one that could solve the downtown flooding problems for small storms at a reasonable cost. The additional concepts are shown, one to a page, in the next section.

5.0 Additional Concept Modelling and Results

5.1 Concept 1

The first additional concept modelled was a large (double 16'x6') bypass culvert for King Creek. This concept was selected to remedy the severe undersizing of the existing King Creek Culvert, which is overtopped at even a 2-year storm. The bypass culvert was meant to prevent overtopping of the King Creek Culvert, and to relieve some of the backwater effects being caused by the culvert system downstream of downtown. The concept was modelled by adding a bypass culvert conduit between the King Creek inlet and the outlet downstream of downtown.

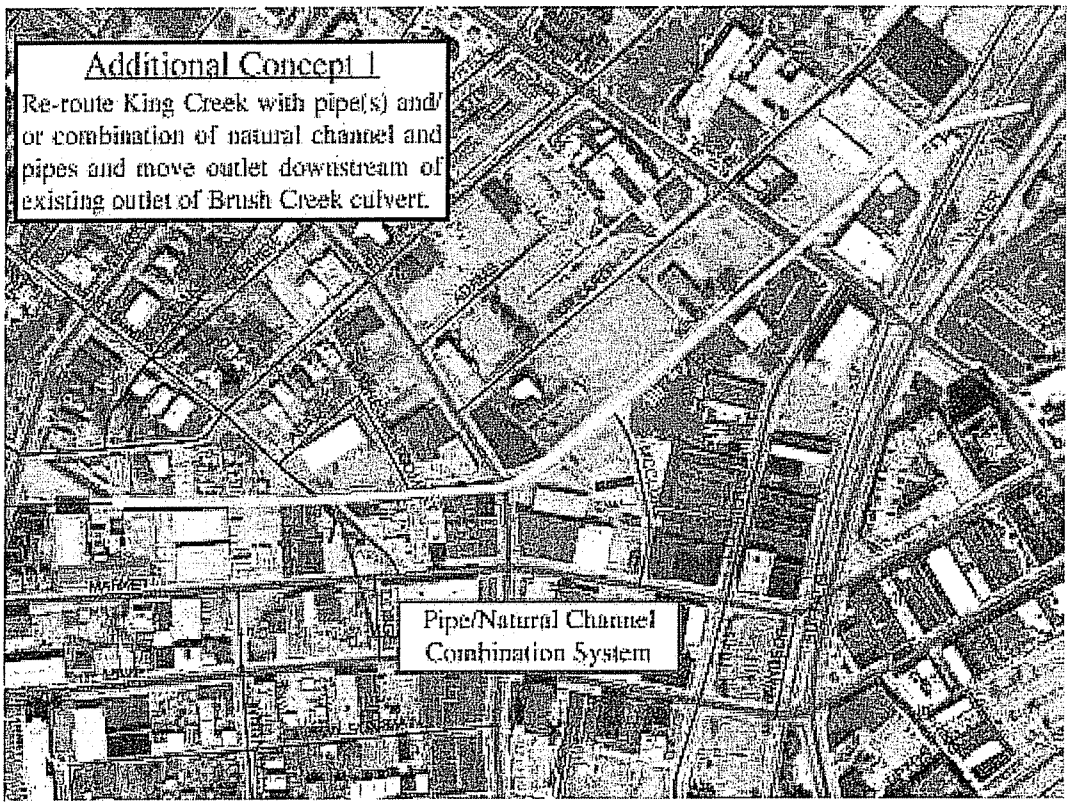


Figure 7: Additional Concept 1

The Concept 1 results showed that the bypass culvert would prevent the downtown from flooding during a 2-year storm by preventing the overflow of the King Creek Culvert. Flooding would still occur at larger storms due to the overflow of Brush Creek into State of Franklin Road and downtown.

5.2 Concept 2

The second additional concept revised the first by using an open channel rather than culvert for the bypass in two places. The sump at the U-Haul facility was also added to better capture overland flow in the downtown area. The sump was modelled as a storage node. Use of the natural channel would necessitate the closing of King Street in the natural channel area. The properties used as a sump would also have to be purchased.

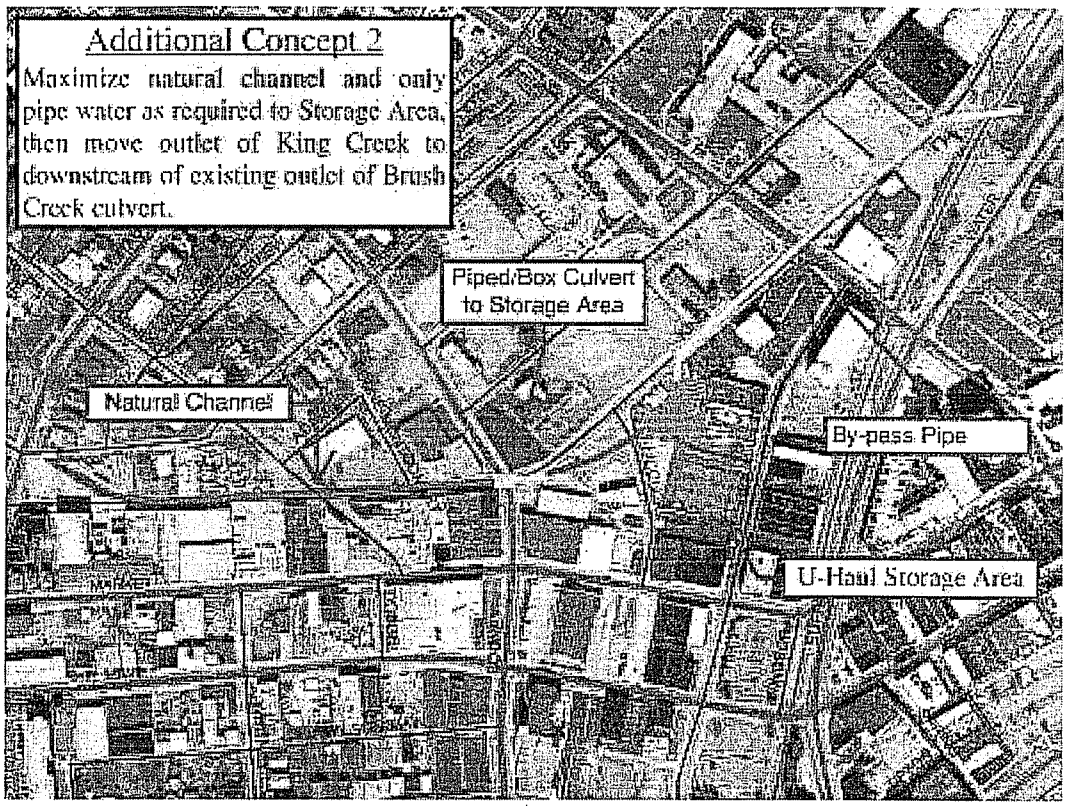


Figure 8: Additional Concept 2

The Concept 2 results showed an increase of flood protection to approximately the 5-year storm due to the increased storage and better capture of overland flow.

5.3 Concept 3

The third additional concept revised the second by addition of three storage areas upstream of the King Creek Culvert. The elevation-area relationships for the storage areas were generated through conceptual excavation plans for each storage area. Each storage area was created by converting a junction node to a storage node in the model. No dams were used in the concept, so that water levels would not be increased and therefore flood properties adjacent to the storage areas.

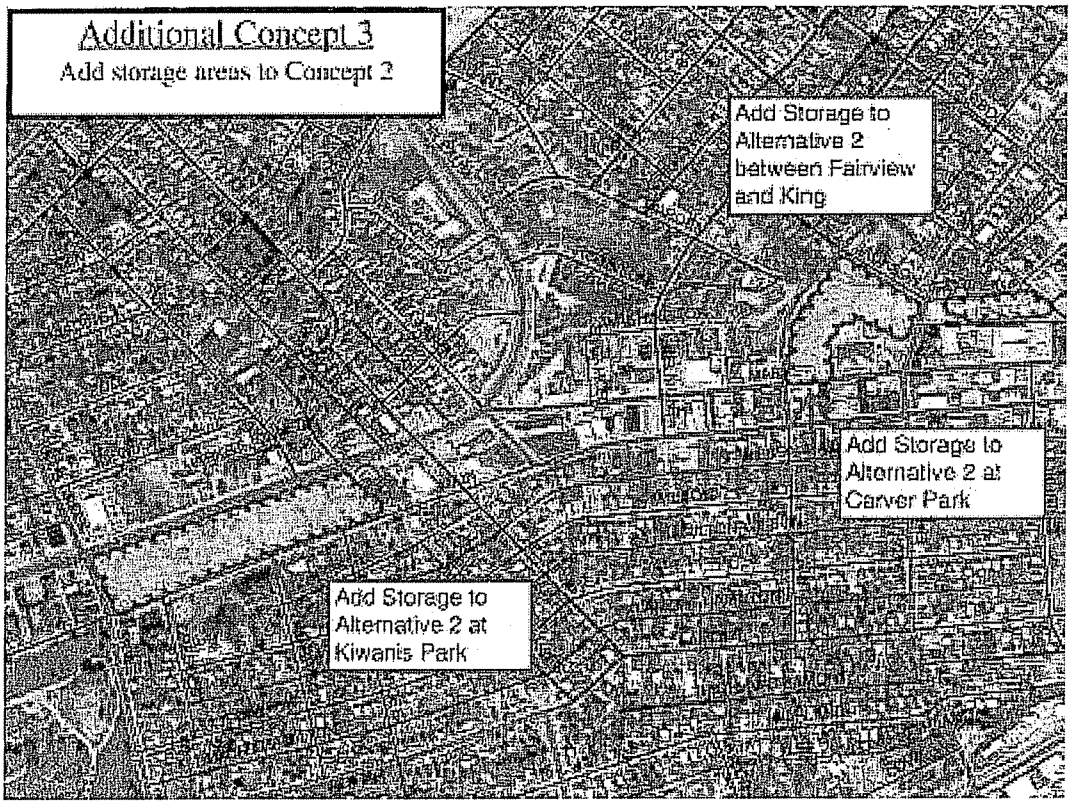


Figure 9: Additional Concept 3

The Concept 3 results showed negligible increase in flood protection due to the small size of the storage areas and lack of suitable topography at the selected locations.

5.4 Concept 4

The fourth additional concept maintained the use of the sump and lower portion of the King Creek bypass. Rather than adding a bypass or natural channel in the upper portion of King Street, however, Concept 4 modelled a new berm between King Street and Downtown. The berm would serve to keep flow in King Street from entering the downtown area, prior to its emptying into the sump. The berm was modelled by raising the street channel offsets at the junctions of King Street and the side streets that join it.

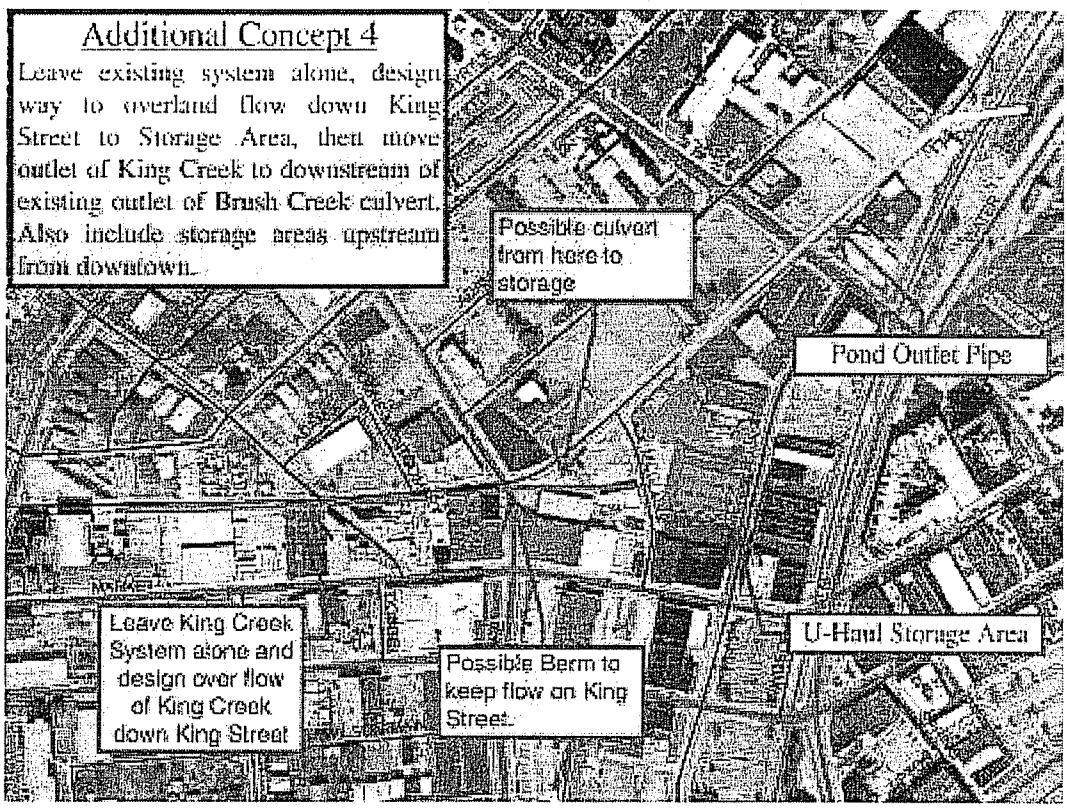


Figure 10: Additional Concept 4

The Concept 4 results showed benefits similar to Concept 2 in the lower downtown area. However, flow depths in King Street were increased significantly. Concept 4 is not advisable due to the dangers of flooding a street, and the possibility of stormwater and sewer backflow due to the high head that would be created between water in King Street and adjacent sewer and stormwater connections.

5.5 Concept 5

The fifth additional concept modelled separation of the three culvert barrels downstream of downtown to isolate the King and Brush Creek flows. This scenario was modelled by adding a new SWMM junction at the confluence of the culverts and separating the King Creek barrel to travel through it without connecting to the Brush Creek barrels.

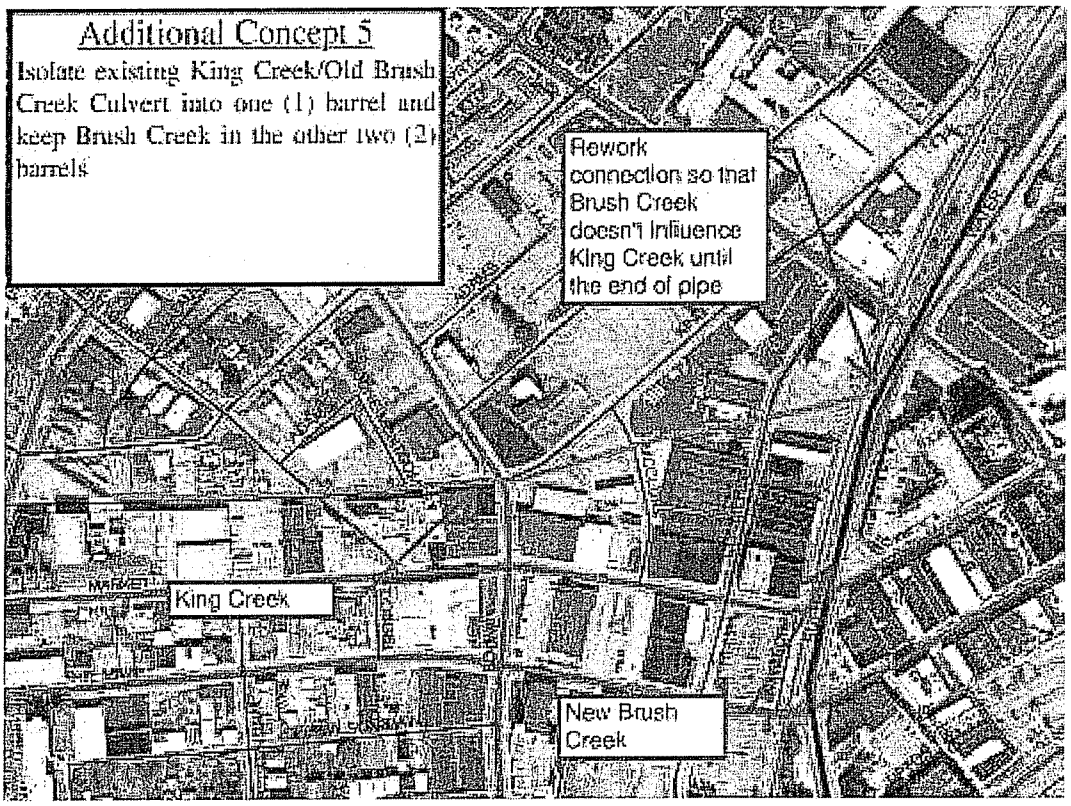


Figure 11: Additional Concept 5

The Concept 5 results showed no appreciable benefit to flooding conditions over the As-Is model.

6.0 Evaluation of Public Works and Additional Concepts

Review of the Public Works and Additional Concepts results made it clear that a small local drainage improvement project would not provide flood protection for even the 2-year storm. A larger bypass culvert or channel would be necessary to keep King Creek from overflowing and to relieve the high backwater at the bottom of downtown. Additionally, a sump at the lowest point of downtown would be necessary to capture overland flows and transfer them to the bypass if a culvert was chosen rather than an open channel.

The models also showed that while a King Creek bypass could be beneficial for the 2-year to 5-year storms, it would not serve for the 10-year and greater storms. Larger storms cause the Brush Creek and Watauga Avenue culverts to overtop and send flow down State of Franklin Road and into downtown. A flooding solution for storms greater than the 5-year would require the Brush Creek overflow to be addressed as well as the King Creek overflow.

The cost of constructing the King Creek bypass and downtown sump would be greater than the benefits to existing structures if only the 2-year and 5-year storms are addressed and the Brush Creek overflows ignored. Due to this prohibitive cost, the City requested AMEC to fashion a concept that would involve the total solution of the downtown drainage problem. This solution would need to have benefits other than flooding abatement in order to be financially desirable. The following section details the final concept that was created to solve the downtown flooding problem.

7.0 Redevelopment Concept

Any expensive drainage improvement project in the downtown would be financially undesirable because many of the buildings to be protected in the downtown are deteriorating and underused. This problem is difficult to solve because of the following circular cause-effect-cause relationship:

- Flooding occurs downtown
- Little investment and maintenance occurs downtown because the buildings flood frequently
- Flooding abatement projects are not done because project costs are greater than the benefits accrued to the deteriorated properties in the downtown
- Flooding occurs downtown...

The downtown area is unlikely to become a vital part of the community if something is not done to break this cycle. As shown in the previous sections, there is no inexpensive way to solve the flooding problem downtown. The only way to break the cycle is to simultaneously solve the flooding problem and encourage significant investment in the properties downtown, many of which are historic. Vibrant downtowns can serve as catalysts for economic growth in medium-sized cities such as Johnson City.

AMEC decided to feature newly restored creeks and a pond in a redevelopment concept that would solve the flooding problem and attract private investment to the downtown area. A large format plot of the redevelopment concept can be found in Appendix B. The stormwater conveyances would be open channels wherever possible. Several of the structures that lie directly over the Old Brush Creek Culvert would be removed. These structures currently have some of the worst flooding and structural issues in the area. All historically significant structures would be preserved. A schematic of the Redevelopment Concept stormwater system is shown in Figure 12.

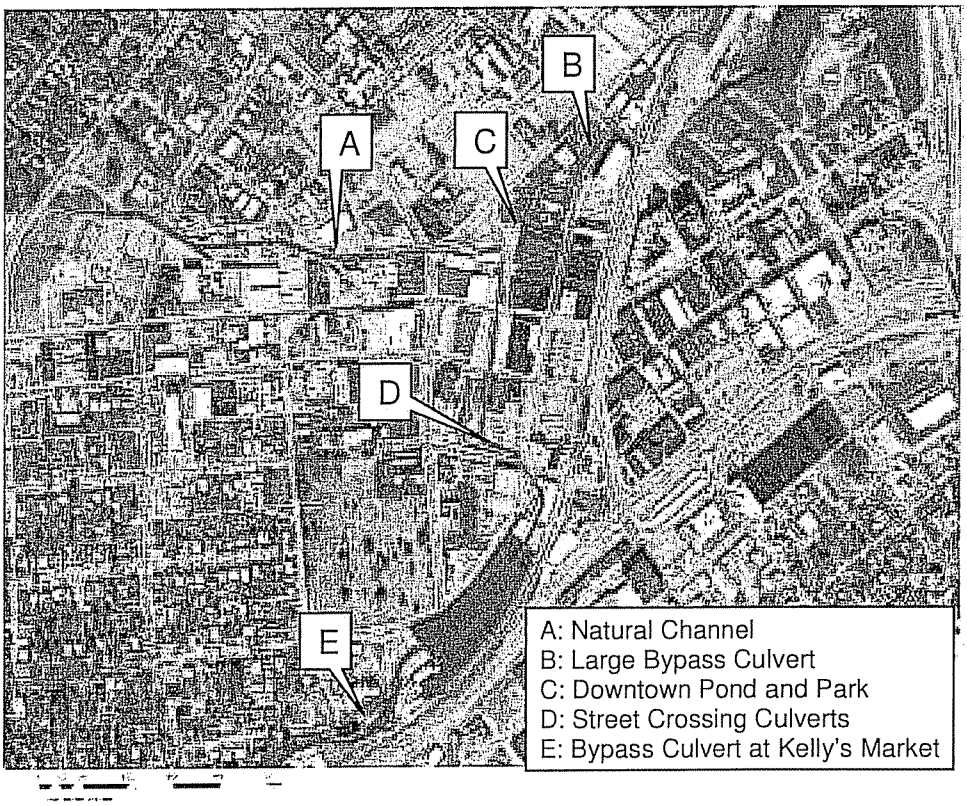


Figure 12: Redevelopment Concept Stormwater Conveyance

The redevelopment would create several unique spaces such as the outdoor environmental classroom, located where the old tobacco warehouse currently sits. There would be greenways along the restored stream channels and a park surrounding the pond. The park would be situated close to the beautiful new library, and could serve as a festival location. Please see Appendix C for additional graphics depicting how the redevelopment could look and what kind of activities could occur in the downtown after the redevelopment.

8.0 Downtown Redevelopment Concept Modelling

The Downtown Redevelopment Concept was broken into three phases so that the City could coordinate incremental investments in downtown infrastructure with corresponding property redevelopment by downtown landowners. The three phases are as follows:

- Phase I: King Street bypass and U-Haul pond
- Phase II: Restoration of Brush Creek to a natural channel and culvert capacity upgrades at Watauga Ave. and Kelly's Market
- Phase III: Installation of Brush Creek regional detention ponds

Phase I: The Downtown Redevelopment Concept model was created by altering the As-Is model through the addition of the King Creek bypass and U-Haul sump, similar to the previously described Concept 2. Open channel was utilized in the model as much as possible, while culverts were employed where loss of usable space and buildings would be unacceptable.

Phase II: Additional culvert capacity was modelled in the Brush Creek floodplain at Watauga Avenue and at Kelly's Market. This additional culvert capacity serves to keep Brush Creek from overtopping the culverts and entering State of Franklin Road during small storms. Brush Creek was modelled as a restored open channel from Sevier Street to the U-Haul pond. Box culverts were modelled where downtown streets crossed Brush Creek.

Phase III: Three large regional detention ponds were modelled in the Brush Creek watershed to reduce flows for the 50- and 100-year storms. This flow reduction ensures that Brush Creek does not overtop culverts and enter State of Franklin Road in the downtown area. All three ponds will remain dry under baseflow and small storm conditions. The regional detention pond locations are displayed in Figure 13.

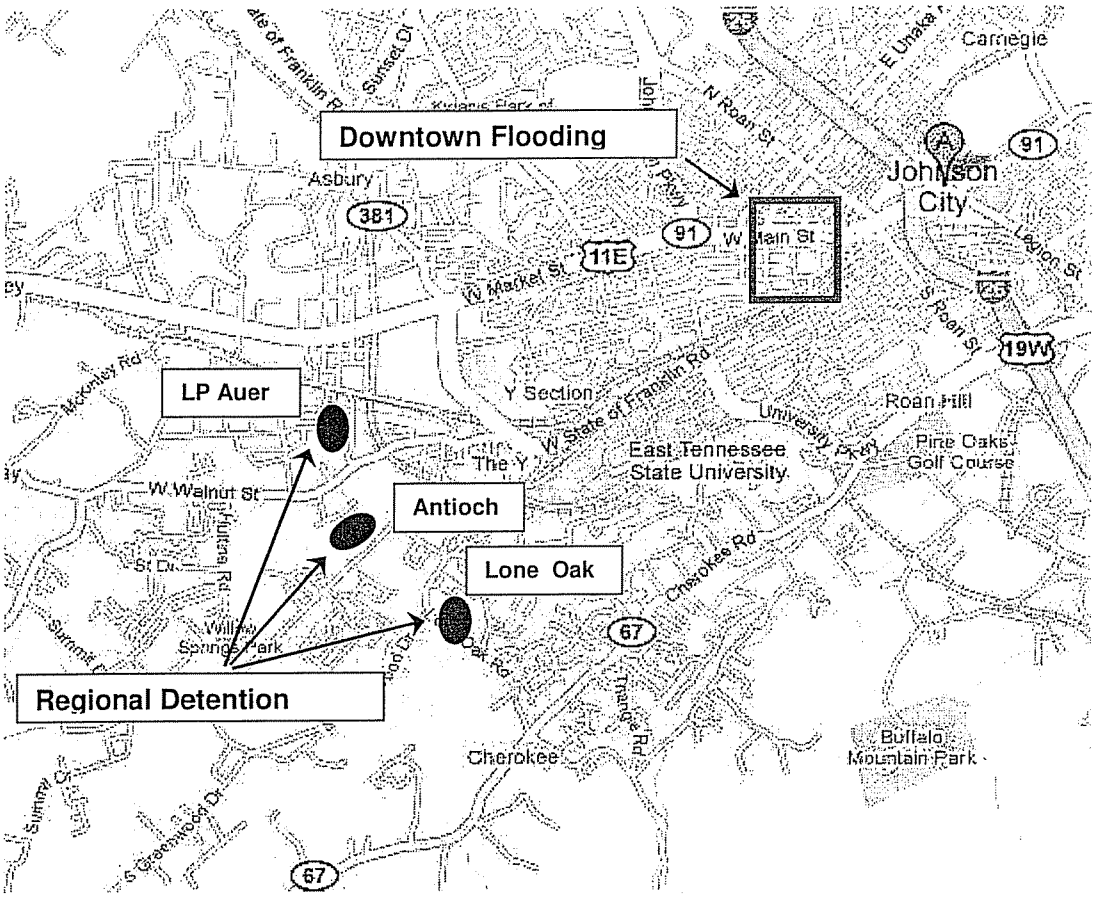


Figure 13: Regional Detention Pond Locations

9.0 Downtown Redevelopment Concept Results

The Phase I, Phase II and Phase III models were run for the 2, 5, 10, 25, 50 and 100 year storms. The model results showed increasing flooding protection with each phase of the downtown redevelopment project. The results can be summarized as follows:

- Phase I: protection to approximately the 5-year storm
- Phase II: protection to approximately the 25-year storm
- Phase III: protection to approximately the 50- to 100-year storm

A structure flooding analysis was then performed using results from the stormwater models. The flooding depth for each structure was found by subtracting the finished floor elevation for each structure from the peak stormwater depth at the most applicable (usually nearest) junction in the stormwater model. Finished floor elevations for the downtown area were taken from surveys done by AMEC's subcontractor, Michael Brady, Inc. Finished floor elevations for the structures East of State of Franklin Road were estimated based on City topographical maps. Buildings with multiple tenants had finished floor elevations surveyed for each tenant.

The structure flooding analysis was performed for each structure, at each storm, for each phase of the project. Structure removal during the project was accounted for. Flooding of parking lots, parks, empty parcels and other open areas was not considered. Figure 14 and Figure 15 demonstrate the results of the structure flooding analysis for the 50-year storm; parcels with flooded structures are shown red, while parcels without flooded structures are shown blue. The structure flooding calculations are included in an Excel spreadsheet on the accompanying compact disc.

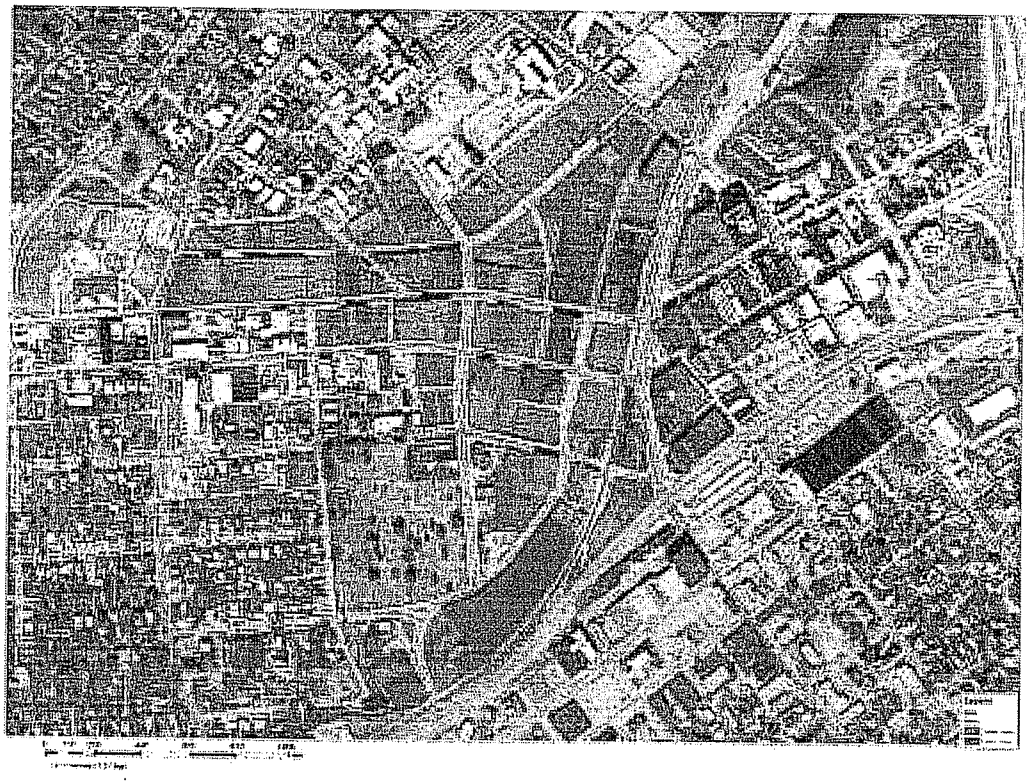


Figure 14: As-Is Structures Flooded for 50-year storm

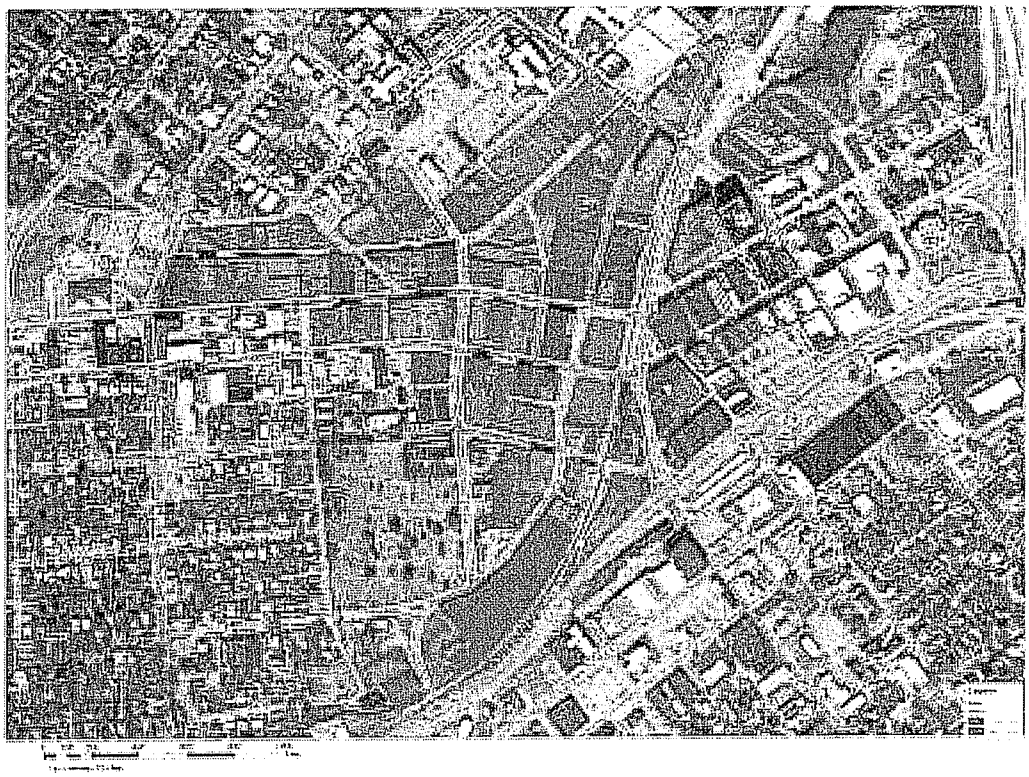


Figure 15: Redevelopment Concept Phase III Structures Flooded for 50-year storm

10.0 Downtown Redevelopment Concept Costs and Benefits

Conceptual cost estimates were prepared for each phase of the Redevelopment Concept using RS Means 2008 cost data. The costs included property acquisition, demolition, design, surveying, permitting, geotechnical consulting, construction, and a contingency. The overall costs are summarized below:

- Phase I: $11 million
- Phase II: $10 million
- Phase III: $5 million

The conceptual cost estimates can be found in Appendix D.

Flood abatement is the main benefit of the Downtown Redevelopment Project. The financial benefit of flood abatement was calculated using the FEMA limited data methodology. Flood depths for each structure were used to determine flood damages as a percentage of structure values using depth-damage functions. This process was performed for each structure, at each storm, for each phase of the Redevelopment Project. The Corps of Engineers depth-damage functions for commercial buildings were chosen over the FEMA function due to the commercial nature of the downtown (US Army Corps, 2006). The selected functions are shown in Figure 16 and Figure 17 below.

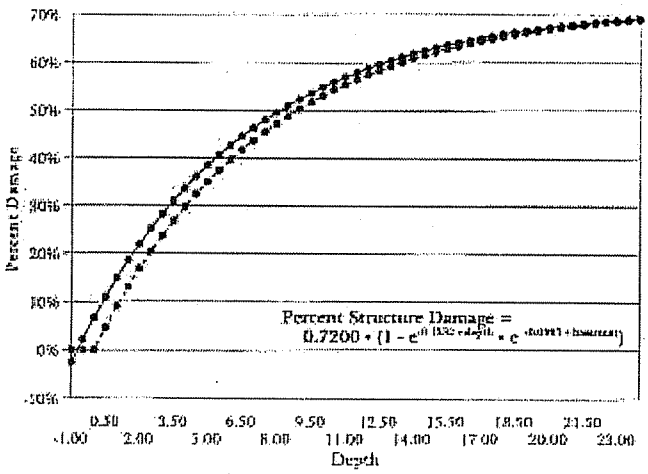


Figure 16: Structure Depth-Damage Function

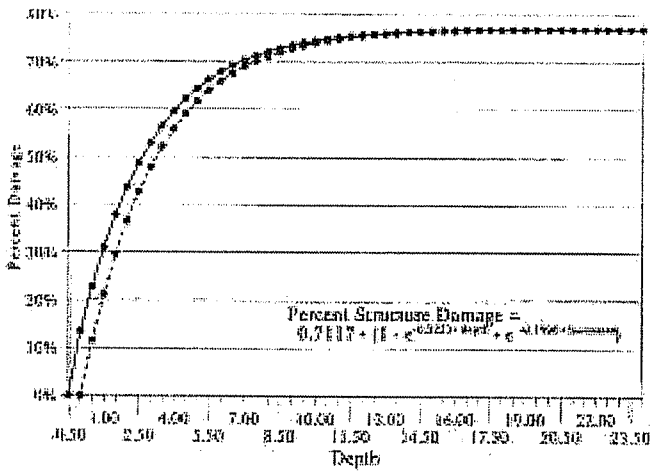


Figure 17: Contents Depth-Damage Function

The resulting damage percentages were then multiplied by the structure values to arrive at damage costs. Structure values were taken from appraised values provided by the City. Structure values for future phases were computed by adjusting property values to $75/SF for areas that were assumed to redevelop at each phase. Damage costs can be found in the structure flooding spreadsheet on the accompanying compact disc.

The overall flood mitigation benefits and project costs were then used in a FEMA limited data cost-benefit analysis for each phase (FEMA, 2005). Each phase used the damage results from the previous phase as its initial condition. The analysis showed the Phase I benefits to roughly balance costs. Phases II and III showed less benefit than cost. Phase I has much more effect on the cost-benefit analysis because it is the portion of the project that relieves flooding for the smaller storms that occur more often. A flood damage cost that occurs once every five years has much more impact that one that occurs once every one hundred years. The results of the cost-benefit analysis can be found in Appendix E.

Finally, the impact of redevelopment on City tax revenues was analyzed using the assumed increase in property values. Tax revenues were found to increase from $110,000 to $785,000 per year for the downtown area. This increased tax revenue could be used to pay for a portion of the Redevelopment Project using tax increment financing. However, a significant portion of the funding will have to come from elsewhere. The tax base analysis can also be found in the structure flooding spreadsheet on the accompanying compact disc.

11.0 Conclusions and Future Actions

The downtown drainage study found that the longstanding flooding problems in the downtown area are caused by backwater effects from constriction below the downtown and overtopping of the undersized King Creek and Brush Creek culverts. The structural condition of the Old Brush Creek culvert is very poor and it should be repaired or demolished. Solution of the flooding problem will require the addition of a large bypass, restoration of natural channels and creation of regional detention ponds. No small scale and inexpensive solution to flooding is possible due to the backwater effects and volume of flow overtopping the existing culverts.

The City must decide whether to invest a significant sum of money to solve the downtown drainage problems and redevelop the downtown into a place that the citizens will be proud to use. The redevelopment concept presented in this report is one alternative for the City to consider. Another alternative would be for the City to simply let the downtown flood and continue to deteriorate; this option may carry liability for the buildings that lie over the deteriorating culverts. A third option would be for the

City to simply purchase all of the structures that flood downtown and turn the area into a park and natural floodplain.

The choice of alternatives will be affected by the public will to fund the redevelopment project and the willingness of landowners to invest money in restoring their historic structures. As of this writing, the City has engaged a consulting firm to evaluate the redevelopment potential of the downtown. The results of this analysis will help the City to make an informed decision on how to proceed with solving the downtown flooding problem. The conceptual models created during this study can serve as the starting point for the design of any detailed design for flood abatement; they are found on the accompanying compact disc.

12.0 References

Camp, Dresser & McKee. Downtown Drainage Study: City of Johnson City, Tennessee. 2003.

Federal Emergency Management Agency. Benefit-Cost Analysis of Hazard Mitigation Projects: Volume 2 Riverine. 2005.

US Army Corps of Engineers. Analysis of Nonresidential Content Value and Depth-Damage Data for Flood Damage Reduction Studies. 1996.

Appendix A: Preliminary Structural Evaluation Report

PRELIMINARY STRUCTURAL OPINION

OLD BRUSH CREEK CULVERT

City of Johnson City

Prepared By:

HODGE ASSOCIATES
engineers · architects

3881 S. Davy Crockett Pkwy.
Morristown, Tennessee 37813
March 21, 2008

STEPHEN D. ROBBINS
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
No. 13783
STATE OF TENNESSEE

PRELIMINARY STRUCTURAL OPINION

OLD BRUSH CREEK CULVERT

Table of Contents

1. Purpose of Report
2. Method
3. Findings
4. Opinions

Appendices

Appendix A – Drawing & Notes

Appendix B – Photographs

March 21, 2008

1. PURPOSE OF REPORT

The purpose of this report is to determine if a full structural evaluation of the Old Brush Creek Culvert is warranted.

This report has been prepared for AMEC as part of their contract with the City of Johnson City for the Downtown Drainage Improvement Project.

2. METHOD

A preliminary walkdown of the Old Brush Creek Culvert was performed on March 13 and 17, 2008. The physical condition of the interior of the culvert was observed and documented with photographs. The majority of the time was spent inside the culvert with limited observation of the exterior. Access was made thru the new Brush Creek Culvert and thru a failed roof section located between W. Market Street and W. Main Street. The investigation team also observed the failed section of the King Street Culvert.

3. FINDINGS

Major elements of the Culvert investigation include:

1. Two distinct sections of the culvert noted as 'Old Section' and 'New Section'.
2. No bottom slab in the culvert.
3. Many post construction invasions for utility lines, street drainage, and roof drains.
4. Several buildings have been constructed over the culvert.
5. King Street Culvert failure.

1. The 'Old Section' appears to have been constructed as two gravity retaining walls at the edge of Brush Creek to provide channelization. The center wall and roof slab was added at a later date to provide floors for buildings. Different designs were used for the roof section at various locations. The street crossings

were also built as separate design sections from the culvert although they may have been installed at the same time.

There has been one slab failure between W. Main Street and W. Market Street. The remainder of this slab will continue to fail if live loads and/or dead loads are imposed on it. The slab is thin and was built as a building floor slab. The underside of the slab has exposed reinforcing steel. The structural beams located at 14 foot centers are in very poor condition. The bottom steel is exposed, some beams are bowed, and one has completely failed.

A second failure has occurred under the building face fronting Lamont Street. This area has a failed center wall, failed footers and one outside wall failure. The settlement is severe enough that water is flowing in the reverse direction in the west barrel. A sewer line in the culvert has deflected and is leaking. There appears to be minimal storm water influent in this section of the culvert and continuing failure should be slow.

The 'New Section' appears to have been built at one time as a double barreled culvert. The railroad section is a separate structure. The west barrel has one foot of accumulated silt and debris. The walls are very thick, one measurement was 24 inches. Concrete cover over reinforcing steel is generally good. There are two areas of structural compromise; the intersection of the King Street Culvert and the wall abutting the railroad culvert.

2. The entire culvert was probably built to span the existing Brush Creek. The bottom of the culvert is the creek bed in most locations, although some channelization may have occurred in the original construction. There are several exposed rock outcroppings. The entire length shows intrusion of ground water flows into the culvert. The installation of footers at the edge of the stream flow without a bottom slab has allowed for undercutting of the footers throughout the length of the culvert. In most cases this is a minor structural problem.

3. Over the many years that this culvert has been in place many utility lines have been installed thru the culvert. Water lines, sewer lines, cable conduit, and abandoned small diameter lines of unknown use are present. Several storm drain pipes have been added and some roof drains have been cut into the top slab or walls. There was a wide variety of methods used to cut thru the concrete with several instances of minor to significant damage caused by the intrusions. Where sewer lines are near the culvert invert there has been water scour induced as the flow goes over the pipe.

4. The 'Old Section' of the culvert has buildings using the outside walls as structural footers for the building walls and as support for flooring. The 'New Section' appears to have buildings spanning over the culvert but not incorporating the culvert structurally.

5. The King Street Culvert has completely failed at the intersection with the Brush Creek Culvert. The North wall is under cut up to 4 feet and has overturned. The south wall is also undercut. Turbulence caused by the intersecting flows of the two culverts is probably the major cause, however, a sewer line just upstream of the failure is acting as a weir dam in the King Street Culvert and induces continuous water scour.

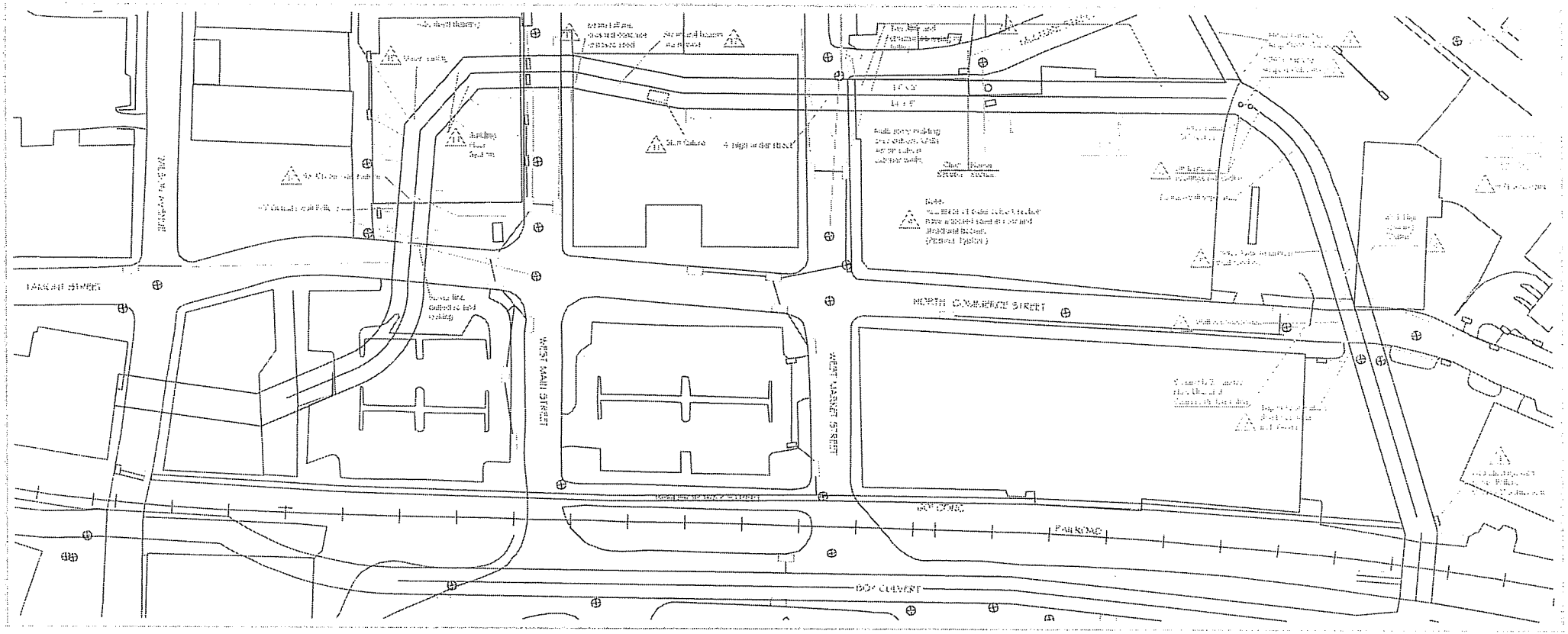
4. OPINIONS

The opinions of the author are two fold as related to the 'Old Section' and 'New Section'. The 'Old Section' of the culvert has started to fail and no amount of rehabilitation will correct its flaws and damage. The City should be made aware of the failure under the existing building and monitor the situation to minimize the possibility of injury to people.

The 'New Section' is sound enough to warrant further analysis and measurement for rehabilitation efforts. The most extensive work will be in the area of the King Street Culvert intersection.

APPENDIX A

DRAWINGS & NOTES

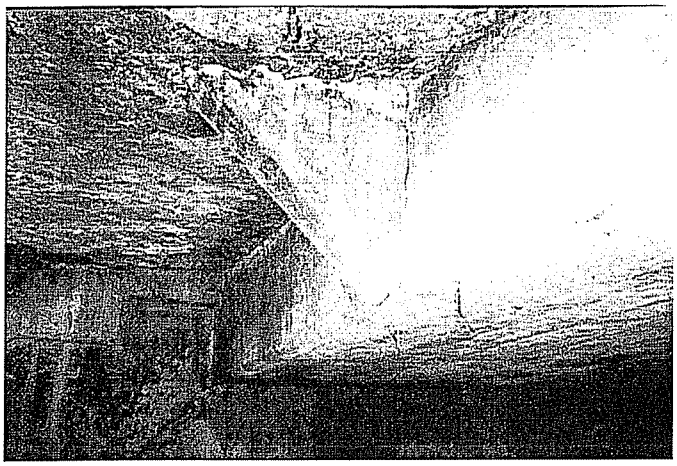

NORTH COMMERCE STREET
WEST MAIN STREET
WEST MARKET STREET
BOX CULVERT
RAILROAD

APPENDIX B

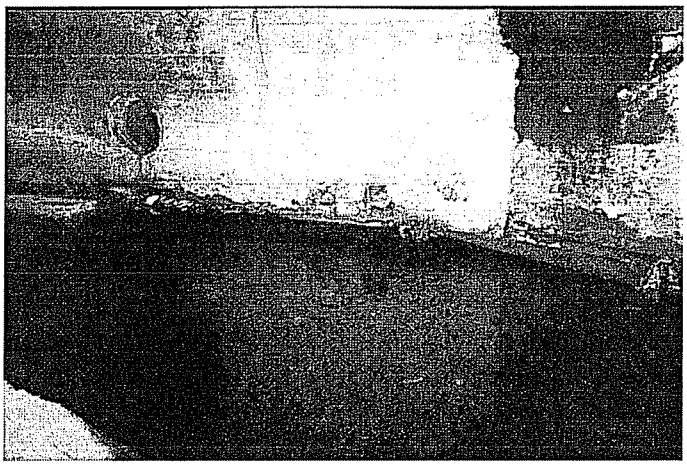
PHOTOGRAPHS

Johnson City Drainage - Picture Point 1

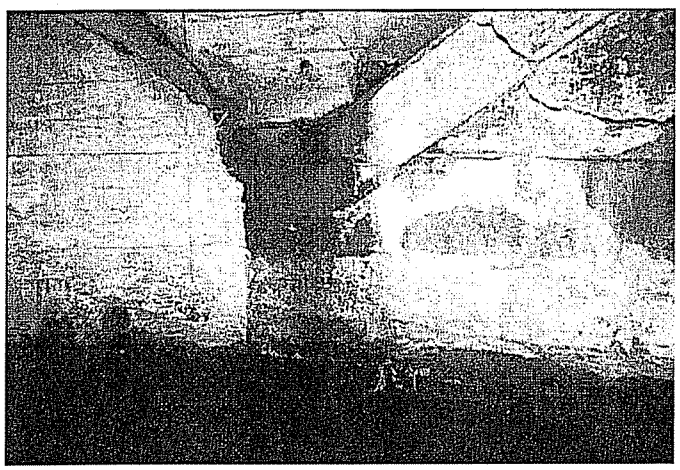
Cam 1-016.jpg



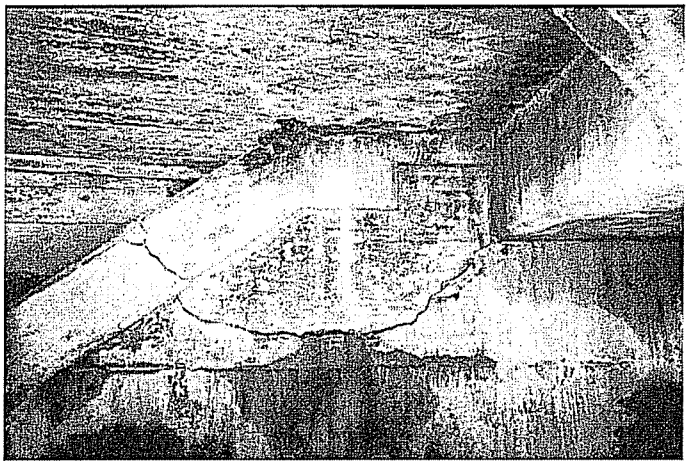
Cam 1-017.jpg



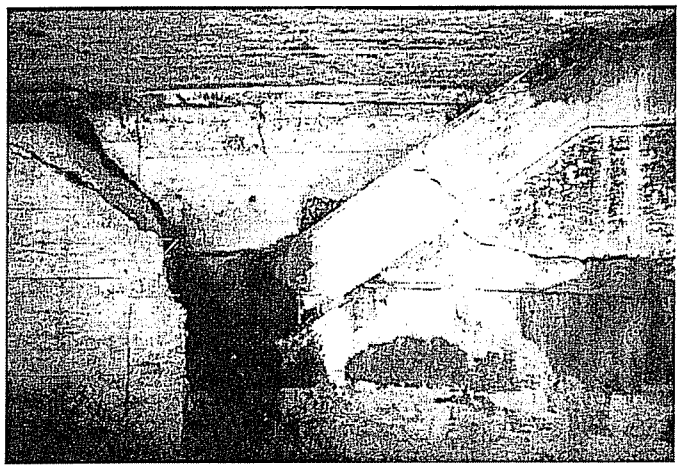
Cam 1-018.jpg



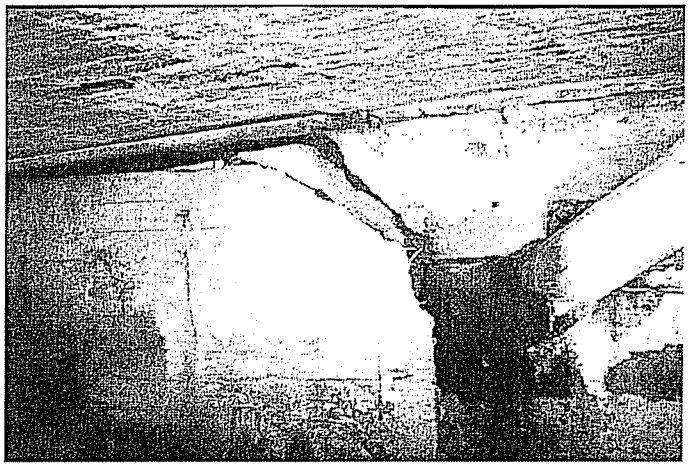
Cam 1-019.jpg



Cam 1-020.jpg

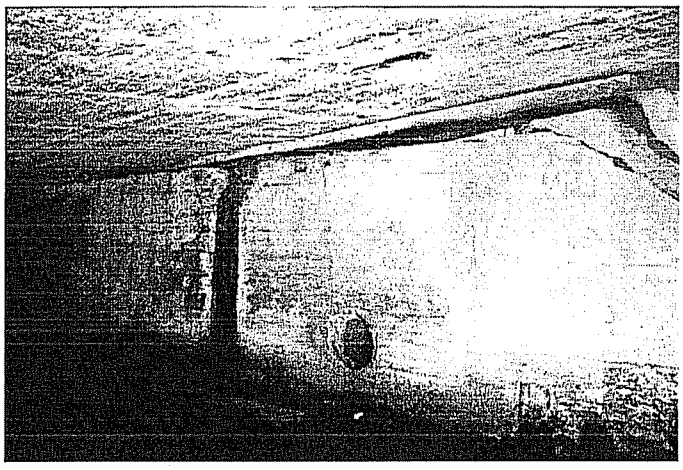


Cam 1-021.jpg



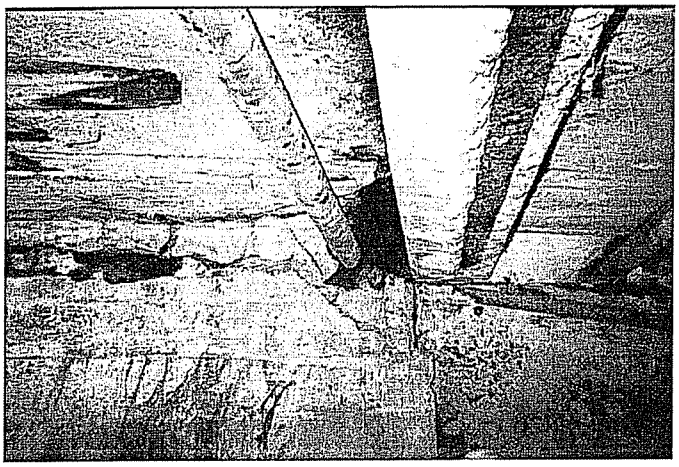
Johnson City Drainage - Picture Point 1

Cam 1-022.jpg

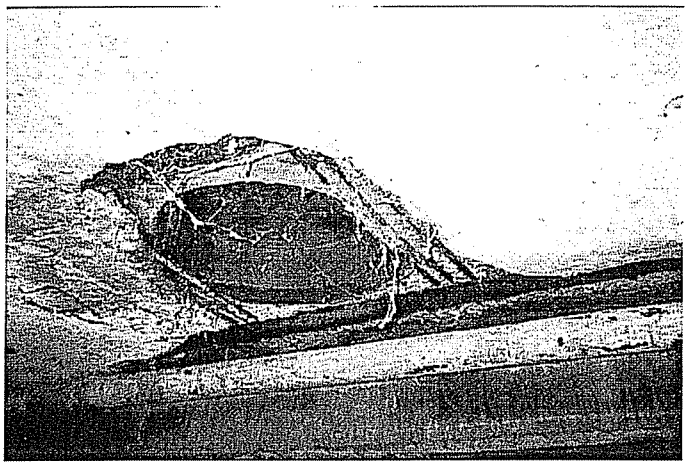


Johnson City Drainage - Picture Point 2

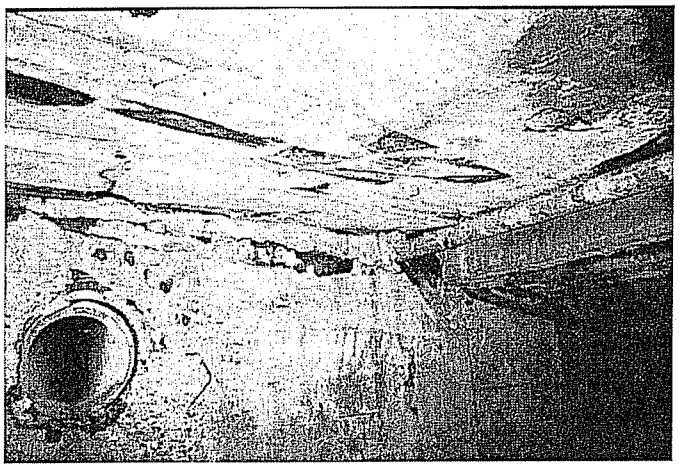
Cam 4-019.jpg



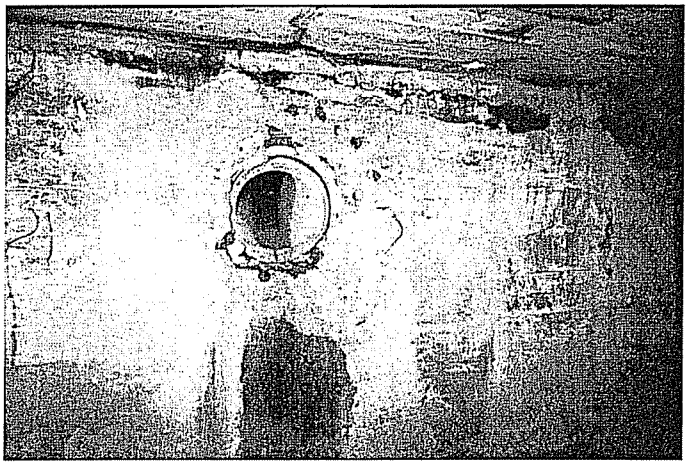
Cam 4-020.jpg



Cam 4-021.jpg

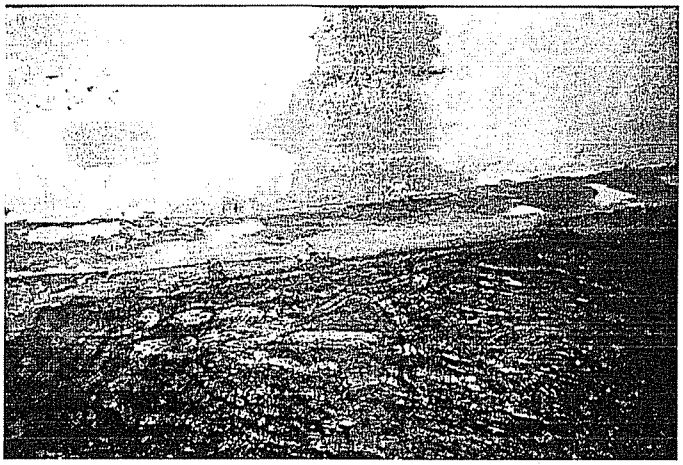


Cam 4-022.jpg



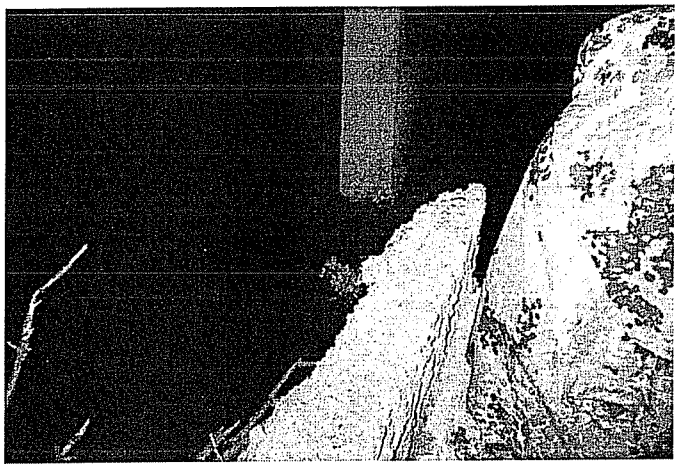
Johnson City Drainage - Picture Point 3

Cam 4-015.jpg

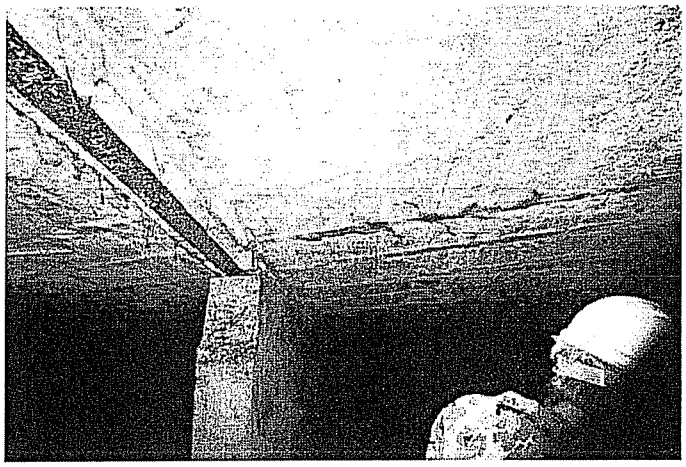


Johnson City Drainage - Picture Point 4

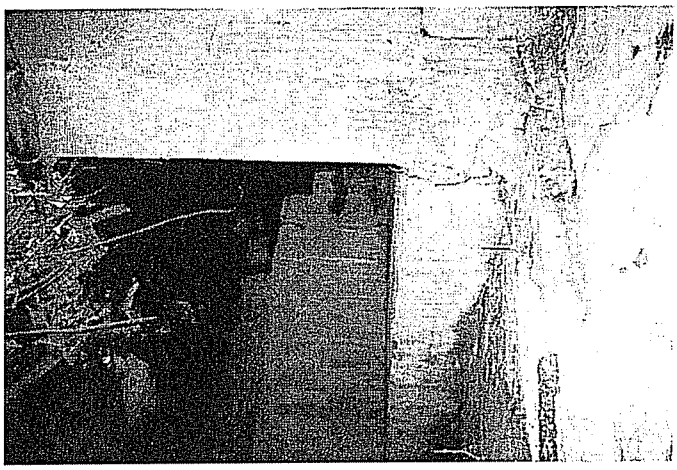
Cam 1-023.jpg



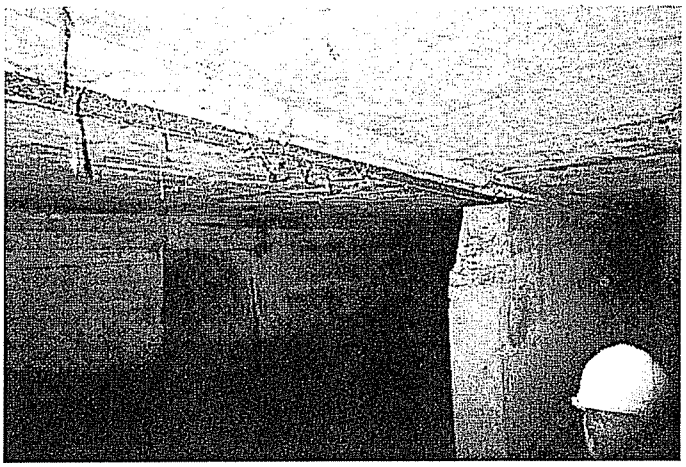
Cam 1-024.jpg



Cam 1-025.jpg



Cam 1-026.jpg

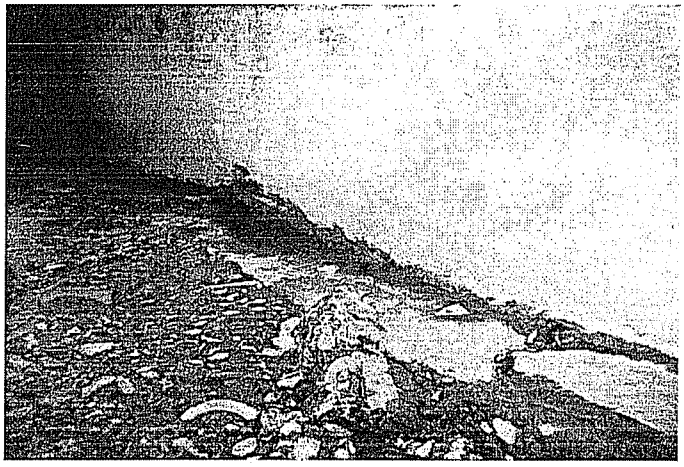


Johnson City Drainage - Picture Point 5

Cam 1-012.jpg

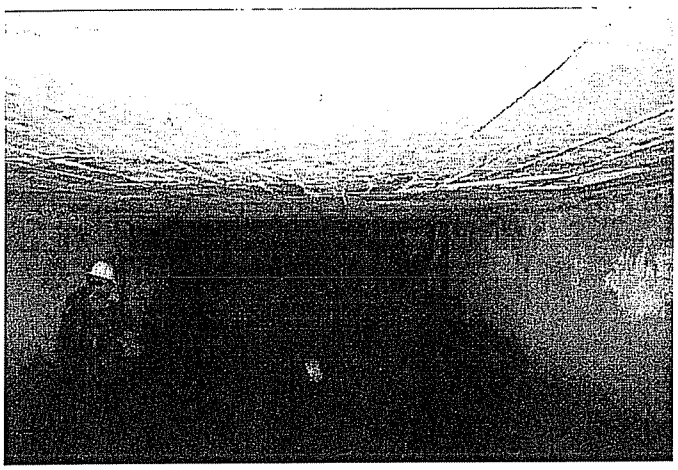
Cam 1-013.jpg

Cam 1-014.jpg



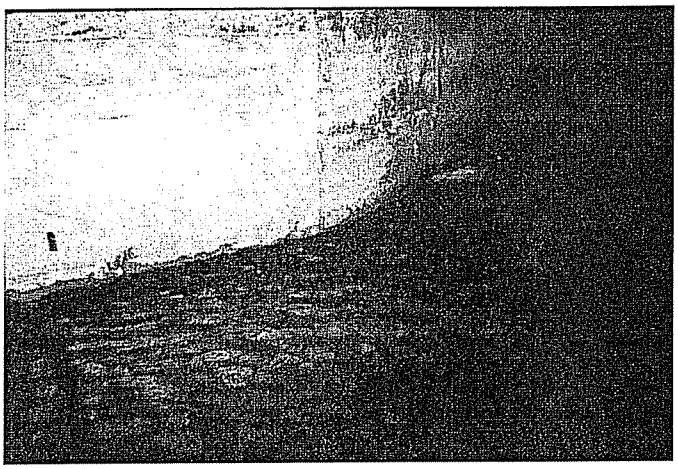
Johnson City Drainage - Picture Point 6

Cam 4-010.jpg

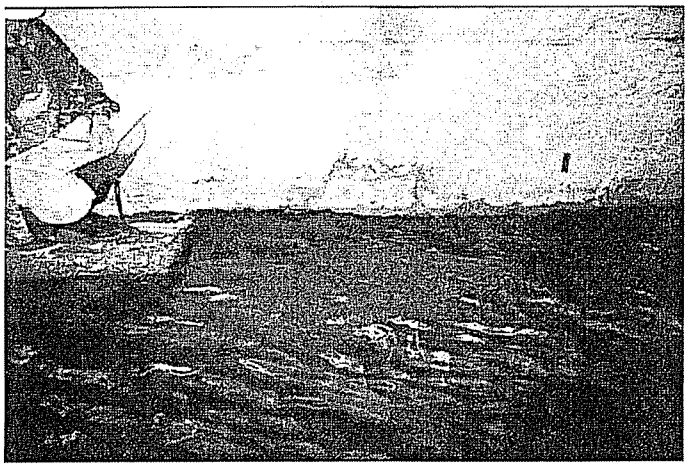


Cam 4-011.jpg

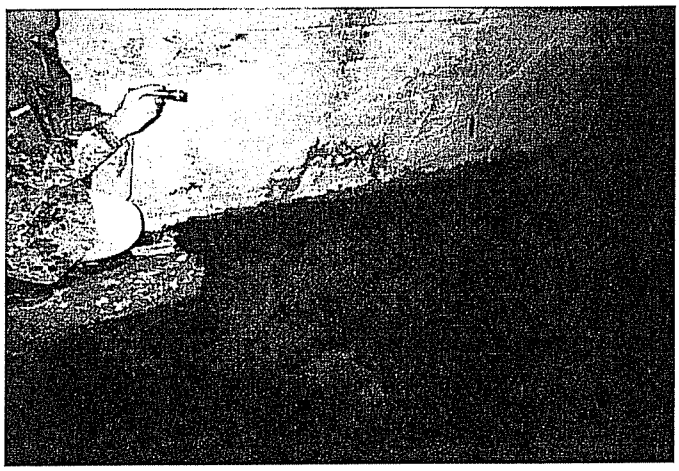
Cam 4-012.jpg



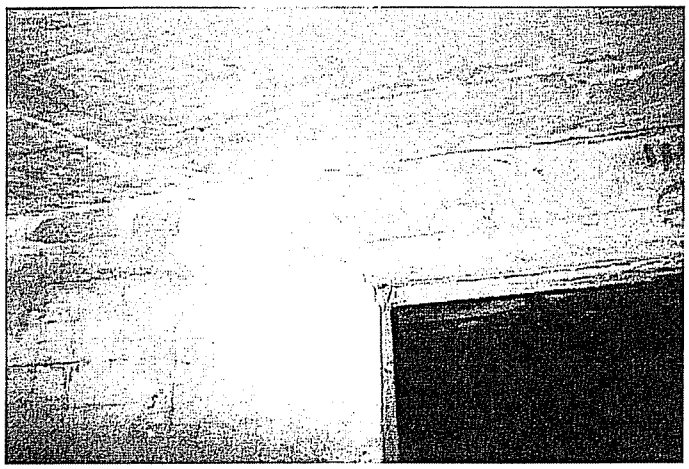
Cam 4-013.jpg



Cam 4-014.jpg

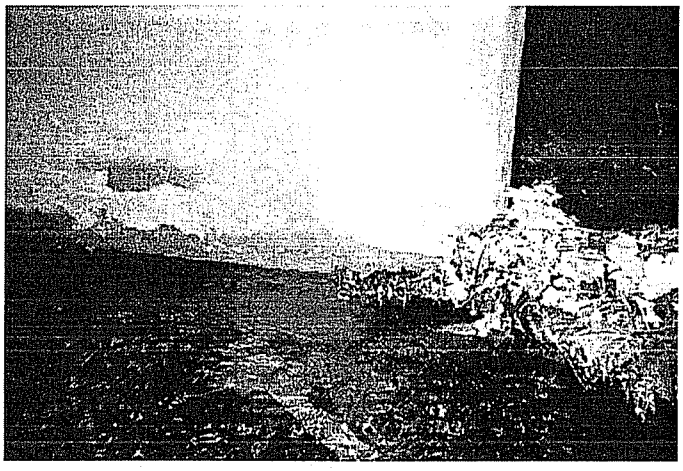


Cam 4-016.jpg



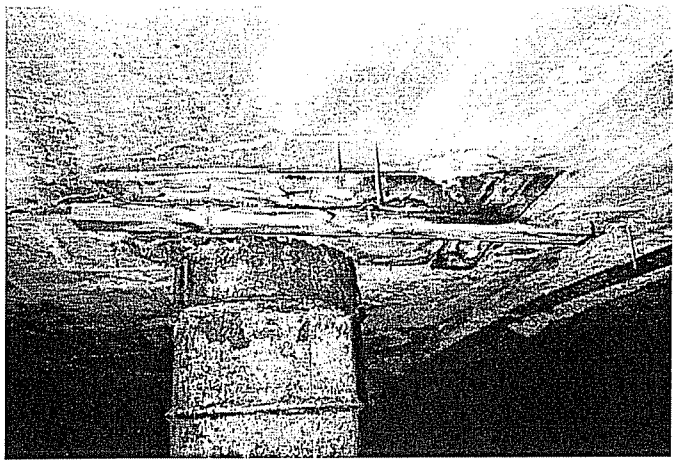
Johnson City Drainage - Picture Point 6

Cam 4-017.jpg

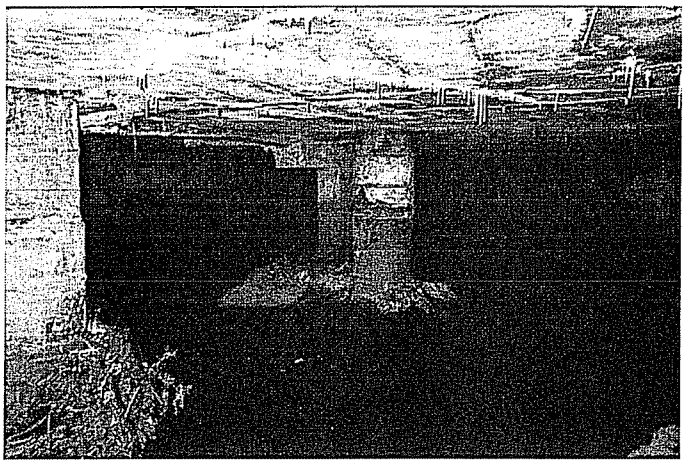


Johnson City Drainage - Picture Point 7

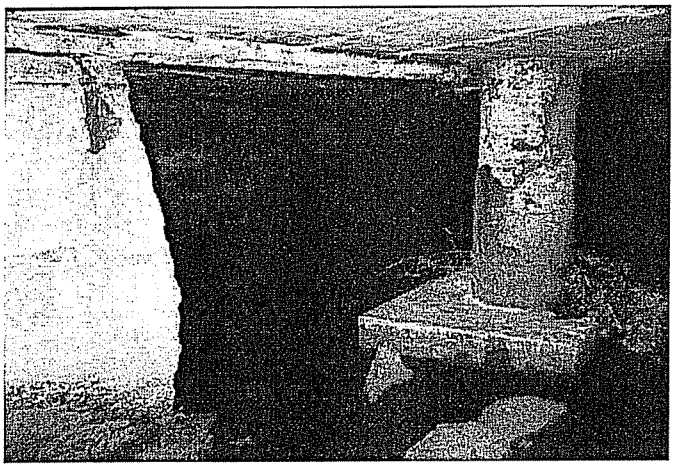
Cam 1-003.jpg



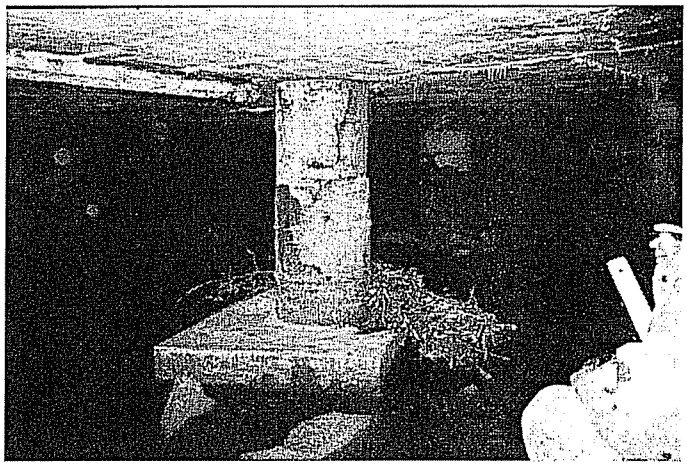
Cam 1-009.jpg



Cam 1-010.jpg

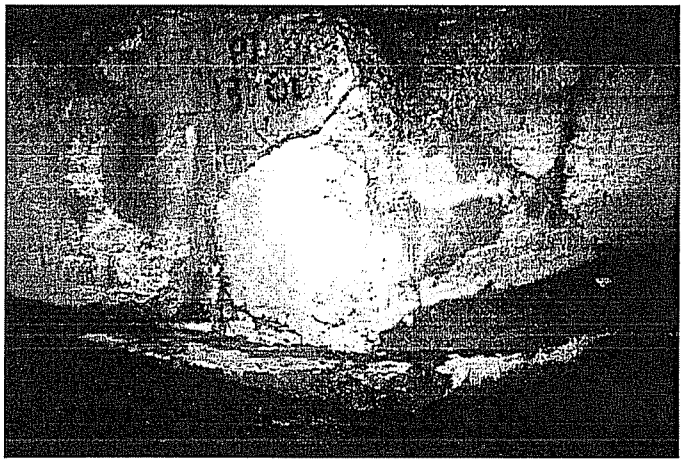


Cam 1-011.jpg

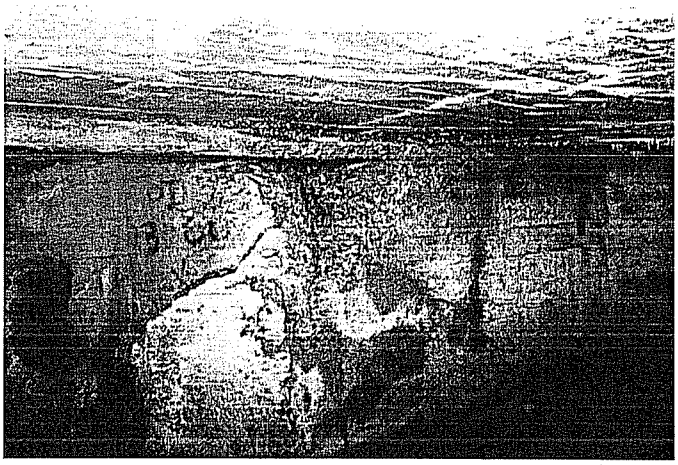


Johnson City Drainage - Picture Point 8

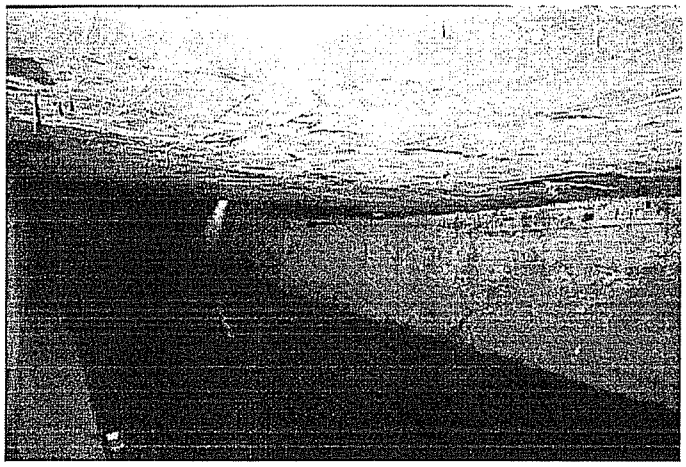
Cam 1-004.jpg



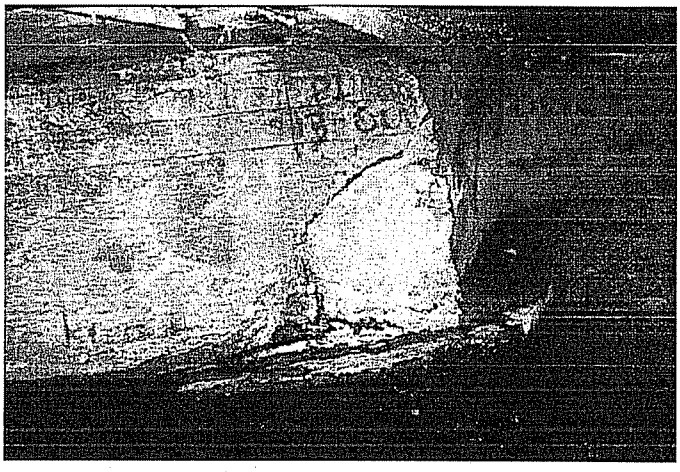
Cam 1-005.jpg



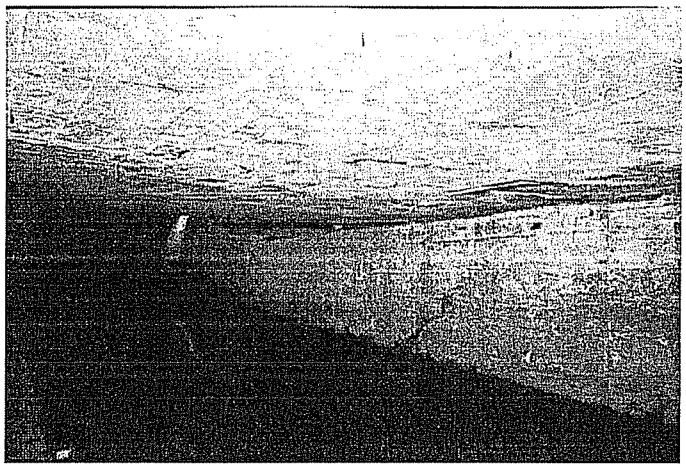
Cam 1-006.jpg



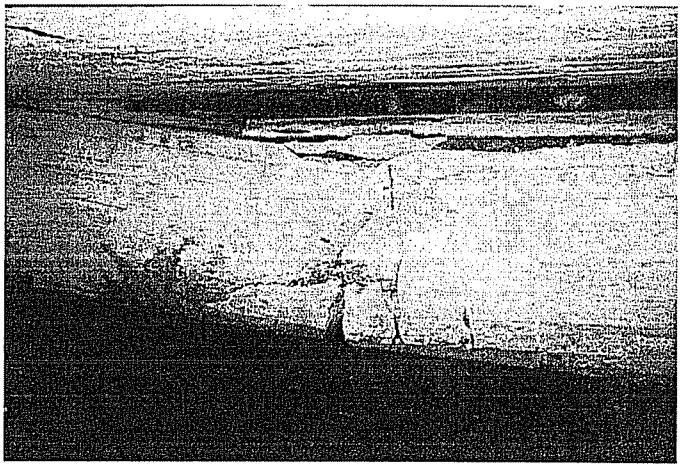
Cam 1-007.jpg



Cam 1-008.jpg



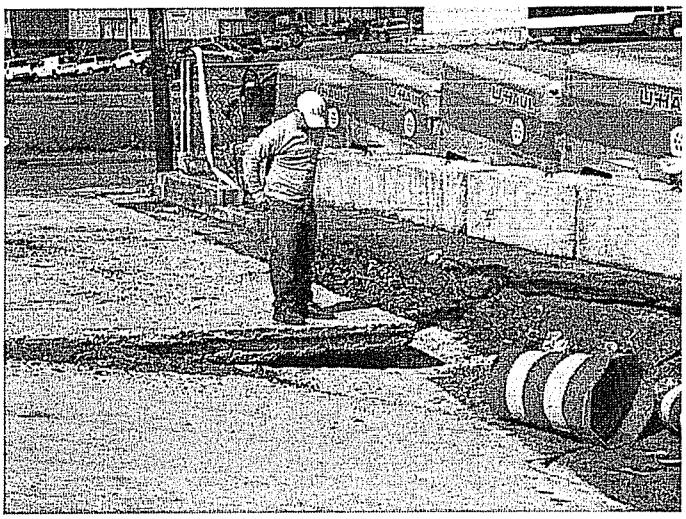
Cam 4-006.jpg



Johnson City Drainage - Picture Point 8

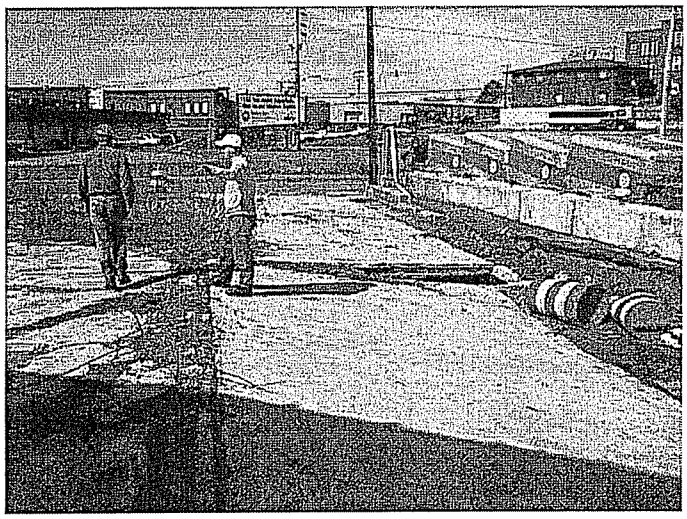
Cam 4-007.jpg

IMG_1719.JPG



IMG_1720.JPG

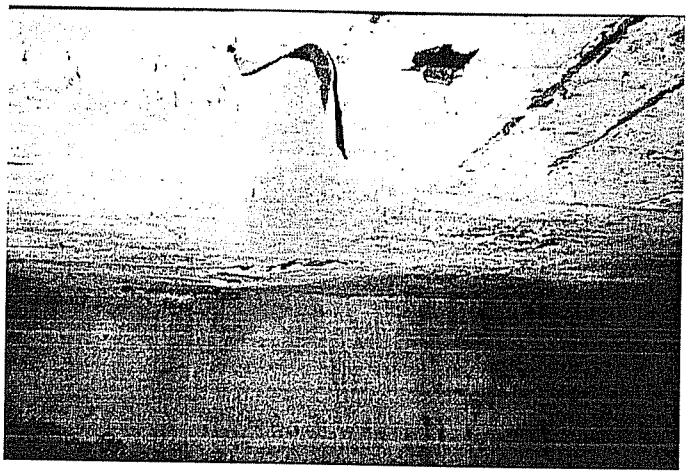
IMG_1722.JPG



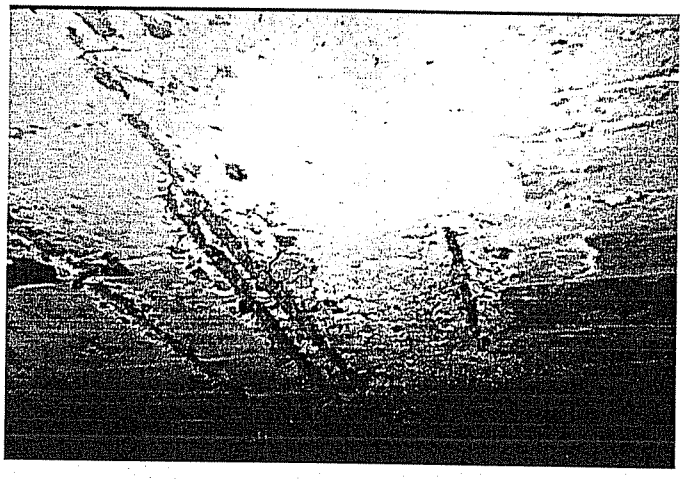
IMG_1724.JPG

Johnson City Drainage - Picture Point 9

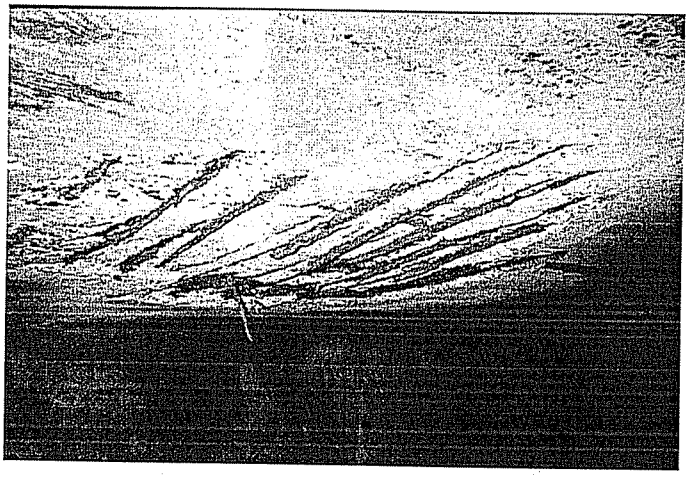
Cam 2-007.jpg



Cam 2-008.jpg

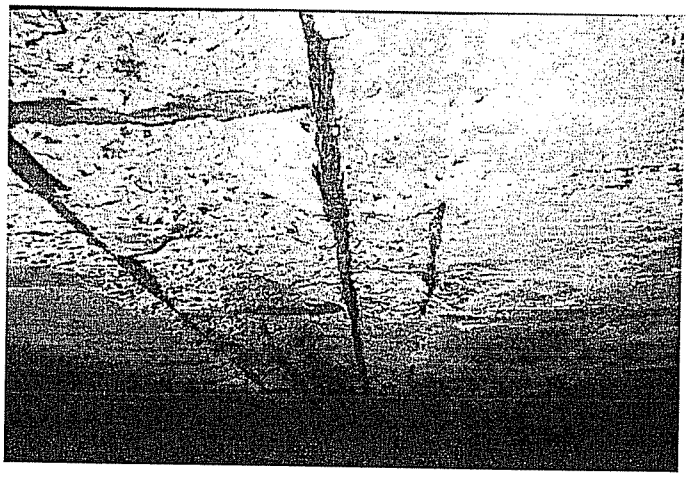


Cam 2-009.jpg

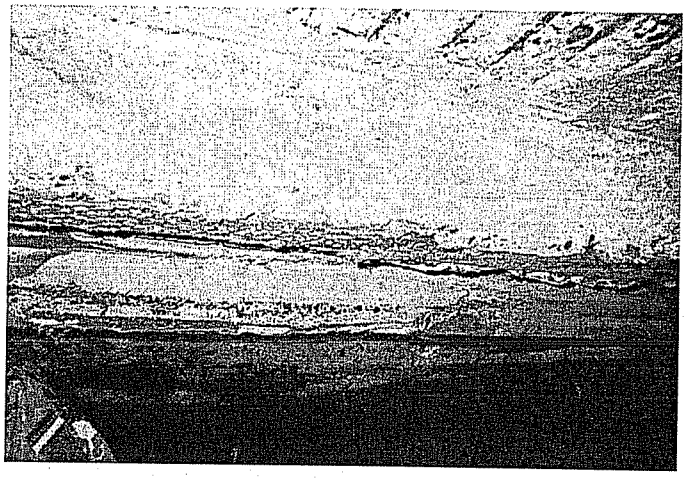


Cam 2-011.jpg

Cam 2-012.jpg

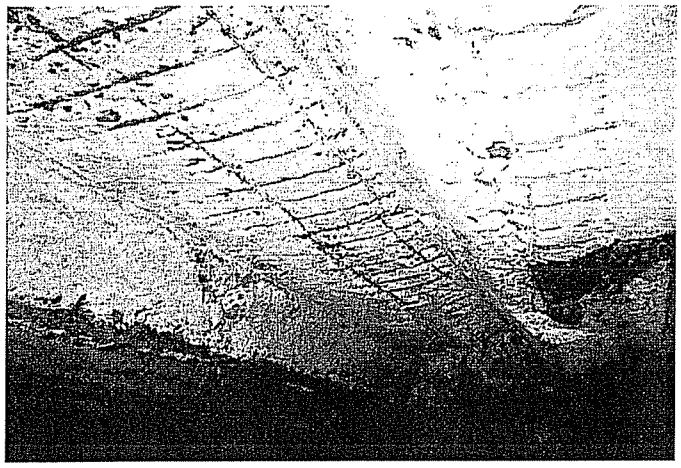


Cam 3-022.jpg



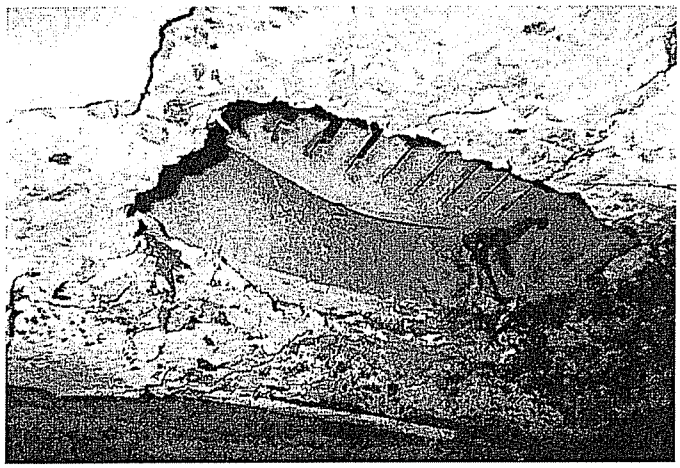
Johnson City Drainage - Picture Point 9

Cam 3-023.jpg

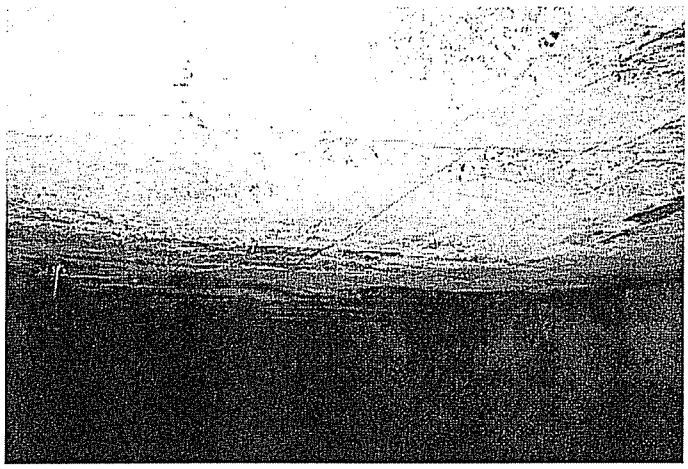


Cam 3-024.jpg

Cam 3-025.jpg



Cam 3-026.jpg



Cam 3-027.jpg

Cam 4-024.jpg

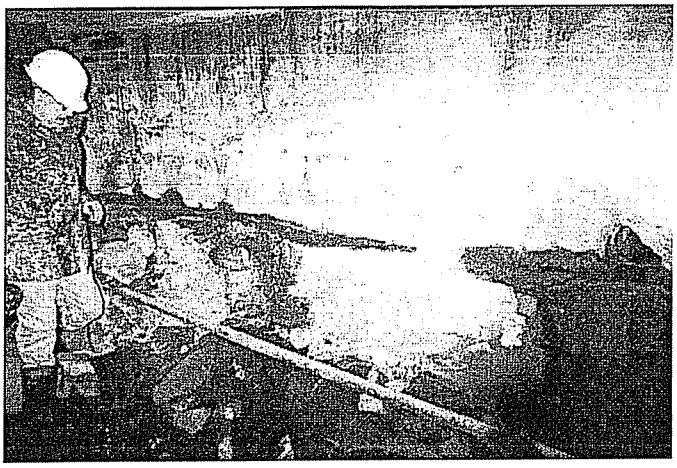
Johnson City Drainage - Picture Point 9

Cam 4-026.jpg

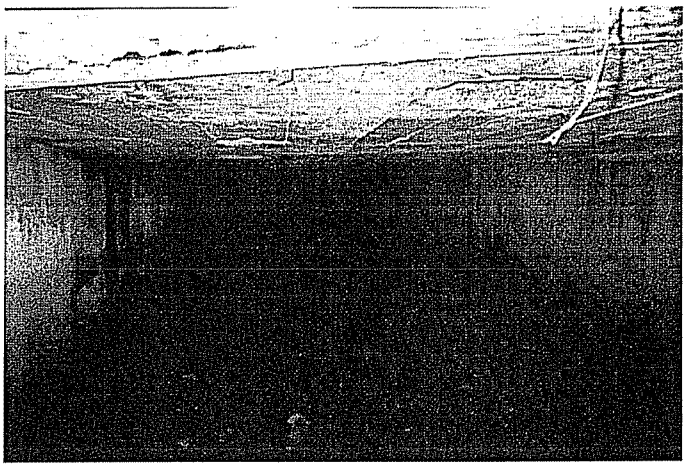
Cam 4-027.jpg

Johnson City Drainage - Picture Point 10

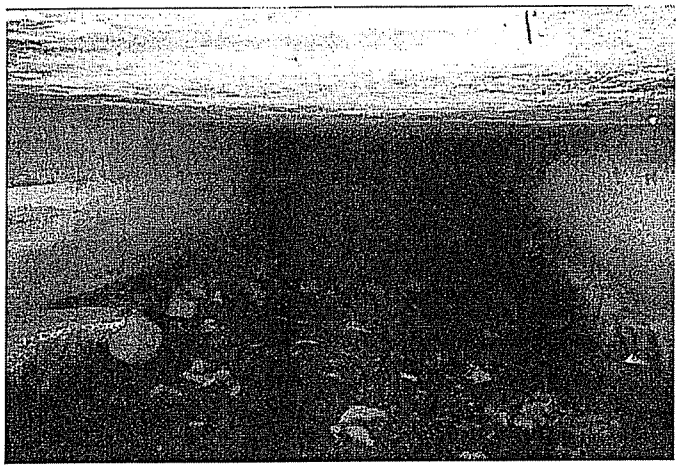
Cam 2-006.jpg



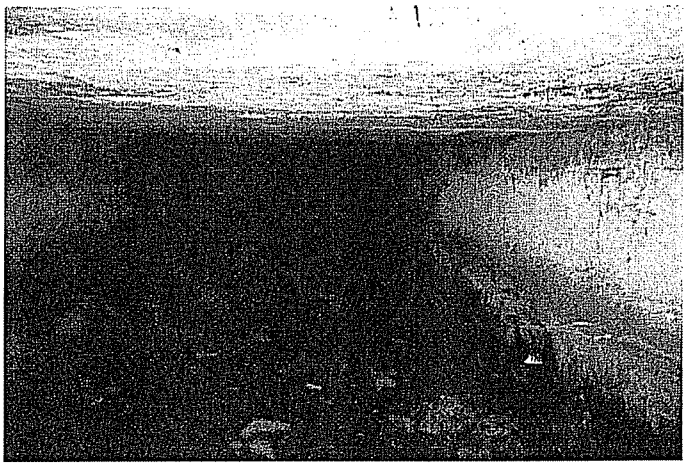
Cam 2-013.jpg



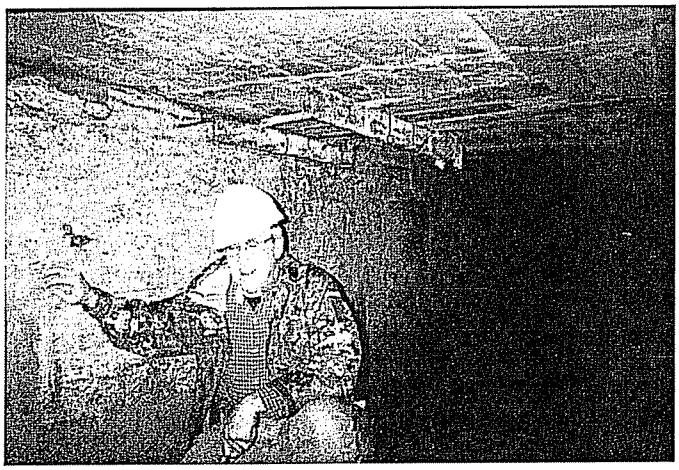
Cam 2-014.jpg



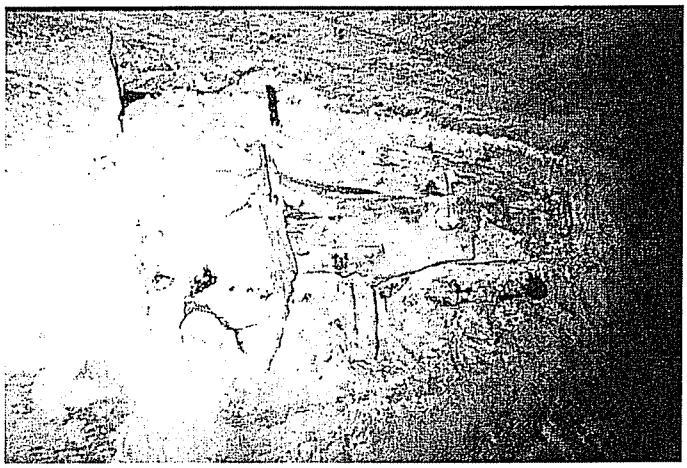
Cam 2-015.jpg



Cam 2-016.jpg



Cam 2-017.jpg



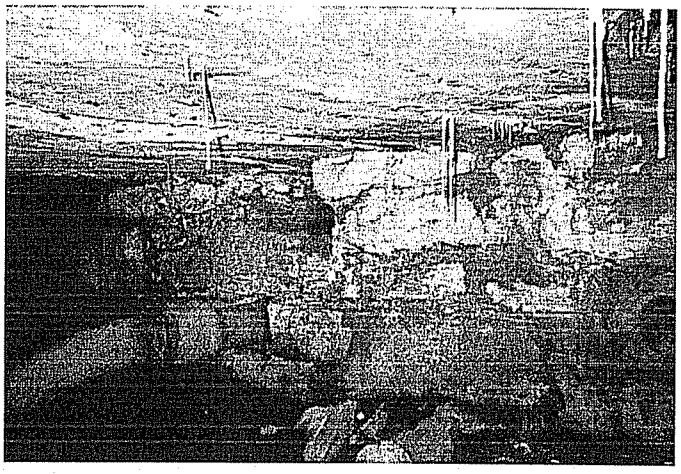
Johnson City Drainage - Picture Point 10

Cam 2-018.jpg

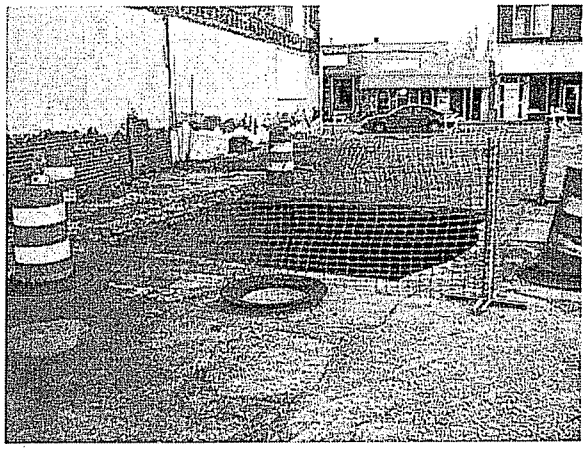
Cam 2-019.jpg

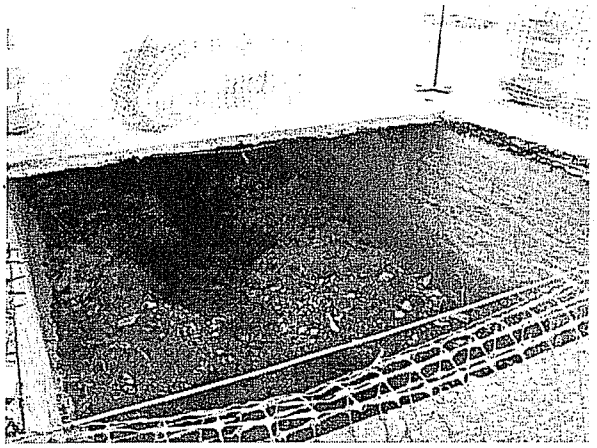
Cam 2-020.jpg

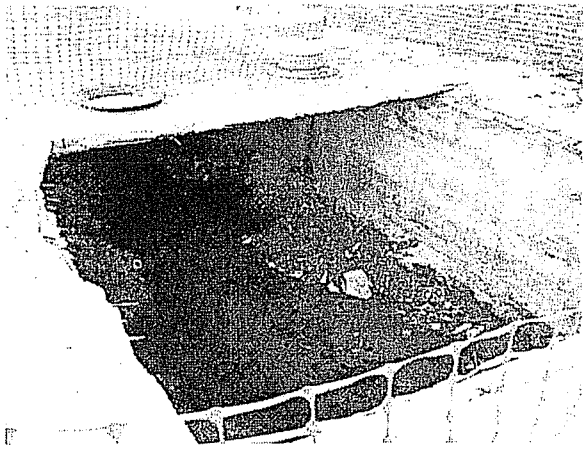
Cam 2-021.jpg

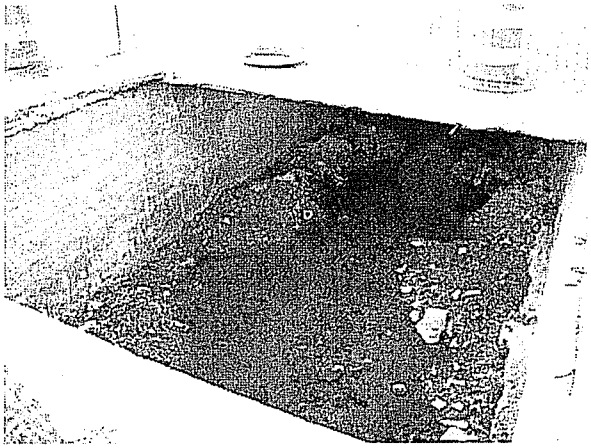


Johnson City Drainage - Picture Point 11



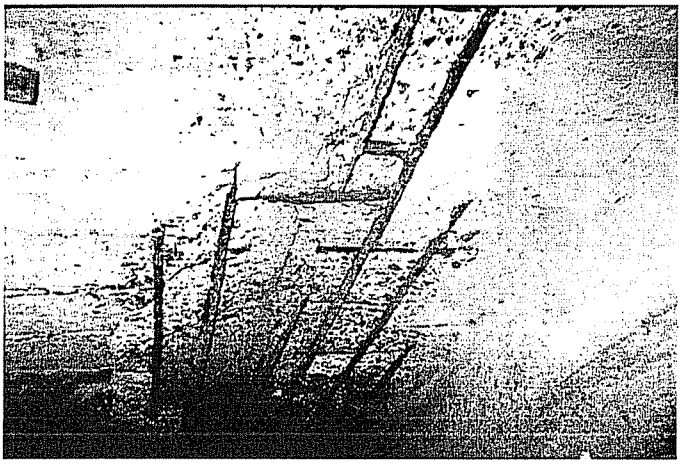




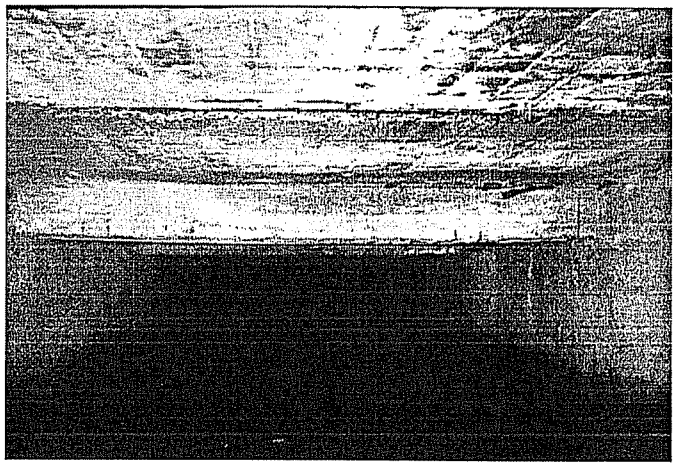


Johnson City Drainage - Picture Point 12

Cam 2-004.jpg

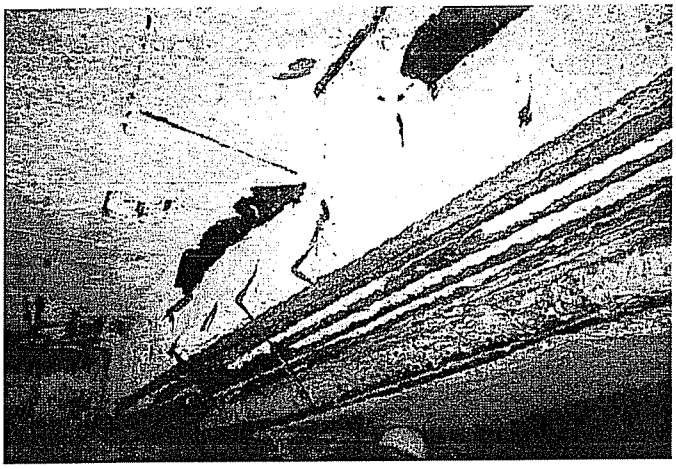


Cam 2-005.jpg

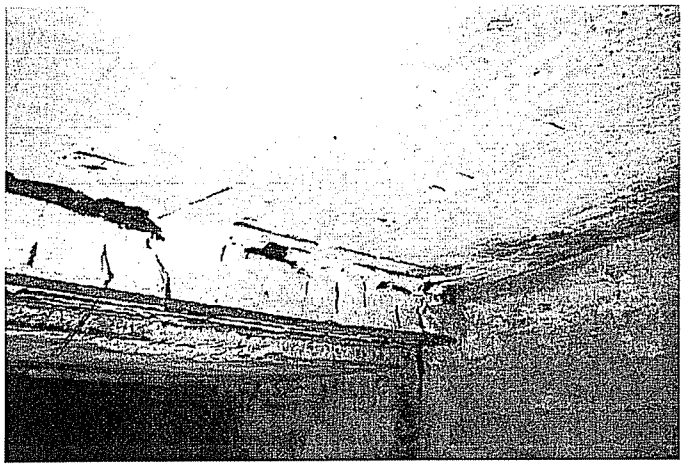


Johnson City Drainage - Picture Point 13

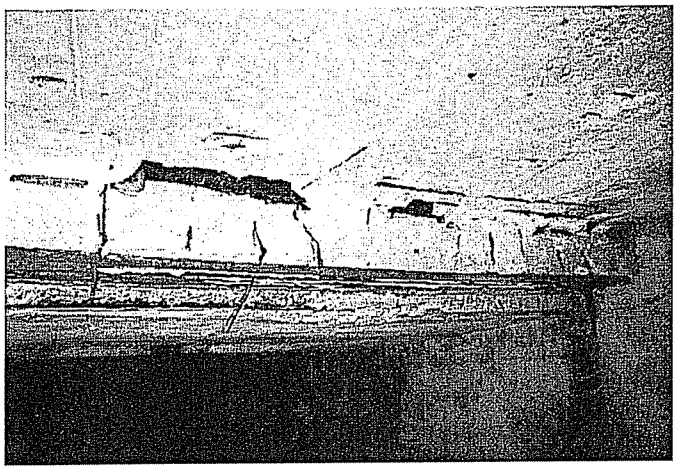
Cam 2-001.jpg



Cam 2-002.jpg



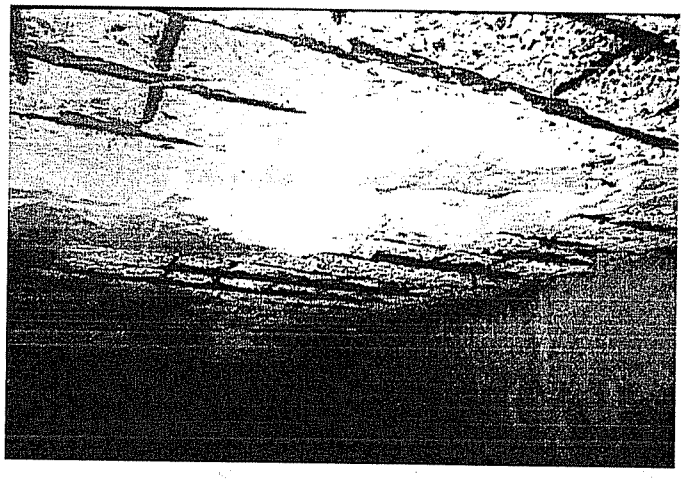
Cam 2-003.jpg



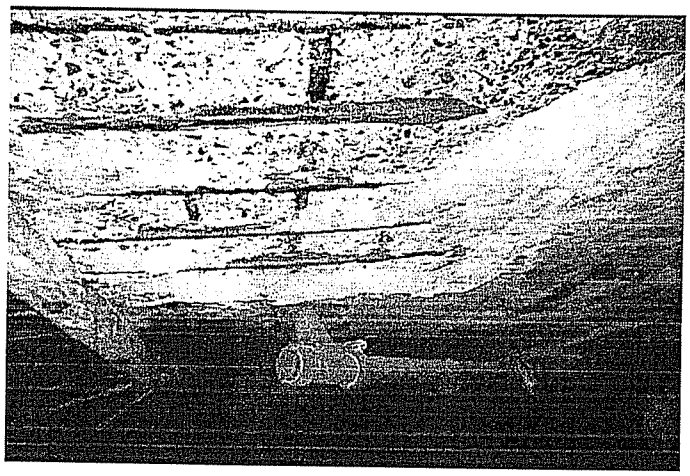
Johnson City Drainage - Picture Point 14

Cam 2-022.jpg

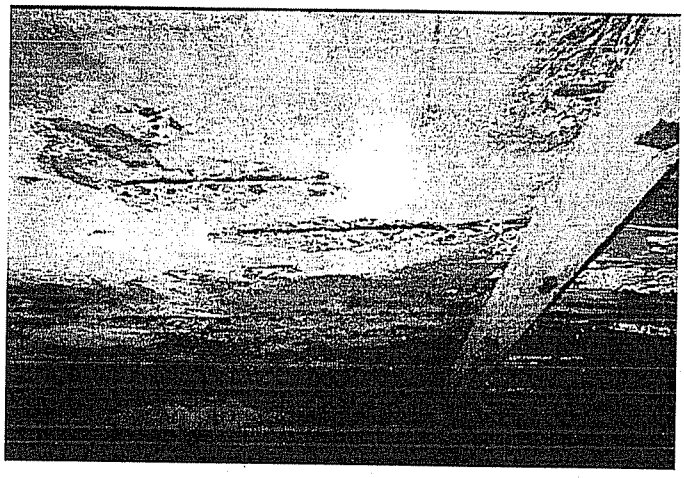
Cam 2-023.jpg



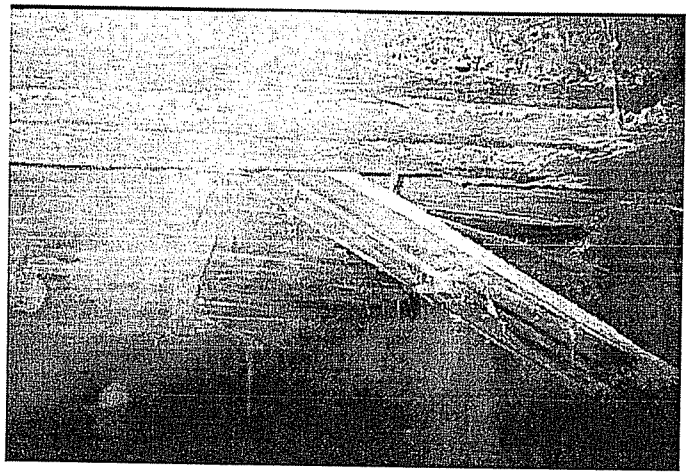
Cam 2-024.jpg



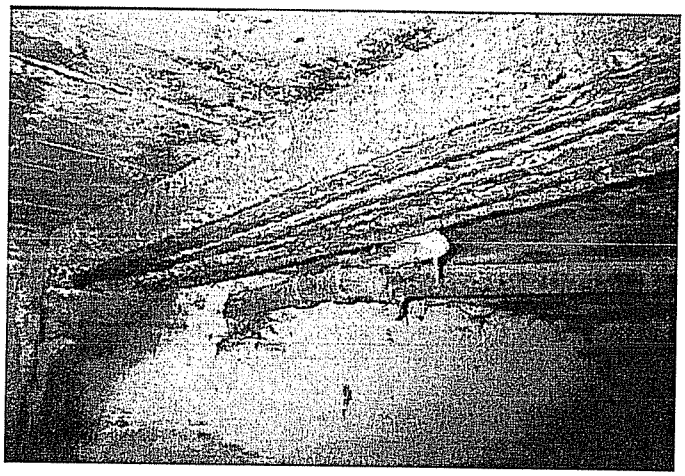
Cam 2-025.jpg



Cam 2-026.jpg

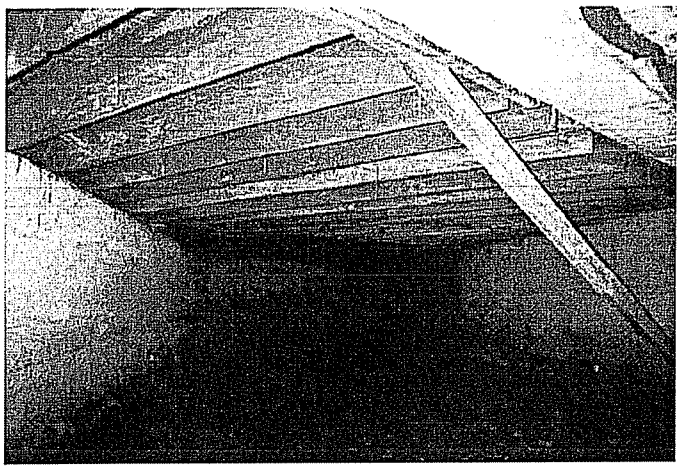


Cam 2-027.jpg

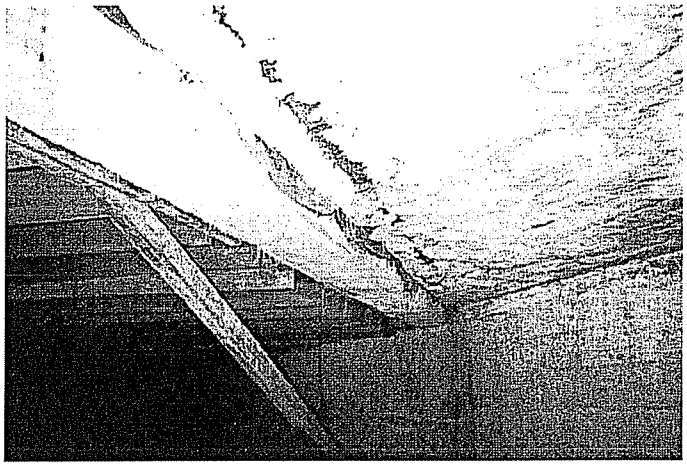


Johnson City Drainage - Picture Point 14

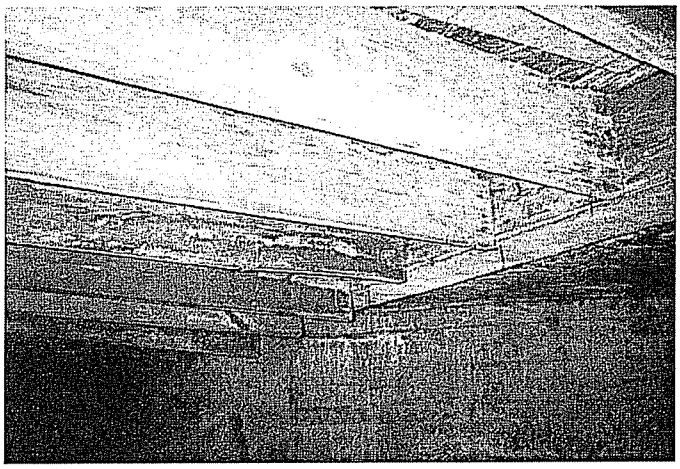
Cam 3-001.jpg



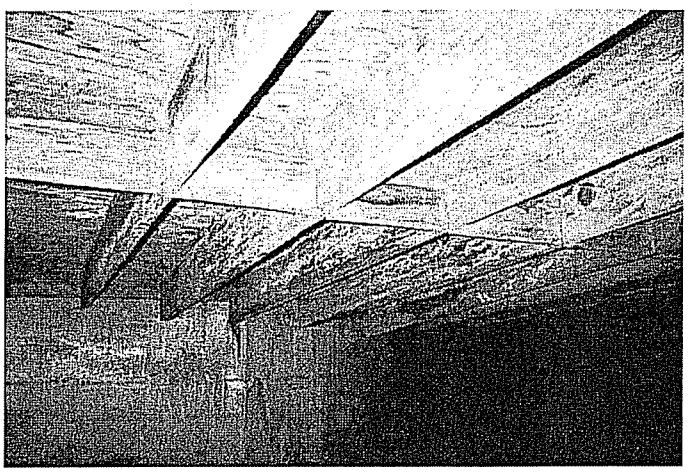
Cam 3-002.jpg



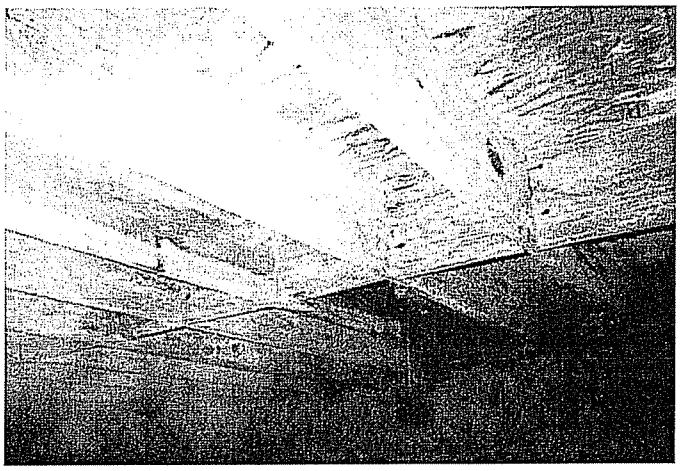
Cam 3-015.jpg



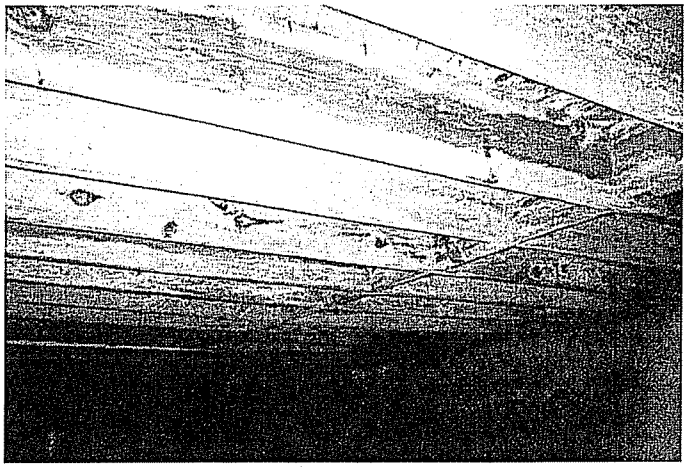
Cam 3-016.jpg



Cam 3-017.jpg

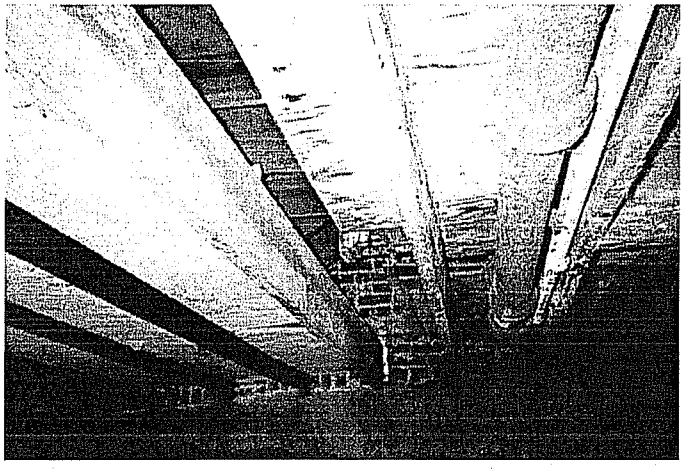


Cam 3-018.jpg

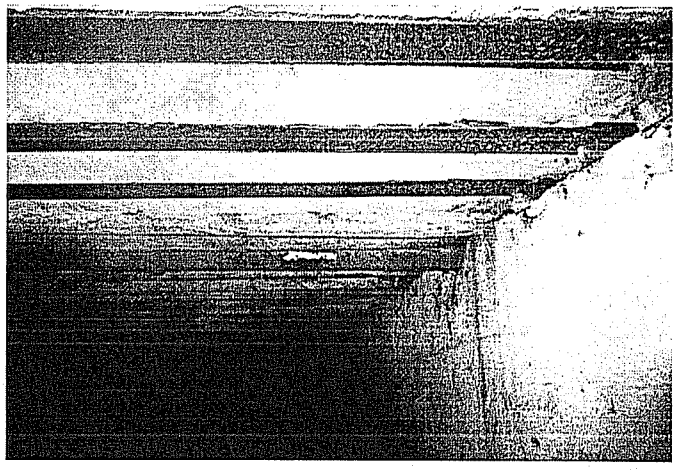


Johnson City Drainage - Picture Point 14

Cam 3-019.jpg



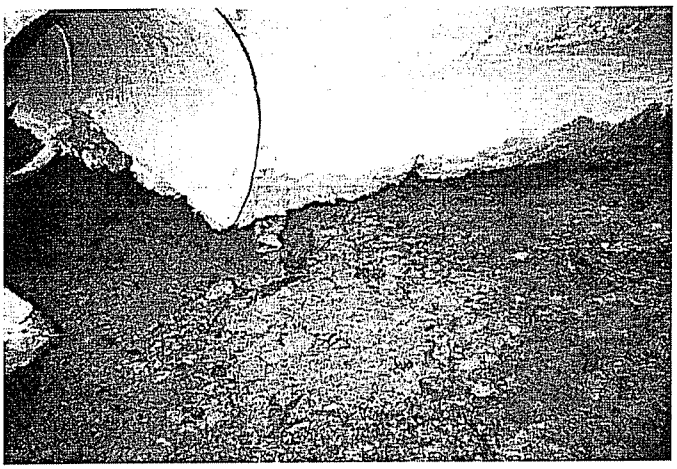
Cam 3-020.jpg



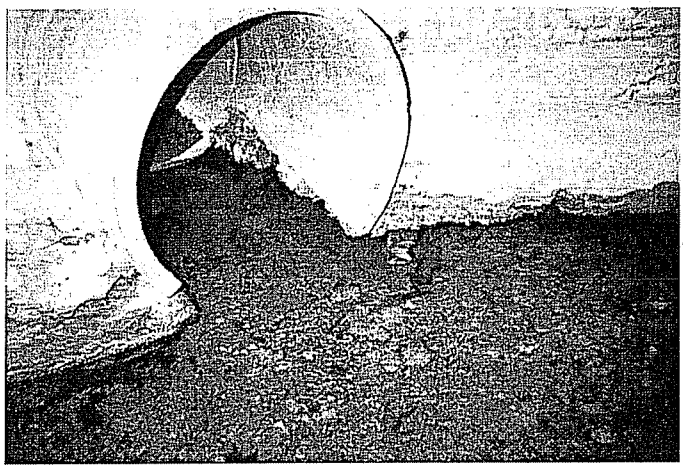
Cam 3-021.jpg

Johnson City Drainage - Picture Point 15

Cam 3-003.jpg

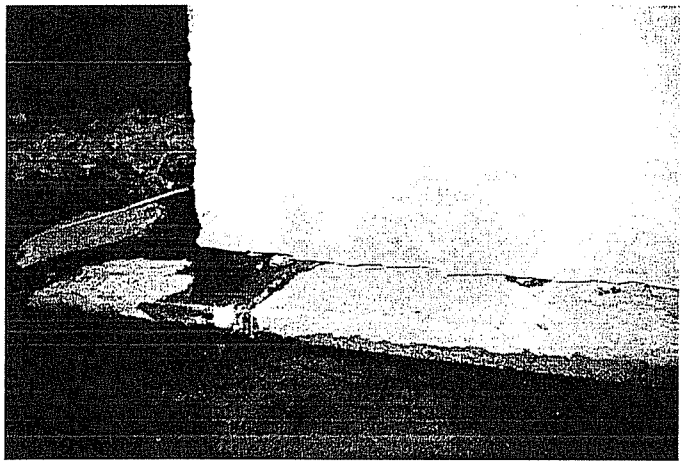


Cam 3-004.jpg

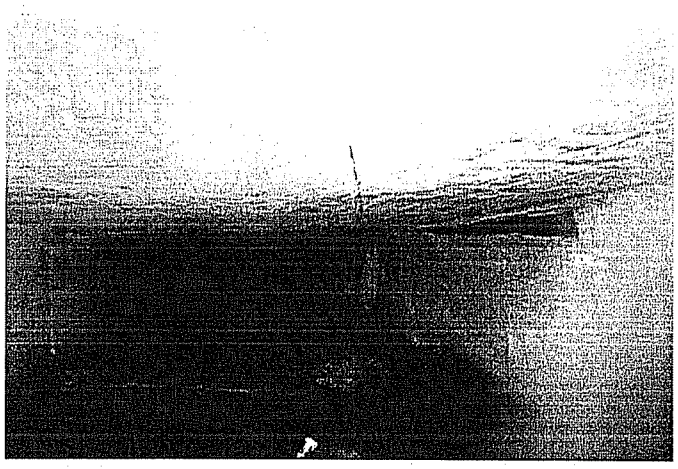


Johnson City Drainage - Picture Point 16

Cam 3-010.jpg



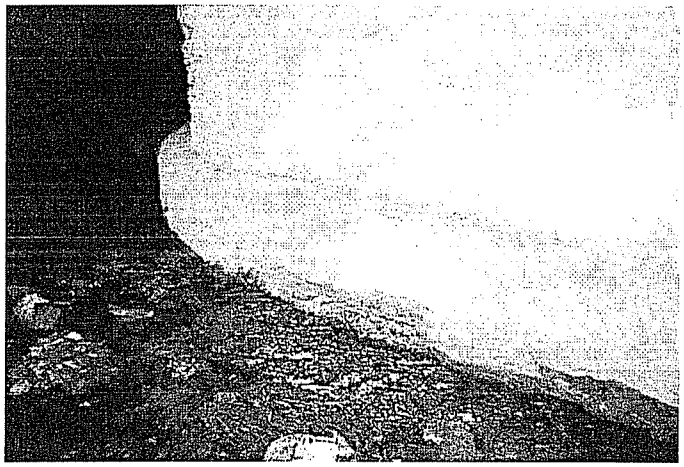
Cam 3-011.jpg



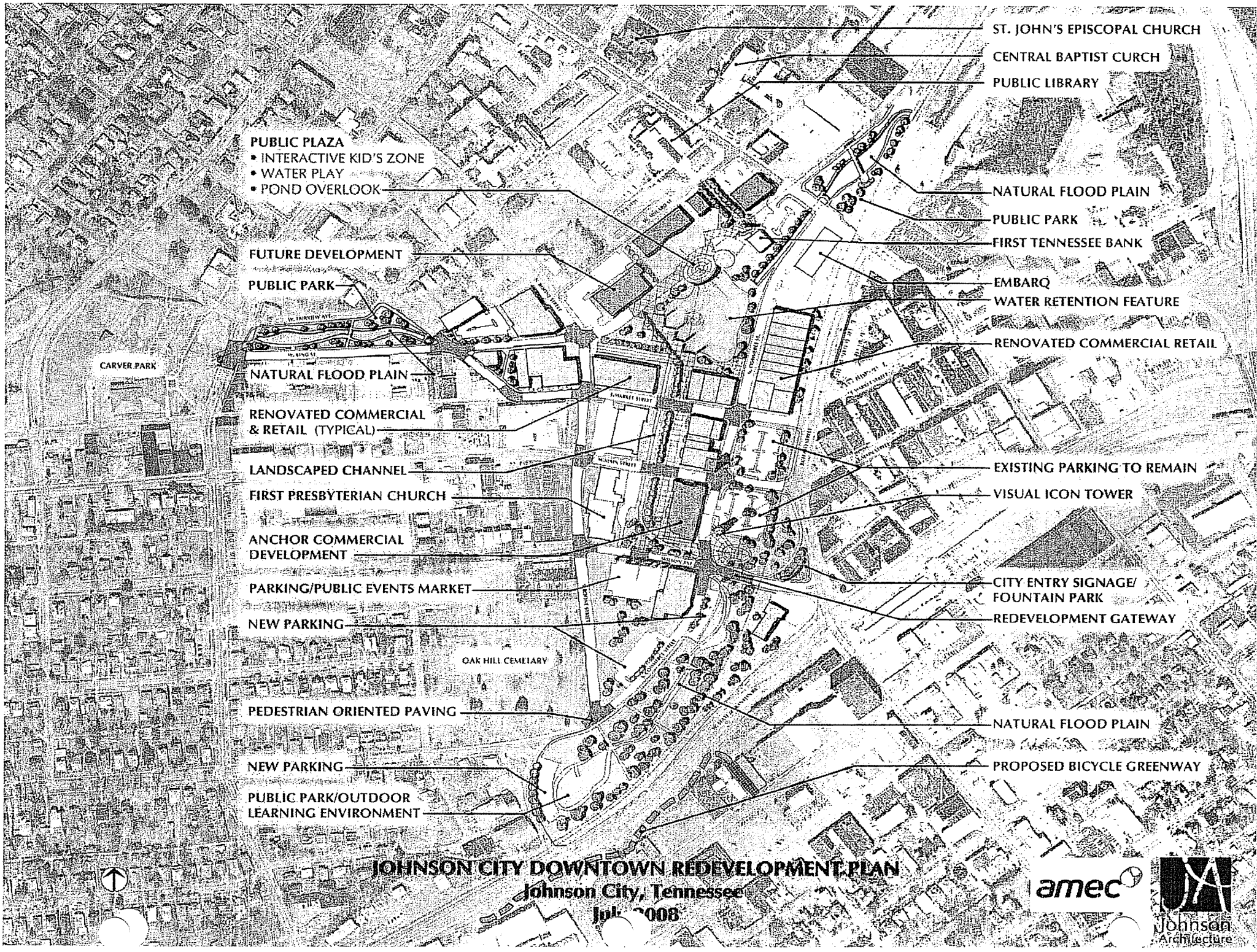
Cam 3-012.jpg

Cam 3-013.jpg

Cam 3-014.jpg



Appendix B: Redevelopment Concept


ST. JOHN'S EPISCOPAL CHURCH
CENTRAL BAPTIST CURCH
PUBLIC LIBRARY
PUBLIC PLAZA
• INTERACTIVE KID'S ZONE
• WATER PLAY
• POND OVERLOOK
NATURAL FLOOD PLAIN
PUBLIC PARK
FIRST TENNESSEE BANK
FUTURE DEVELOPMENT
EMBARQ
PUBLIC PARK
WATER RETENTION FEATURE
RENOVATED COMMERCIAL RETAIL
CARVER PARK
NATURAL FLOOD PLAIN
RENOVATED COMMERCIAL
& RETAIL (TYPICAL)
LANDSCAPED CHANNEL
EXISTING PARKING TO REMAIN
FIRST PRESBYTERIAN CHURCH
VISUAL ICON TOWER
ANCHOR COMMERCIAL
DEVELOPMENT
PARKING/PUBLIC EVENTS MARKET
CITY ENTRY SIGNAGE/
FOUNTAIN PARK
NEW PARKING
REDEVELOPMENT GATEWAY
OAK HILL CEMETARY
PEDESTRIAN ORIENTED PAVING
NATURAL FLOOD PLAIN
NEW PARKING
PROPOSED BICYCLE GREENWAY
PUBLIC PARK/OUTDOOR
LEARNING ENVIRONMENT
JOHNSON CITY DOWNTOWN REDEVELOPMENT PLAN
Johnson City, Tennessee
July 2008
amec
Johnson
Architecture

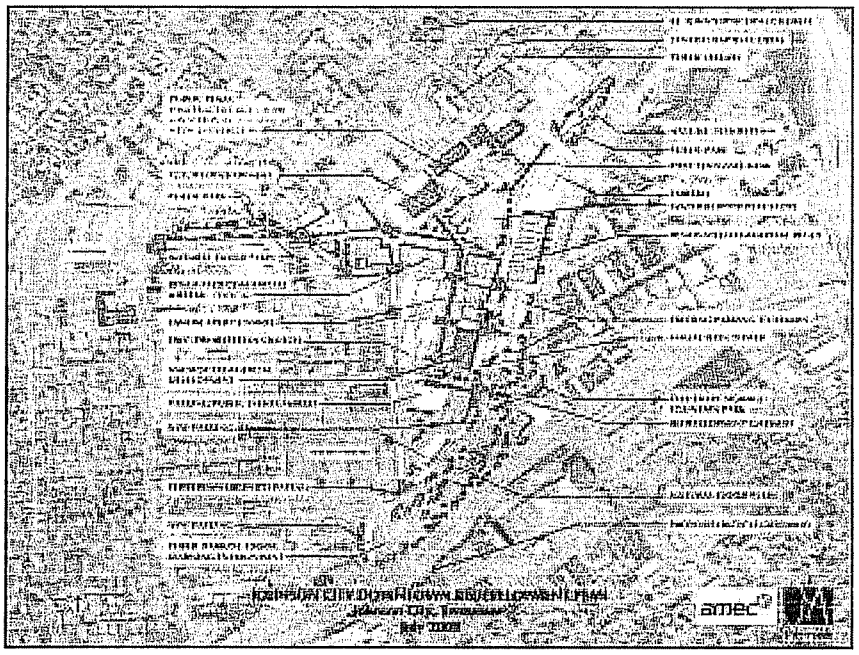
Appendix C: Redevelopment Concept Graphics

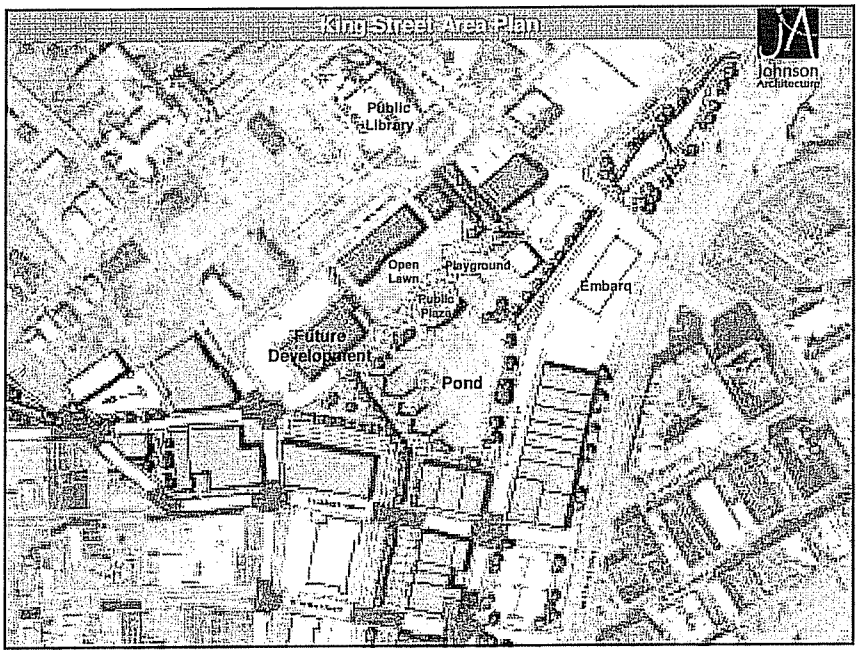
Conceptual Downtown Redevelopment Plan

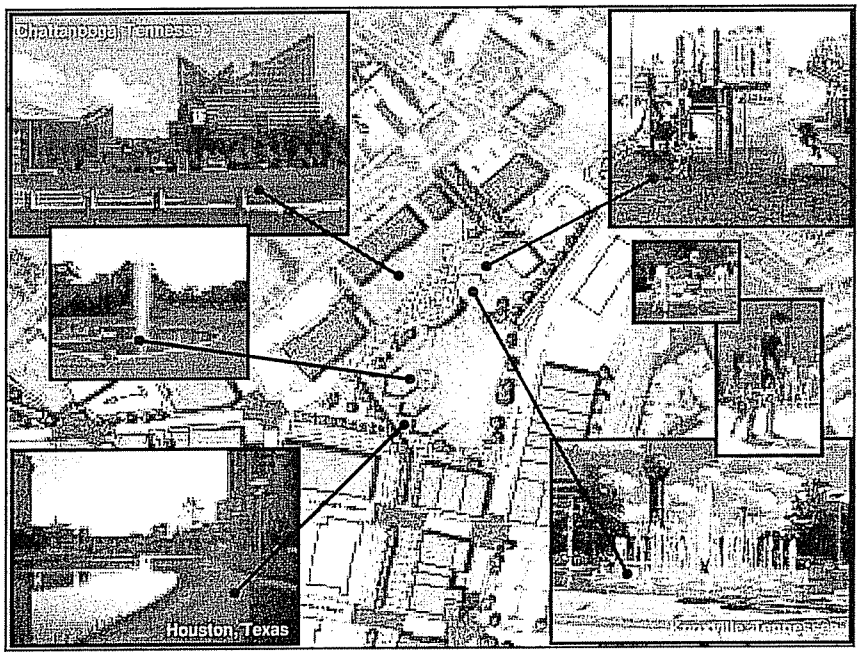
Johnson Architecture

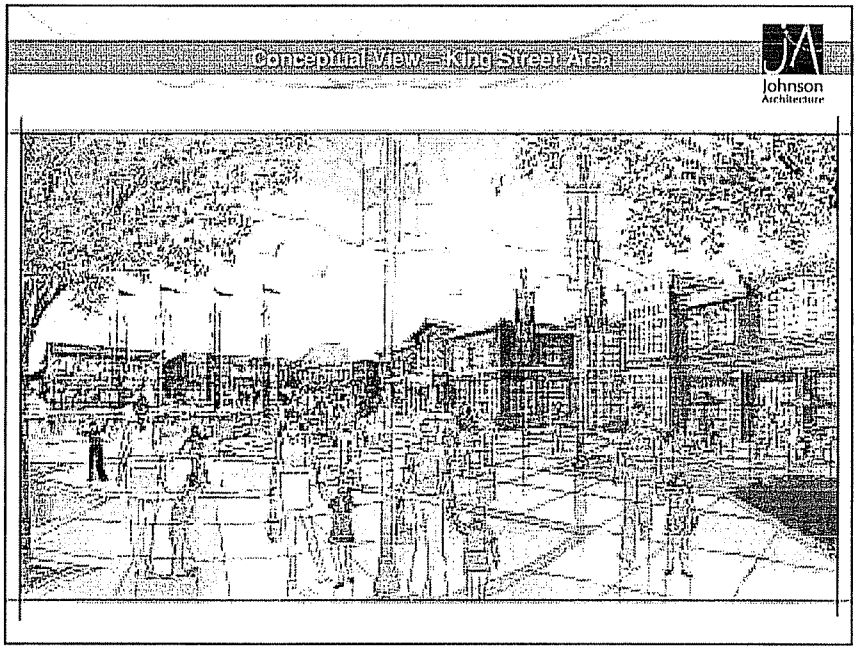
Goals of Redevelopment:

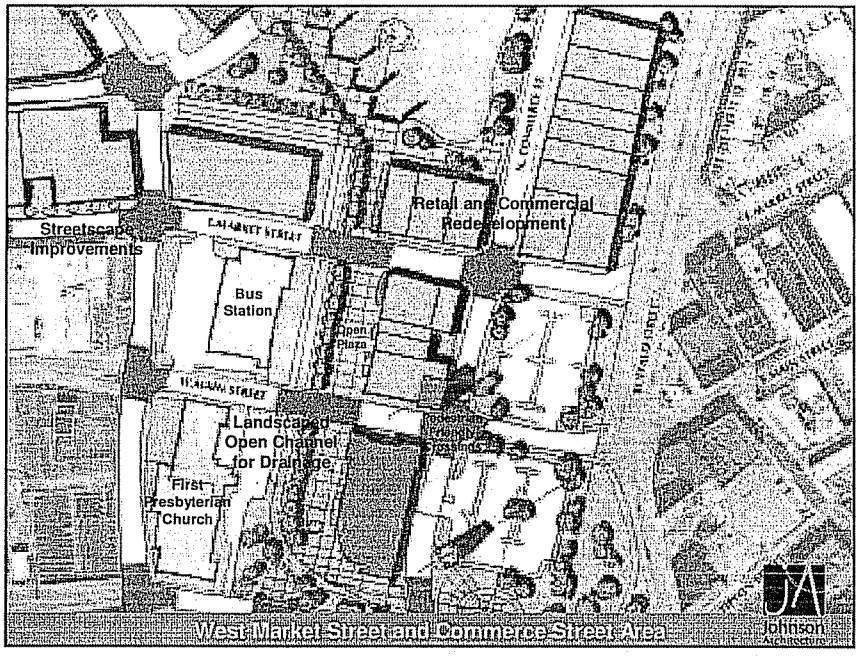
- Re-establish the downtown district as the city center
- Acknowledge the intrinsic value of a historic downtown
- Highlight "unique spaces"
- Provide range of uses and activities
- Combine new retail and residential opportunities
- Incorporate storm drainage systems into plan

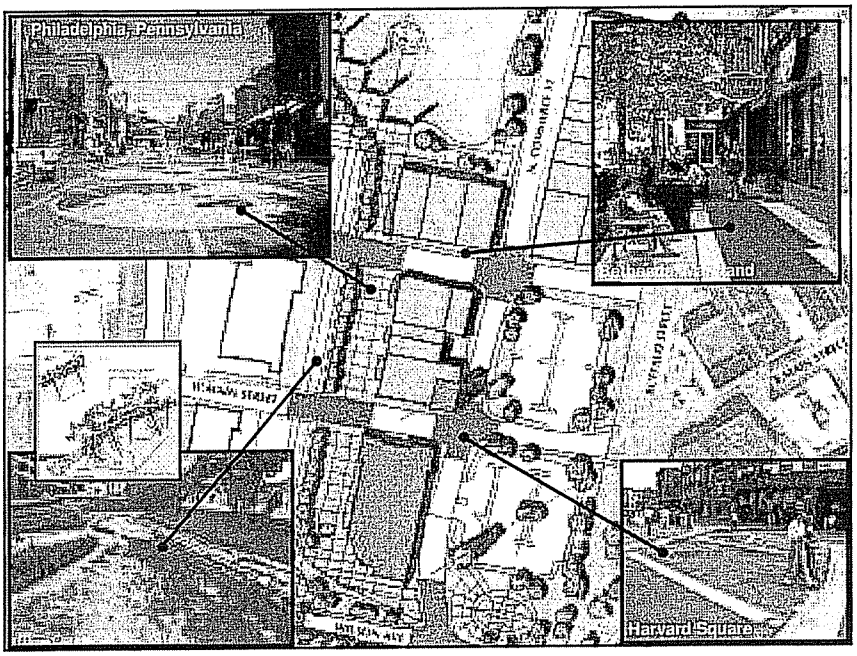


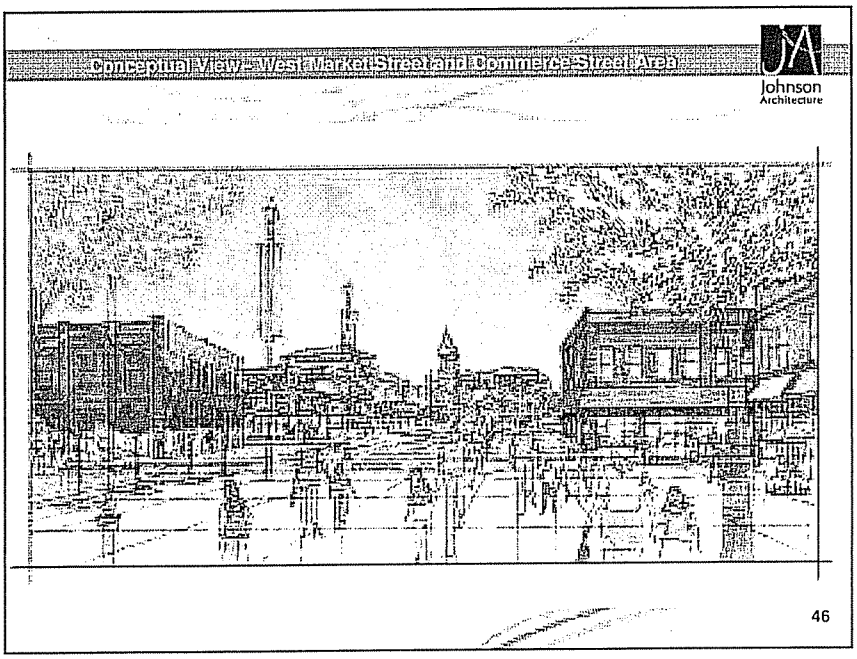

King Street Area Plan
Johnson Architecture
Public Library
Open Lawn
Playground
Public Plaza
Embarq
Future Development
Pond

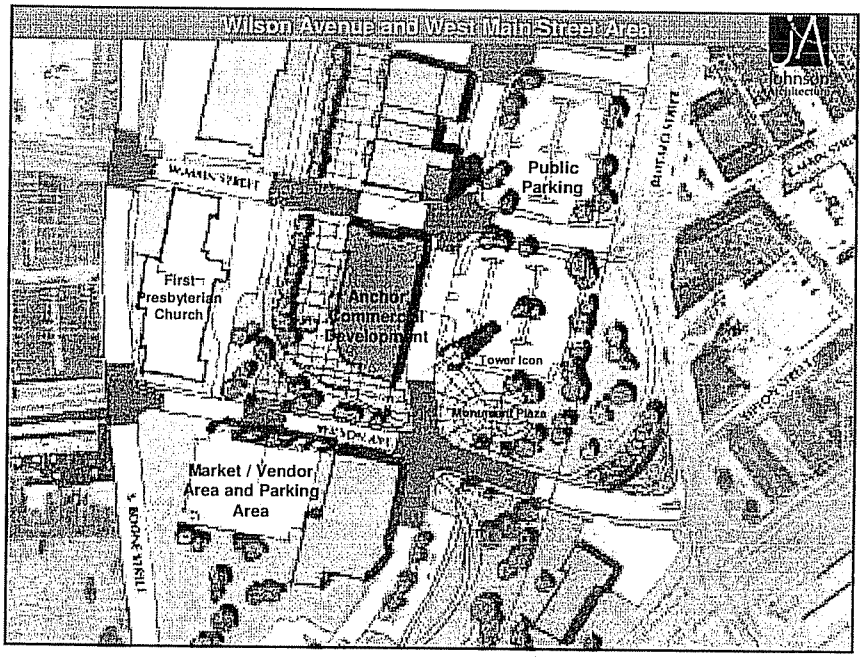

Chattanooga, Tennessee
Houston, Texas

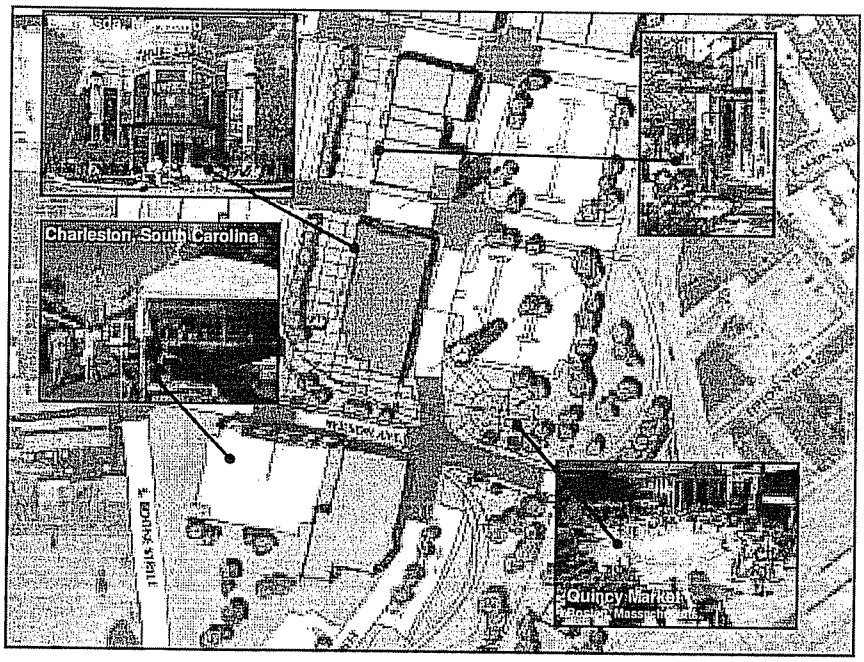

Conceptual View – King Street Area
Johnson
Architecture

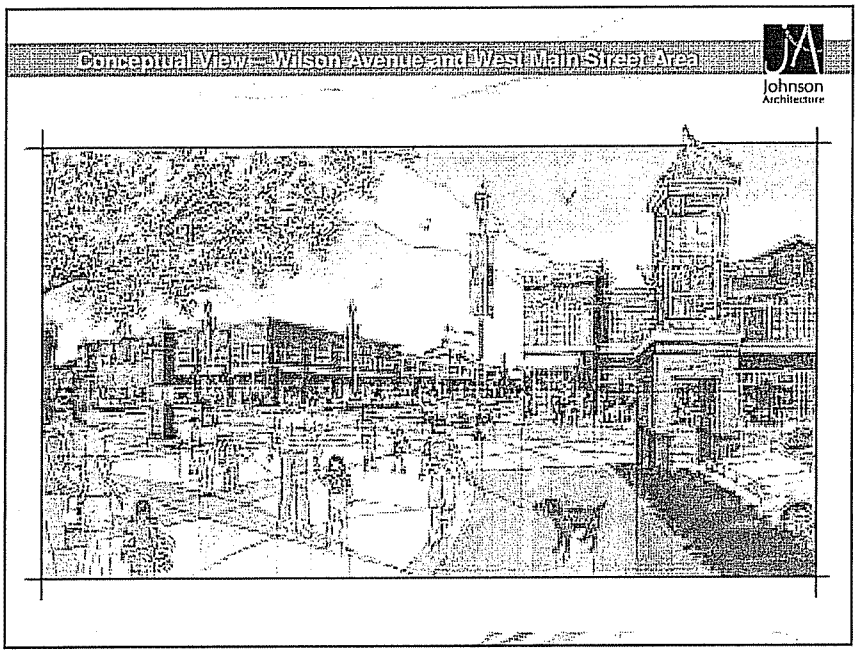

Streetscape
Improvements
Retail and Commercial
Redevelopment
Bus
Station
Open
Plaza
Landscaped
Open Channel
for Drainage
First
Presbyterian
Church
West Market Street and Commerce Street Area
Johnson
Architecture

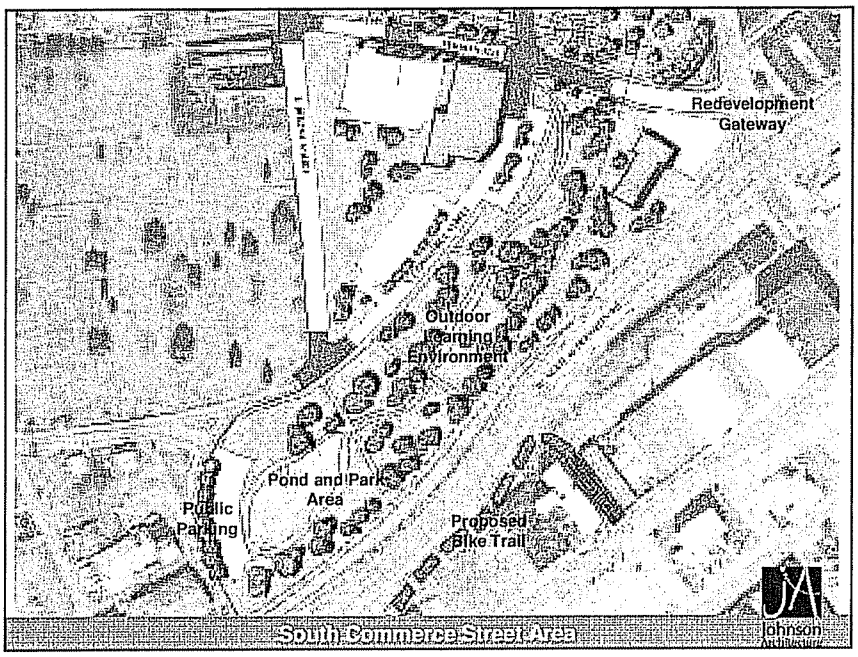

Philadelphia, Pennsylvania
Harvard Square

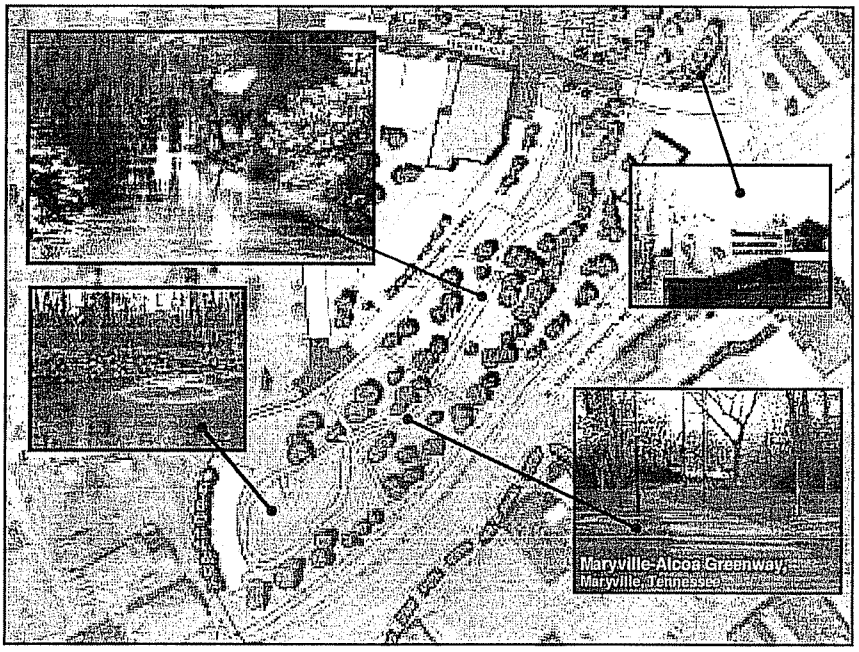

Conceptual View - West Market Street and Commerce Street Area
Johnson
Architecture
46

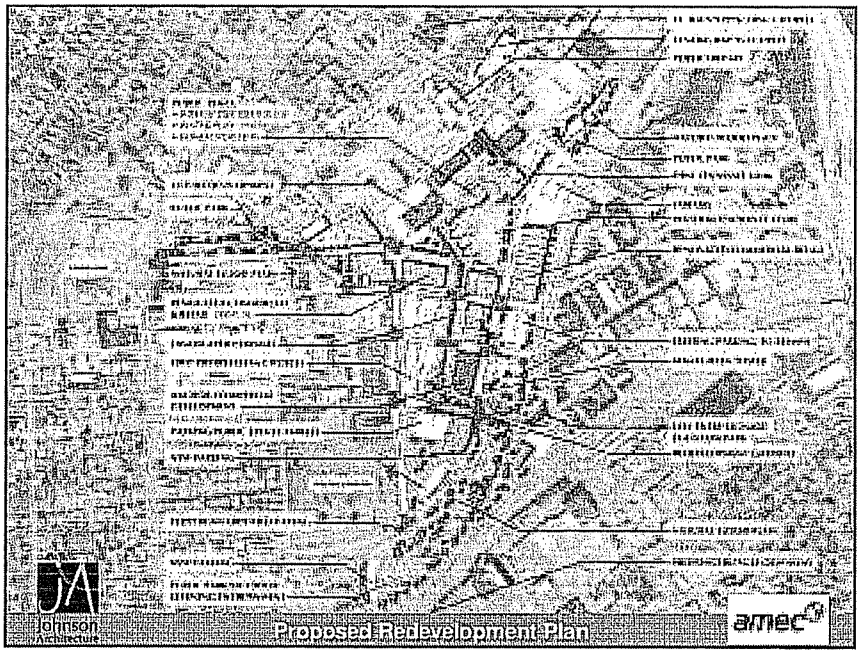

Wilson Avenue and West Main Street Area
Johnson Architecture
Public Parking
First Presbyterian Church
Anchor Commercial Development
Tower Icon
Monument Plaza
Market / Vendor Area and Parking Area


Charleston, South Carolina
Quincy Market


Conceptual View – Wilson Avenue and West Main Street Area
Johnson
Architecture


Redevelopment
Gateway
Outdoor
Learning
Environment
Pond and Park
Area
Public
Parking
Proposed
Bike Trail
South Commerce Street Area
Johnson


Maryville-Alcoa Greenway
Maryville, Tennessee


Johnson Architecture
Proposed Redevelopment Plan
amec

Appendix D: Cost Estimates

Phase I: U-Haul Pond

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
13333	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$41,900
521500	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$130,400
45400	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$212,500
5215	022203300100	Selective demolition, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$234,700
1200	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$2,000
1000	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$12,500
1300	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$20,600
4	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$800
28100		Earthwork			$ 6.00	$168,600
28100	023154900330	Hauling, 1 mi trip, 12 CY truck	CY	$ 3.91	$ 5.00	$140,500
1		Riser Structure	Ea.		$ 20,000.00	$20,000
45	022405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$33,800
8889	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$11,500
1000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$900
600	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$9,800
5	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$1,200
2	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$2,400
600	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$4,000
600	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$1,600
4	026304001120	Storm Drainage Manholes, Frames, and Covers, concrete, precast, 4' I.D., 6' deep, excludes base, excavation, backfill, frame and cover	Ea.	$ 1,202.75	$ 1,202.75	$4,800
80	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$25,500
					Construction	**$1,080,000**

126 W. Market (1/2)	$113,000
111 McClure	$28,400
119 McClure	$53,900
125 W. King	$23,200
128 Commerce	$104,500
114 W. King	$235,200
110 Commerce	$117,300
116 McClure	$15,500
Property Acquisition	**$691,000**
Design/Surveying/CM/Permitting/Geotechnical	$110,000
Contingency	**$160,000**
Amenities	**$2,250,000**
Overall Total	**$4,290,000**

Phase I: Bypass Entrance

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total
1167	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$3,700
700	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$1,200
500	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$6,300
900	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$14,200
45000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$11,300
3000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$14,000
2484.722	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$111,800
4	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$800
9333	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$23,700
9333	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$36,500
45	022405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$33,800
900		Stream treatment	LF		$ 200.00	$180,000
2000	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$2,600
2700	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$2,400
825	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$13,500
10	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$2,400
2	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$2,400
825	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$5,600
825	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$2,200
2200	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick	S.F.	$ 3.25	$ 3.25	$7,200
43	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$13,700

Construction $490,000

319 Watauga $18,000

317 West Fairview $6,500

315 West Fairview $14,100

313 West Fairview $51,500

311 West Fairview $46,200

246 West King Street $86,200

Property Acquisition $222,500

Design/Surveying/CM/Permitting/Geotechnical $50,000

Contingency $70,000

Overall Total $830,000

Phase I: King Street Bypass Culverts

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
4000	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$12,600
450000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$112,500
30000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$140,400
6220.833333	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$279,900
2400	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$4,000
1280	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$16,000
750	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$11,900
5000	022602001400	between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$98,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
2	023052502000	Mobilization or demobilization, crane, truck-mounted, up to 75 ton, includes both mobilization/demobilization	Ea.	$ 99.76	$ 99.76	$200
1666.666667	023101000011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	S.Y.	$ 0.48	$ 0.48	$800
4481.481481	023151101900	Backfill, trench, up to 300' haul, dozer backfilling, excludes compaction	L.C.Y.	$ 1.68	$ 1.68	$7,500
4481.481481	023153107020	Compaction, around structures and trenches, 3 passes, 18" wide, 6" lifts, walk behind, vibrating plate	E.C.Y.	$ 1.65	$ 1.65	$7,400
4481.481481	023153109000	Compaction, water for, 3000 gallon truck, 3 mile haul	E.C.Y.	$ 1.49	$ 1.49	$6,700
14263.74074	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$36,200
9782	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$38,200
3888.888889	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$39,300
2222.222222	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$2,900
6600	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$5,800
1500	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$24,500
20	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$4,800
6	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$7,100
1	025303002500	Packaged Utility Lift Ststions, packaged sewage lift station, 200,000 GPD, excludes fencing or external piping	Ea.	$202,722.70	$ 202,722.70	$202,700
1500	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$10,100
1500	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$4,000
3	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 25,000.00	$75,000
8	026304001120	Storm Drainage Manholes, Frames, and Covers, concrete, precast, 4' I.D., 6' deep, excludes base, excavation, backfill, frame and cover	Ea.	$ 1,202.75	$ 1,202.75	$9,600
2000	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$2,400,000
180	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$135,000
1	026305300500	Public Storm Utility Drainage Piping, precast concrete, box culvert, set up charge at plant, excludes excavation or backfill, add	Job	$ 5,541.58	$ 5,541.58	$5,500
1		Tunnel under railroad	Ea.		$ 300,000.00	$300,000
1833.333333	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$18,500
1666.666667	027403100160	Plant-mix asphalt paving, for highways and large paved areas, binder course, 3" thick	S.Y.	$ 9.71	$ 9.71	$16,200
1666.666667	027403100300	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 1" thick	S.Y.	$ 3.42	$ 3.42	$5,700
1000	027703000416	Cast-in place concrete curbs & gutters, concrete, machine formed, radius, 6" x 18" radius	L.F.	$ 6.93	$ 6.93	$6,900
6000	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	S.F.	$ 3.25	$ 3.25	$19,500
90	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$28,700

Construction	**$4,100,000**
Bank Lot and Repave	$200,000
Property Acquisition	**$200,000**
Design/Surveying/CM/Permitting/Geotechnical	**$410,000**
Contingency	**$620,000**
Overall Total	**$5,130,000**

Phase I: Downstream Open Channel

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
333	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$1,000
450	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$800
500	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$6,300
550	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$8,700
375000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$93,800
25000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$117,000
4990.278	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$224,600
4	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$800
8148	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$20,700
8148	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$31,900
45	022405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$33,800
450		Stream treatment	LF		$ 200.00	$90,000
1000	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$1,300
1350	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$1,200
675	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$11,000
10	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$2,400
2	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$2,400
675	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$4,500
675	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$1,800
1800	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick	S.F.	$ 3.25	$ 3.25	$5,900
56	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$17,900

Construction	**$680,000**
Good Samaritan	$100,000
Property Acquisition	**$100,000**
Design/Surveying/CM/Permitting/Geotechnical	**$70,000**
Contingency	**$100,000**
Overall Total	**$950,000**

Phase II: Downtown Park and Stream

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
4629.62963	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$14,500
2955000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$738,8
197000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$922,00
41550	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$1,869,800
4000	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$6,700
1280	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$16,000
4000	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$63,300
6000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$118,400
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
5000	023101000011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	S.Y.	$ 0.48	$ 0.48	$2,400
30000	023156100610	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering	B.C.Y.	$ 2.54	$ 2.54	$76,200
30000	023154900330	Hauling, 1 mi trip, 12 CY truck	CY		$ 3.91	$117,300
2000		Channel Stabilization	L.F.		$ 200.00	$400,000
13333.33333	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$17,200
6000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$5,300
3000	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$48,900
10	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$2,400
6	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$7,100
1	025303002500	Packaged Utility Lift Ststions, packaged sewage lift station, 200,000 GPD, excludes fencing or external piping	Ea.	$ 202,722.70	$ 202,722.70	$202,700
3000	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$20,200
3000	025504641000	Natural Gas Piping, polyethylene, coils natural gas distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$7,900
6	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 15,000.00	$90,000
180	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$216,000
2	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 15,000.00	$30,000
500	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$600,0
2	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 15,000.00	$30,0
60	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$72,000
1		Earthwork, demo and repave for Wautauga and Kelly's Market			$ 125,000.00	$125,000
120	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$90,000
1	026305300500	Public Storm Utility Drainage Piping, precast concrete, box culvert, set up charge at plant, excludes excavation or backfill, add	Job	$ 5,541.58	$ 5,541.58	$5,500
500	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$5,100
500	027403100160	Plant-mix asphalt paving, for highways and large paved areas, binder course, 3" thick	S.Y.	$ 9.71	$ 9.71	$4,900
500	027403100300	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 1" thick	S.Y.	$ 3.42	$ 3.42	$1,700
300	027703000416	Cast-in place concrete curbs & gutters, concrete, machine formed, radius, 6" x 18" radius	L.F.	$ 6.93	$ 6.93	$2,100
8000	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	S.F.	$ 3.25	$ 3.25	$26,000
1		Landscaping and amenities	Ea.		$ 400,000.00	$400,000
285	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$90,800

Construction	**$6,450,000**
133 West Main	$138,700
127 West Main	$34,300
125 West Main	$42,100
123 West Main	$19,400
119 West Main	$47,100
102 Commerce	$18,400
104 Commerce	$52,600
8 Wilson	$203,000
105 Wilson (Red Cross)	$0
103 Wilson	$104,900
Lamont	$56,50
Lamont	$88,3
125 Lamont	$823,6
Property Acquisition	**$1,630,000**
Design/Surveying/CM/Permitting/Geotechnical	**$650,000**
Contingency	**$970,000**
Overall Total	**$9,700,000**

Phase III: LP Auer Dam

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
2600	022202505050	Demolish, remove pavement & curb, remove bituminous pavement, 4" to 6" thick, excludes hauling and disposal fees	S.Y.	$ 3.14	$ 3.14	$8,200
750000	022201100080	Building demolition, large urban projects, masonry, includes 20 mile haul, excludes foundation demolition, dump fees	C.F.	$ 0.25	$ 0.25	$187,500
50000	022201300420	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, wire mesh reinforced, 6" thick, excludes disposal costs and dump fees	S.F.	$ 4.68	$ 4.68	$234,000
7500	022203300100	Selective demoliton, dump charges, typical urban city, building construction materials, includes tipping fees only	Ton	$ 104.50	$ 45.00	$337,500
1800	022203811700	Selective demolition, water & sewer piping & fittings, plastic Pipe, 6"-8", diameter, excludes excavation	L.F.	$ 1.68	$ 1.68	$3,000
256	022203830200	Selective demolition, manholes & catch basins, manhole or catch basin, cast in place, 4'-8' deep, excludes excavation	SF Face	$ 12.51	$ 12.51	$3,200
75	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$1,200
1000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$19,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
27000	023101000011	Fine grading, finish grading granular subbase for highway paving, +/- 1"	S.Y.	$ 0.48	$ 0.48	$13,000
40000		Excavate, haul, place and compact dam	B.C.Y.	$ 5.00	$ 10.00	$400,000
1500		Channel Stabilization	L.F.		$ 100.00	$150,000
16666.66667	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$21,500
4500	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$4,000
1350	025107600300	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, 40' lengths, 8" diameter, SDR 21	L.F.	$ 16.31	$ 16.31	$22,000
5	025107601400	Public Water Utility Distribution Piping, piping HDPE, butt fusion joints, fittings, elbows, 90 degree, 8" diameter, SDR 21	Ea.	$ 239.01	$ 239.01	$1,200
3	025106009040	Water Utility distribution Valves, gate valve, N.R.S., with rubber gaskets, 8" diameter, includes valve box with lid, excludes excavation and backfill	Ea.	$ 1,181.44	$ 1,181.44	$3,500
1350	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$9,100
1350	025504641000	distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$3,600
4	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 10,000.00	$40,000
100	026305300350	Public Storm Utility Drainage Piping, concrete, box culvert, precast, base price, 8' long, 10' x 8', excludes excavation or backfill	L.F.	$ 751.39	$ 1,200.00	$120,000
200	026305302090	60" diameter RCP, no backfill or compaction	L.F.		$ 233.07	$46,600
90	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$67,500
1	026305300500	Public Storm Utility Drainage Piping, precast concrete, box culvert, set up charge at plant, excludes excavation or backfill, add	Job	$ 5,541.58	$ 5,541.58	$5,500
3120	027202000100	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	S.Y.	$ 10.11	$ 10.11	$31,500
2600	027403100160	Plant-mix asphalt paving, for highways and large paved areas, binder course, 3" thick	S.Y.	$ 9.71	$ 9.71	$25,200
2600	027403100300	Plant-mix asphalt paving, for highways and large paved areas, wearing course, 1" thick	S.Y.	$ 3.42	$ 3.42	$8,900
1800	027703000416	Cast-in place concrete curbs & gutters, concrete, machine formed, radius, 6" x 18" radius	L.F.	$ 6.93	$ 6.93	$12,500
900	027752750310	Sidewalks, driveways, and patios, sidewalk, concrete, cast-in-place with 6 x 6 - W1.4 x W1.4 mesh, broomed finish, 3000 psi, 4" thick, excludes base	S.F.	$ 3.25	$ 3.25	$2,900
1		Landscaping and amenities	Ea.		$ 30,000.00	$30,000
75	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$23,900

Construction	**$1,840,000**
102 LP Auer	$381,600
108 LP Auer	$158,300
McKinley Road Trailer Park (1/4)	$20,500
Property Acquisition	**$560,000**
Design/Surveying/CM/Permitting/Geotechnical	**$180,000**
Contingency	**$280,000**
Overall Total	**$2,860,000**

Phase III: Lone Oak Dam

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
75	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$1,200
1000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$19,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
15000		Excavate, haul, place and compact dam	B.C.Y.	$ 5.00	$ 10.00	$150,000
1000		Channel Stabilization	L.F.		$ 100.00	$100,000
11111.11111	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$14,300
3000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$2,600
1000	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$6,700
1000	025504641000	distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$2,600
4	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 10,000.00	$40,000
200	026305302090	60" diameter RCP, no backfill or compaction	L.F.		$ 233.07	$46,600
474.0740741		Excavate trench, place culvert, backfill and compact	C.Y.		$ 20.00	$9,500
90	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$67,500
1		Landscaping and amenities	Ea.		$ 10,000.00	$10,000
50	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$15,900

Construction	**$490,000**
Obtain deed restrictions	$100,000
Property Acquisition	**$100,000**
Design/Surveying/CM/Permitting/Geotechnical	**$50,000**
Contingency	**$70,000**
Overall Total	**$710,000**

Phase III: Antioch Dam

Quantity	LineNumber	Description	Unit	Total O&P	AMEC O&P	Ext. Total O&P
75	022203840200	Selective demolition, box culvert, precast, 8' x 10' x 3' to 8' x 12' x 8', excludes excavation	L.F.	$ 15.83	$ 15.83	$1,200
1000	022602001400	Cofferdams, soldier beams & lagging, H piles with wood sheeting horizontal between piles, no hydrostatic head, 1 line of braces, 3" wood sheeting, 15' deep, maximum	S.F.	$ 19.73	$ 19.73	$19,700
6	023052500020	Mobilization or demobilization, dozer, loader, backhoe or excavator, 70 H.P. to 250 H.P., up to 50 miles	Ea.	$ 189.89	$ 189.89	$1,100
30000		Excavate, haul, place and compact dam	B.C.Y.	$ 5.00	$ 10.00	$300,000
2000		Channel Stabilization	L.F.		$ 100.00	$200,000
22222.22222	023707000020	Synthetic erosion control, jute mesh, 100 SY per roll, 4' wide, stapled	S.Y.	$ 1.29	$ 1.29	$28,700
6000	023707001100	Synthetic erosion control, silt fence, polypropylene, adverse conditions, 3' high	L.F.	$ 0.88	$ 0.88	$5,300
2000	025307802080	Public Sanitary Utility Sewerage Piping, piping polyvinyl chloride pipe, B & S, 13' lengths, 8" diameter, SDR 35, excludes excavation or backfill	L.F.	$ 6.74	$ 6.74	$13,500
2000	025504641000	distribution, 60 PSI, 1/2" diameter, @ 100', coupling, SDR 11, excludes excavation or backfill	L.F.	$ 2.64	$ 2.64	$5,300
4	026101000580	Concrete Culverts, headwall concrete, precast, 30 degree skewed wingwall, 60" diameter pipe	Ea.	$ 7,635.06	$ 10,000.00	$40,000
275	026305302090	60" diameter RCP, no backfill or compaction	L.F.		$ 233.07	$64,100
651.8518519		Excavate trench, place culvert, backfill and compact	C.Y.		$ 20.00	$13,000
90	22405001120	Dewatering with 6" centrifugal pump, per day	Day	$ 750.00	$ 750.00	$67,500
1		Landscaping and amenities	Ea.		$ 10,000.00	$10,000
100	029204000020	Sodding, bluegrass sod, on level ground, 1" deep, 8 M.S.F.	M.S.F.	$ 318.77	$ 318.77	$31,900

Construction	**$800,000**
Obtain deed restrictions	$250,000
Property Acquisition	**$250,000**
Design/Surveying/CM/Permitting/Geotechnical	**$80,000**
Contingency	**$120,000**
Overall Total	**$1,250,000**

Appendix E: Cost-Benefit Analysis

FEMA Benefit-Cost Analysis of Hazard Mitigation Projects

LIMITED DATA MODULE

Version 5.2.3
May 2, 2006

Report of Benefit-Cost Analysis

Project	**Downtown Drainage - I**
Address	**209 Water Street**
City, State, Zip	**Johnson City**
County	**City of Johnson City**
Applicant	**City of Johnson City**
Contact Person	**Andrew Best, PE**
Analysis Date	**7/3/2008**
Analyst	**Curt Jawdy**
Scenario Run ID	
File Save As Name	**I.xls**
Disaster Number	
DSR Number	

FEMA Disclaimer:
The results produced by this analysis are neither conclusive evidence that the proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

PROJECT INFORMATION

Disaster Number		Project	Downtown Drainage - I
DSR Number		Address	209 Water Street
DSR Category		City, State, Zip	Johnson City
DSR Subject		County	Washington
Inspection Date		Applicant	City of Johnson City
Application Date		Contact Person	Andrew Best, PE
Analysis Date	7/3/2008	Scenario Run ID	
Analyst	Curt Jawdy	File Save As Name	I.xls

PROJECT DATA

Phase I of Downtown Drainage Project. Includes open channel, pond three large culverts, and local collection along Market St. Discount rate per CWSRF.

Project Useful Life (Years)	75
Base Year of Costs	2008
Historic Preservation Issues (Yes or No)?	Yes
Environmental Issues (Yes or No)?	?

Economic Factors: Discount Rate (%) 3.00 Present Value Coefficient 29.70

Net Mitigation Project Cost: $11,000,000

Notes: Conceptual cost only. Includes property acquisition.

Additional Annual Maintenance Cost ($/year) for Mitigation Project	$10,000
Present Value of Additional Annual Maintenance Cost ($)	$297,018
TOTAL MITIGATION PROJECT COST	$11,297,018

TYPE OF FACILITY (for Loss of Function): BUILDINGS

FACILITY DESCRIPTION: Downtown Buildings

Loss of Function for Buildings

Annual Budget of Public/Nonprofit Agencies	$1,000,000
Cost of Providing Services from this Building ($/day)	$2,740
Post-Disaster Continuity Premium ($/day)	$2,000
Total Value of Lost Services ($/day)	$4,740

FLOOD HISTORY

Estimated Frequency of Declared Flood Event (Years): 2

Data Sources and Documentation

SWMM flood models were used for flood elevations with various designs and storm sizes.
Finished floor elevations for each building were surveyed.
Flood elevations for each structure at each phase for each storm were taken from the nearest SWMM node.
Demolished buildings had flood depths set to zero. New buildings assumed to cover 60% of lot area.
$75/SF used for redeveloped building valuation, $50/SF in fringe areas. Appraised value used for As-Is case.
Flood depths were calculated for each structure. Corps DDF functions applied for damages.
Damages for each phase/storm/building were calculated from DDF results and summed for input below.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

DAMAGES BEFORE MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$537,060				$0	$537,060
5	$1,186,995				$0	$1,186,995
10	$1,684,025				$0	$1,684,025
25	$2,021,402				$0	$2,021,402
50	$2,229,840				$0	$2,229,840
100	$2,521,545				$0	$2,521,545
250					$0	$2,521,545
500					$0	$2,521,545
					Total Annualized Damages	$566,375

Data Sources and Documentation

Damages Before Mitigation are for the As-Is condition.

DAMAGES AFTER MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$48,709				$0	$48,709
5	$371,390				$0	$371,390
10	$738,864				$0	$738,864
25	$838,030				$0	$838,030
50	$1,459,261				$0	$1,459,261
100	$2,060,605				$0	$2,060,605
250					$0	$2,060,605
500					$0	$2,060,605
					Total Annualized Damages	$205,472

Data Sources and Documentation

Damages After Mitigation are for the Phase I condition.

SUMMARY OF BENEFITS AND COSTS

	Expected Annual	Present Value
Expected Annual Damages Before Mitigation	$566,375	$16,822,360
Expected Annual Damages After Mitigation	$205,472	$6,102,887
Expected Avoided Damages After Mitigation (BENEFITS)	$360,903	$10,719,472
PROJECT COSTS	$11,297,018	
PROJECT BENEFITS	$10,719,472	
BENEFITS MINUS COSTS	($577,546)	
BENEFIT-COST RATIO	0.95	

Data Sources and Documentation

FEMA Disclaimer: The results produced by this analysis are neither conclusive evidence that a proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

FEMA Benefit-Cost Analysis of Hazard Mitigation Projects

LIMITED DATA MODULE

Version 5.2.3
May 2, 2006

Report of Benefit-Cost Analysis

Project	**Downtown Drainage - II**
Address	**209 Water Street**
City, State, Zip	**Johnson City**
County	**City of Johnson City**
Applicant	**City of Johnson City**
Contact Person	**Andrew Best, PE**
Analysis Date	**7/3/2008**
Analyst	**Curt Jawdy**
Scenario Run ID	
File Save As Name	**II.xls**
Disaster Number	
DSR Number	

FEMA Disclaimer:
The results produced by this analysis are neither conclusive evidence that the proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

PROJECT INFORMATION

Disaster Number		Project	Downtown Drainage - II
DSR Number		Address	209 Water Street
DSR Category		City, State, Zip	Johnson City
DSR Subject		County	Washington
Inspection Date		Applicant	City of Johnson City
Application Date		Contact Person	Andrew Best, PE
Analysis Date	7/3/2008	Scenario Run ID	
Analyst	Curt Jawdy	File Save As Name	II.xls

PROJECT DATA

Phase II of Downtown Drainage Project. Includes open channel, downtown culverts, Kelly's Market bypass, Wautauga culvert upgrade and warehouse natural channel. Discount rate per CWSRF.

Project Useful Life (Years)	75
Base Year of Costs	2008
Historic Preservation Issues (Yes or No)?	Yes
Environmental Issues (Yes or No)?	?

Economic Factors: Discount Rate (%) 3.00 Present Value Coefficient 29.70

Net Mitigation Project Cost: $10,000,000

Notes: Conceptual cost only. Includes property acquisition.

Additional Annual Maintenance Cost ($/year) for Mitigation Project	$10,000
Present Value of Additional Annual Maintenance Cost ($)	$297,018
TOTAL MITIGATION PROJECT COST	$10,297,018

TYPE OF FACILITY (for Loss of Function): BUILDINGS

FACILITY DESCRIPTION: Downtown Buildings

Loss of Function for Buildings

Annual Budget of Public/Nonprofit Agencies	$500,000
Cost of Providing Services from this Building ($/day)	$1,370
Post-Disaster Continuity Premium ($/day)	$500
Total Value of Lost Services ($/day)	$1,870

FLOOD HISTORY

Estimated Frequency of Declared Flood Event (Years): 2

Data Sources and Documentation

SWMM flood models were used for flood elevations with various designs and storm sizes.
Finished floor elevations for each building were surveyed.
Flood elevations for each structure at each phase for each storm were taken from the nearest SWMM node.
Demolished buildings had flood depths set to zero. New buildings assumed to cover 60% of lot area.
$75/SF used for redeveloped building valuation, $50/SF in fringe areas. Appraised value used for As-Is case.
Flood depths were calculated for each structure. Corps DDF functions applied for damages.
Damages for each phase/storm/building were calculated from DDF results and summed for input below.

LIMITED DATA MODULE
Benefit-Cost Analysis of Flood Mitigation Projects

DAMAGES BEFORE MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$48,709				$0	$48,709
5	$371,390				$0	$371,390
10	$738,864				$0	$738,864
25	$838,030				$0	$838,030
50	$1,459,261				$0	$1,459,261
100	$2,060,605				$0	$2,060,605
250					$0	$2,060,605
500					$0	$2,060,605
					Total Annualized Damages	$205,472

Data Sources and Documentation

Damages Before Mitigation are for the Phase I condition.

DAMAGES AFTER MITIGATION

Flood Frequency Events (Years)	Scenario Flood Damages			Loss of Function Time and Dollars		TOTAL Damages and Losses
				Days	Losses	
1					$0	$0
2	$1,574				$0	$1,574
5	$29,463				$0	$29,463
10	$66,759				$0	$66,759
25	$292,495				$0	$292,495
50	$479,005				$0	$479,005
100	$743,830				$0	$743,830
250					$0	$743,830
500					$0	$743,830
					Total Annualized Damages	$37,107

Data Sources and Documentation

Damages After Mitigation are for the Phase II condition.

SUMMARY OF BENEFITS AND COSTS

	Expected Annual	Present Value
Expected Annual Damages Before Mitigation	$205,472	$6,102,887
Expected Annual Damages After Mitigation	$37,107	$1,102,149
Expected Avoided Damages After Mitigation (BENEFITS)	$168,365	$5,000,738
PROJECT COSTS	$10,297,018	
PROJECT BENEFITS	$5,000,738	
BENEFITS MINUS COSTS	($5,296,280)	
BENEFIT-COST RATIO	0.49	

Data Sources and Documentation

FEMA Disclaimer: The results produced by this analysis are neither conclusive evidence that a proposed project is cost-effective, nor a guarantee that a project is eligible for any government grant for whatever purpose.

APPENDIX F

Glossary

Acceleration
The rate of change of velocity with respect to time. Acceleration due to gravity at the earth's surface is 9.8 meters per second squared. That means that every second that something falls toward the surface of earth its velocity increases by 9.8 meters per second.

Asset
Any manmade or natural feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.

Base Flood
Flood that has a 1 percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood.

Base Flood Elevation (BFE)
Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.

Bedrock
The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Building
A structure that is walled and roofed, principally above ground and permanently
affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

Coastal High Hazard Area
Area, usually along an open coast, bay, or inlet that is subject to inundation by storm surge and, in some instances, wave action caused by storms or seismic sources.

Coastal Zones
The area along the shore where the ocean meets the land as the surface of the land rises above the ocean. This land/water interface includes barrier islands, estuaries, beaches, coastal wetlands, and land areas having direct drainage to the ocean.

Community Rating System (CRS)
An NFIP program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.

Computer-Aided Design And Drafting (CADD)
A computerized system enabling quick and accurate electronic 2-D and 3-D drawings, topographic mapping, site plans, and profile/cross-section drawings.

Contour
A line of equal ground elevation on a topographic (contour) map.

Critical Facility
Facilities that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals.

Debris
The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.

Digitize
To convert electronically points, lines, and area boundaries shown on maps into x, y coordinates (e.g., latitude and longitude, universal transverse mercator (UTM), or table coordinates) for use in computer applications.

Displacement Time
The average time (in days) which the building's occupants typically must operate from a temporary location while repairs are made to the original building due to damages resulting from a hazard event.

Duration
How long a hazard event lasts.

Earthquake
A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates.

Erosion
Wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, or other geologic processes.

Erosion Hazard Area
Area anticipated to be lost to shoreline retreat over a given period of time. The projected inland extent of the area is measured by multiplying the average annual long-term recession rate by the number of years desired.

Essential Facility
Elements that are important to ensure a full recovery of a community or state following a hazard event. These would include: government functions, major employers, banks, schools, and certain commercial establishments, such as grocery stores, hardware stores, and gas stations.

Extent
The size of an area affected by a hazard or hazard event.

Extratropical Cyclone
Cyclonic storm events like Nor'easters and severe winter low-pressure systems. Both West and East coasts can experience these non-tropical storms that produce gale-force winds and precipitation in the form of heavy rain or snow. These cyclonic storms, commonly called Nor'easters on the East Coast because of the direction of the storm winds, can last for several days and can be very large – 1,000-mile wide storms are not
uncommon.

Fault
A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.

Federal Emergency Management Agency (FEMA)
Independent agency created in 1978 to provide a single point of accountability for all Federal activities related to disaster mitigation and emergency preparedness, response and recovery.

Fire Potential Index (FPI)
Developed by USGS and USFS to assess and map fire hazard potential over broad areas. Based on such geographic information, national policy makers and on-the-ground fire managers established priorities for prevention activities in the defined area to reduce the risk of managed and wildfire ignition and spread. Prediction of fire hazard shortens the
time between fire ignition and initial attack by enabling fire managers to pre-allocate and stage suppression forces to high fire risk areas.

Flash Flood
A flood event occurring with little or no warning where water levels rise at an extremely fast rate.

Flood
A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

Flood Depth
Height of the flood water surface above the ground surface.

Flood Elevation
Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level.

Flood Hazard Area
The area shown to be inundated by a flood of a given magnitude on a map.

Flood Insurance Rate Map (FIRM)
Map of a community, prepared by the Federal Emergency Management Agency that shows both the special flood hazard areas and the risk premium zones applicable to the community.

Flood Insurance Study (FIS)
A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.

Floodplain
Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.

Frequency
A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its probability – of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered. Fujita Scale of Tornado Intensity
Rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 indicates minimal damage such as broken tree limbs or signs, while and F5 indicated severe damage sustained.

Functional Downtime
The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.

Geographic Area Impacted
The physical area in which the effects of the hazard are experienced.

Geographic Information Systems (GIS)
A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.

Ground Motion
The vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter, but soft soils can further amplify ground motions

Hazard
A source of potential danger or adverse condition. Hazards in this how-to series will include naturally occurring events such as floods, earthquakes, tornadoes, tsunami, coastal storms, landslides, and wildfires that strike populated areas. A natural event is a hazard when it has the potential to harm people or property.

Hazard Event
A specific occurrence of a particular type of hazard.

Hazard Identification
The process of identifying hazards that threaten an area.

Hazard Mitigation
Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.

Hazard Profile
A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

HAZUS (Hazards U.S.)
A GIS-based nationally standardized earthquake loss estimation tool developed by FEMA.

Hurricane
An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74-miles-per-hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricanes develop over the North Atlantic Ocean, northeast Pacific Ocean, or the South Pacific Ocean east of 160°E longitude. Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Hydrology
The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

Infrastructure
Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and includes an area's

transportation system such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry-docks, piers and regional dams.

Intensity
A measure of the effects of a hazard event at a particular place.

Landslide
Downward movement of a slope and materials under the force of gravity.

Lateral Spreads
Develop on gentle slopes and entail the sidelong movement of large masses of soil as an underlying layer liquefies in a seismic event.

Liquefaction
The phenomenon that occurs when ground shaking causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.

Loss of Bearing Strength
Results when the soil supporting structures liquefies. This can cause structures to tip and topple.

Lowest Floor
Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure.

Magnitude
A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.

Mitigation Plan
A systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to hazards.

National Flood Insurance Program (NFIP)
Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 CFR §60.3.

National Geodetic Vertical Datum of 1929 (NGVD)
Datum established in 1929 and used in the NFIP as a basis for measuring flood, ground, and structural elevations, previously referred to as Sea Level Datum or Mean Sea Level. The Base Flood Elevations shown on most of the Flood Insurance Rate Maps issued by the Federal Emergency Management Agency are referenced to NGVD.

National Weather Service (NWS)
Prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to Federal and state entities in preparing weather and flood warning plans.

Nor'easter
An extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow or rain.

Outflow
Follows water inundation creating strong currents that rip at structures and pound them with debris, and erode beaches and coastal structures.

Planimetric
Describes maps that indicate only man-made features like buildings.

Planning
The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.

Probability
A statistical measure of the likelihood that a hazard event will occur.

Recurrence Interval
The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.

Repetitive Loss Property
A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1000 each have been paid within any 10-year period since 1978.

Replacement Value
The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality.

Richter Scale
A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935.

Risk
The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood

of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine
Of or produced by a river.

Scale
A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

Scarp
A steep slope.

Scour
Removal of soil or fill material by the flow of flood waters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

Seismicity
Describes the likelihood of an area being subject to earthquakes.

Special Flood Hazard Area (SFHA)
An area within a floodplain having a 1 percent or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by darkly shaded areas with zone designations that include the letter A or V.

Stafford Act
The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

State Hazard Mitigation Officer (SHMO)
The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

Storm Surge
Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.

Structure
Something constructed. (See also Building)

Substantial Damage
Damage of any origin sustained by a structure in a Special Flood Hazard Area whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage.

Super Typhoon
A typhoon with maximum sustained winds of 150 mph or more.

Surface Faulting
The differential movement of two sides of a fracture – in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.

Tectonic Plate
Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that cause seismic activity.

Topographic
Characterizes maps that show natural features and indicate the physical shape of the land using contour lines. These maps may also include manmade features.

Tornado
A violently rotating column of air extending from a thunderstorm to the ground.

Tropical Cyclone
A generic term for a cyclonic, low-pressure system over tropical or subtropical waters.**Tropical Depression**
A tropical cyclone with maximum sustained winds of less than 39 mph.

Tropical Storm
A tropical cyclone with maximum sustained winds greater than 39 mph and less than 74 mph.

Tsunami
Great sea wave produced by submarine earth movement or volcanic eruption.

Typhoon
A special category of tropical cyclone peculiar to the western North Pacific Basin, frequently affecting areas in the vicinity of Guam and the North Mariana Islands. Typhoons whose maximum sustained winds attain or exceed 150 mph are called super typhoons.

Vulnerability
Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the

vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation
itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.

Vulnerability Assessment
The extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.

Water Displacement
When a large mass of earth on the ocean bottom sinks or uplifts, the column of water directly above it is displaced, forming the tsunami wave. The rate of displacement, motion of the ocean floor at the epicenter, the amount of displacement of the rupture zone, and the depth of water above the rupture zone all contribute to the intensity of the tsunami.

Wave Runup
The height that the wave extends up to on steep shorelines, measured above a reference level (the normal height of the sea, corrected to the state of the tide at the time of wave arrival).

Wildfire
An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.

Zone
A geographical area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area