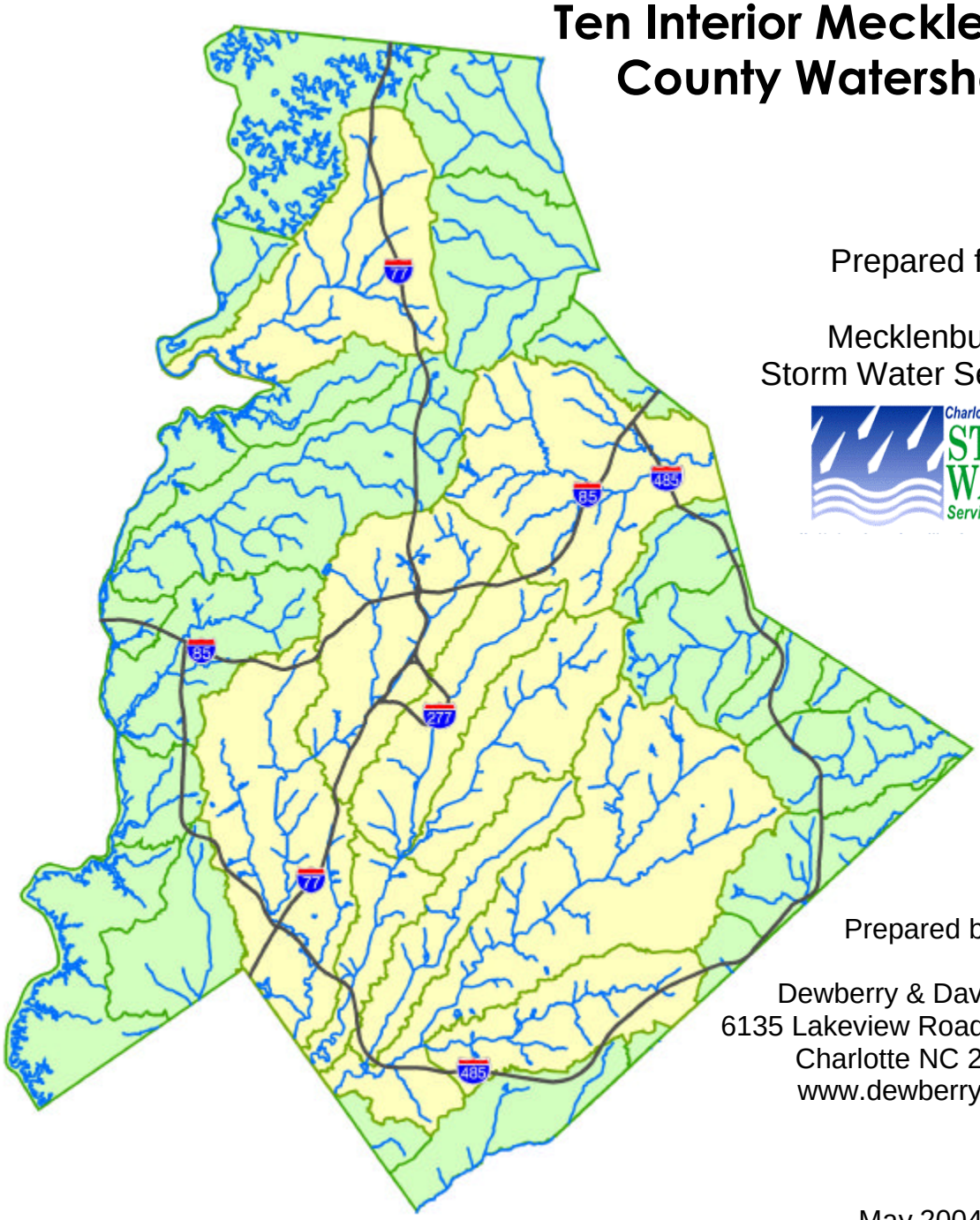
FLOOD HAZARD MITIGATION AND ENVIRONMENTAL RESTORATION SUMMARY REPORT

Ten Interior Mecklenburg County Watersheds



Prepared for

Mecklenburg
Storm Water Services

Charlotte-Mecklenburg STORM WATER Services

Prepared by

Dewberry & Davis, Inc.
6135 Lakeview Road, Suite 400
Charlotte NC 28269
www.dewberry.com

May 2004

Dewberry

MECKLENBURG COUNTY
STORM WATER SERVICES

PRELIMINARY ENGINEERING SUMMARY REPORT

FLOOD HAZARD MITIGATION AND ENVIRONMENTAL RESTORATION SUMMARY FOR TEN INTERIOR MECKLENBURG COUNTY WATERSHEDS

ACKNOWLEDGEMENT

The project staff of Dewberry would like to express our sincere appreciation to Mecklenburg County Storm Water Services (MCSWS) for its assistance and support during this project.

DISCLAIMER

This summary report is for planning purposes only. These study results and recommendations are preliminary and should not be used for construction without additional detailed engineering design analysis.

CERTIFICATION

I hereby certify that this Flood Hazard Mitigation and Environmental Restoration Summary Report, for Mecklenburg County was prepared by me or under my direct supervision.

Signed, sealed, and dated this _14_ day of May 2004.

By: Neal Banerjee

Neal Banerjee, PE, CFM
Project Manager

(SEAL)

MECKLENBURG COUNTY
STORM WATER SERVICES
PRELIMINARY ENGINEERING SUMMARY REPORT

FLOOD HAZARD MITIGATION AND ENVIRONMENTAL RESTORATION SUMMARY FOR TEN INTERIOR MECKLENBURG COUNTY WATERSHEDS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

GLOSSARY

Base Flood Elevation (BFE):	Water surface elevation based on the 1% annual chance flood (100-year flood).
Future Condition Floodplain (FCF):	Floodplain delineated for the 1% chance of flood event in any given year using future land use condition. It is currently defined as Floodplain Land Use Map (FLUM) in Mecklenburg County.
Community Encroachment Floodway	The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the community base flood, without cumulatively increasing the water surface elevation more than 0.1 feet. No structure or fill may be added without special permit.
Existing Condition Floodplain:	Floodplain delineated for the 1% chance of flood event in any given year using current land use condition. It is defined as the same as within the Flood Insurance Rate Map (FIRM).
FEMA	Federal Emergency Management Agency
FEMA Floodway	The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the FEMA base flood, without cumulatively increasing the water surface elevation more than 0.5 feet.
MCSWS	Mecklenburg County Storm Water Services Department
WSE	Water surface elevation

1. INTRODUCTION

1.1. Project Background

Mecklenburg County Storm Water Services (MCSWS) has recently completed preliminary engineering studies that investigated flood hazard mitigation strategies (primary focus) and provided broad-level environmental characterization (secondary focus) for ten (10) of the most urbanized watersheds in Mecklenburg County, North Carolina. The 10 study watersheds, hereafter referred to as the Study Watersheds, are listed in alphabetical below:

- Briar Creek Watershed
- Four Mile Creek Watershed
- Irwin Creek Watershed
- Lower Little Sugar Creek Watershed
- Mallard Creek Watershed
- McAlpine Creek Watershed
- McDowell Creek Watershed
- McMullen Creek Watershed
- Sugar Creek Watershed
- Upper Little Sugar Creek Watershed

The studies were conducted on a watershed-wide basis between 2000 and 2003 and resulted in ten separate preliminary engineering reports – one report for each of the Study Watersheds. A list of all ten reports is listed in the reference section at the end of this report. The primary focus of the reports was to conduct a review of pertinent stream/watershed information, assess flood damages, and investigate flood hazard mitigation alternatives within the FEMA/County-regulated future condition floodplains (FCFs). A secondary focus was to provide a broad-level characterization of environmental quality in the Watersheds and to offer general recommendations for environmental restoration. Per the context of the studies, environmental restoration opportunities were typically only identified in conjunction with flood hazard mitigation improvement alternatives.

This report summarizes the findings and recommendations of the 10 watershed study reports, and presents an overall strategy for flood hazard mitigation for the Study Watersheds. The preliminary engineering studies and this summary report represent the continuing effort of the County to develop and implement a long-term flood mitigation strategy and a defined process to reduce the risk to life and property within Mecklenburg County. The first major effort began in 1998, when the County commenced a project to develop new floodplain regulations and remap all of the FEMA floodplains in the County. A previous study (ABSG Consulting, 2001) has estimated that the new regulations and floodplain remapping will potentially save the County (and tax payers) approximately $300 million in potential flood damages by greatly restricting development/re-development in flood prone areas.

1.2. Study Area

The Study Watersheds encompass an approximate 276 square mile area in Mecklenburg County, North Carolina. The Study Watersheds, which comprise 10 of the 33 major County watersheds, are primarily located in the central and southern portions of the County, with the exception of the McDowell Creek watershed, which is located in the northern portion of the County. The Study Watersheds account for approximately 50% of the 546 total square miles in within the County, and over 80% (198 of 235 square miles) of the City of Charlotte total area. There are 55 FEMA/County-regulated streams (Study Streams) within the Study Watersheds that result in a total stream length of approximately 207 miles. Table 1 provides general summary information for the Study Watersheds. Figure 1 shows a map of the Study Watersheds and Study Streams.

Table 1. Study Watersheds Summary

Study Report Number	Watershed Name	Report Author	Watershed Area (sq mi.)	Number of Study Streams	Length of Study Streams (mi.)
1	**Lower Little Sugar Creek**	HDR Engineering	10.1	1	9.3
2	**Mallard Creek**	HDR Engineering	38.8	10	31.5
3	**Sugar Creek**	HDR Engineering	37.5	5	27.6
4	**Four Mile Creek**	Watershed Concepts	18.6	2	12
5	**McAlpine Creek**	Watershed Concepts	59.2	12	43.4
6	**McDowell Creek**	Watershed Concepts	26.3	7	19.5
7	**Briar Creek**	Dewberry	21.6	4	13.9
8	**Irwin Creek**	Dewberry	29.9	7	22.9
9	**McMullen Creek**	Dewberry	15.3	2	11.6
10	**Upper Little Sugar Creek**	Dewberry	19.2	5	15
TOTALS			**276.5**	**55**	**206.7**

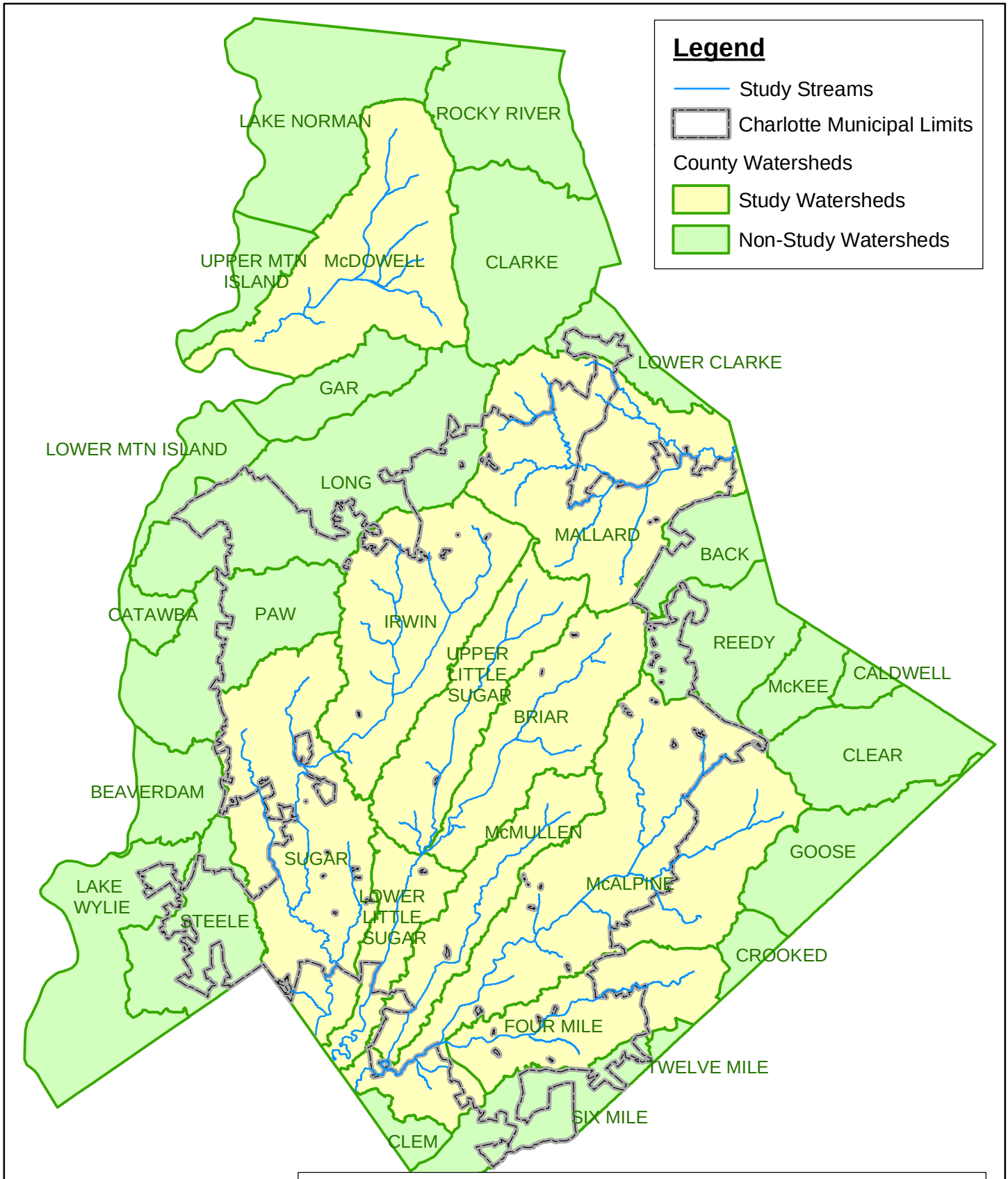


Figure 1 -
Study Watersheds Map

Charlotte-Mecklenburg STORM WATER Services

Dewberry

2. FLOOD HAZARD MITIGATION SUMMARY

2.1. Floodprone Structures

Structures and areas along the 55 Study Streams that are within the mapped 100-year future condition floodplain were evaluated and considered in the preliminary engineering studies for potential flood hazard mitigation and environmental restoration improvements. The study reports identified a total of 2646 buildings (excluding miscellaneous accessory buildings such as garages, sheds, park shelters, etc.) that are within the boundaries of the Study Stream FCFs. Further evaluation and comparison with County building elevation certificates revealed that 1006 (38%) of the 2646 buildings have a finished floor elevation below the predicted 100-year FCF water surface elevation, and thus are expected to incur flood damage. The number of flooding buildings within each of the individual watersheds ranged from zero buildings in the McDowell Creek watershed to 367 flooding buildings in the Briar Creek watershed. The majority (approximately 74%) of both the floodprone and the flooding buildings were located in the most central watersheds within the City of Charlotte - the Briar Creek, Upper Little Sugar Creek, McMullen Creek, and Irwin Creek watersheds.

2.2. Roadway Overtopping

Roadway overtopping refers to the situation where the calculated water surface elevation (WSE) in a stream is above the top of the roadway surface or other stream crossing. Although this study focused on the mitigation of floodprone buildings, overtopping depths were identified at each road crossing, since overtopping can represent a significant hazard during large storm events. For example, motor vehicles can be swept away in as little as 24 inches of flood flow depths over a road.

Roadway culverts/bridges are typically designed to pass a certain frequency storm event without overtopping, based on their level of service. For example, a residential road is often designed to be protected from 10-yr and smaller storm events, whereas an interstate may be designed to be protected from 100-yr and smaller storm events. Storms larger than the design frequency are "allowed" to overtop the road, and thus are not considered to be a problem. However, it is considered a problem if a storm event equal to or smaller than the design frequency overtops the roadway (ex. a 2-yr or 10-yr event overtops a residential roadway).

Roadway overtopping depths were identified for the Study Watersheds by comparing results of the County's HEC-RAS flood models to roadway geometry. Evaluating the level of service and an appropriate "designed" capacity for road crossings was beyond the scope of the preliminary engineering studies, therefore roadway overtopping "problems" were not specifically identified. However, estimated 100-yr future condition flooding depths at all stream crossings are provided for information in Appendix A. Roadways are organized by stream and sorted by flood depth in descending order.

2.3. Estimated Flood Damages

Flood damages were estimated for the 1006 "flooding" buildings using the FEMA Riverine Flood, Full Data Module Benefit:Cost model, hereafter referred to FEMA BC. Three of the earlier studies (Four Mile Creek, McDowell Creek, and McAlpine Creek) also included damages from minor flooding (e.g. crawlspace and unfinished basement flooding) for floodprone buildings that had finished floor elevations above the 100-yr FCF water surface elevation. The total present worth value of flood damages for all 1006 buildings was estimated at approximately $513 million. Similar to the number of floodprone and flooding buildings, estimated damages within the individual watersheds range from less than $100,000 in the Four Mile Creek watershed to almost $400 million

in the Briar Creek watershed. It should be noted that estimated flood damages are unproportionally high in the Briar Creek watershed primarily due to one problem area (between Monroe Road and Independence Boulevard). This problem area is predicted to experience frequent and severe flooding – subsequently resulting in extremely high flood damage estimates (over $300 million).

2.4. Flood Hazard Mitigation Improvement Alternatives

Since flood hazard mitigation of buildings predicted to incur flood damage was the primary focus of the preliminary engineering studies, mitigation improvement alternatives were investigated for the 1006 flooding buildings. For clarity in analysis and presentation, the identified buildings were first categorized into flood problem areas based on study stream, geographic proximity, and cause/magnitude of flooding. The studies grouped the 1006 buildings into approximately 160 problem areas. Each problem area was then individually evaluated for one or more flood hazard mitigation improvements. Improvement alternatives varied at each problem area, but generally included: property acquisition, structure elevation, flood proofing, construction of floodwalls/levees, infrastructure improvements, and a "no action option".

There were two primary criteria used to evaluate and compare the different improvement alternatives – location in reference to the community encroachment (0.1 foot) floodway, and the cost-effectiveness (i.e. benefit:cost ratio) of implementing flood mitigation improvements. Structures located within the community encroachment (0.1 foot) floodway were in general given higher priority from those outside of the floodway due to public safety considerations (i.e. the floodway is considered an especially hazardous area due to high velocities and potential debris hazards) and the fact that local floodplain regulations greatly restrict potential construction/re-construction in the floodway. Per the direction of MCSWS, the study reports for three central watersheds (i.e. Briar, Upper Little Sugar, and Irwin) further emphasized mitigation of structures in the floodway by recommending acquisition for nearly all these structures – regardless of their cost-effectiveness.

Cost-effectiveness was the other primary consideration in evaluating improvement alternatives. In general (with the exception being structures located in the community encroachment floodway), improvement alternatives were not recommended unless they yielded a benefit:cost (B:C) ratio of equal to or greater than 1.0 – indicating that the benefit (i.e. damages removed from an improvement alternative) was equal to or greater than the cost to implement the alternative. If none of the alternatives evaluated for a given problem area produced a B:C of 1.0 or higher, no action (i.e. leave situation as is) was recommended for the problem area.

In addition to the primary criteria described above, other considerations such as flood reduction capability, constructability, social/environmental impacts, and hydraulic impacts, were used to develop the final recommendations. These issues were generally used to rule out an alternative all together (e.g. alternative may be cost-effective, but not technically or politically feasible), or to help prioritize between multiple cost-effective alternatives within a problem area.

Based on the alternative evaluation and subsequent economic analysis, the preliminary engineering reports recommend a total approximately $113 million in potential mitigation improvements within the Study Watersheds - $70 million for structures in the community encroachment floodway and $43 million for structures in the floodplain fringe (i.e. outside of the floodway). Estimated mitigation improvements costs range from $0 in the Four Mile Creek and McDowell Creek watersheds to approximately $47 million in the Briar Creek watershed. The Upper Little Sugar Creek watershed has the second highest estimated improvement cost at $34 million. The remaining six watersheds

have recommended mitigation costs in the $1.0 million to $10 million range, with an average of approximately $3.2 million.

The recommended improvements were estimated to remove over $478 million (93%) of the total $513 in flood damage predicted with the FEMA BC model. This indicates that as a whole, the majority of the estimated flood damages can be removed very cost effectively. Spending approximately $113 million in improvement costs will eliminate $478 million in expected damages – an overall benefit:cost ratio of 4.2. The estimated flood damage removal and corresponding benefit:cost ratio for structures in the community encroachment floodway are $69 million, and 1.0 (= $69M / $70M). Mitigation of structures in the floodplain fringe produces an estimated flood damage reduction and corresponding benefit:cost ratio of $409 million and 9.6 (= $409M / $43M). However, again it should be noted that the one problem area in the Briar Creek watershed (between Monroe Road and Independence Boulevard) skews the overall B:C ratio upward. Table 2 provides a summary of flood hazard mitigation related information for each of the individual Study Watersheds and as a whole.

Table 2. Flood Hazard Mitigation Summary

Watershed Name	# Problem Areas	# Floodprone Buildings	# Flooding Buildings (*)	Estimated Flood Damage ($)	# Buildings Protected by Recommended Mitigation	Flood Damage Removed By Mitigation	Estimated Costs of Recommended Mitigation
Lower Little Sugar Creek	9	248	109 (13)	$28,493,200	79	$22,501,600	$10,495,158
Mallard Creek	7	86	25 (2)	$5,538,768	24	$5,387,500	$1,525,125
Sugar Creek	12	164	97 (9)	$19,473,600	76	$17,030,386	$5,302,721
Four Mile Creek	2	9	1 (0)	$67,466	0	$0	$0
McAlpine Creek	27	109	39 (12)	$6,266,943	11	$3,590,228	$2,166,180
McDowell Creek	4	15	0 (0)	$115,002	0	$0	$0
Briar Creek	32	897	367 (154)	$399,024,676	244	$393,870,774	$47,081,993
Irwin Creek	24	278	126 (34)	$15,869,989	68	$10,843,992	$7,334,453
McMullen Creek	19	309	74 (24)	$10,129,610	30	$7,235,676	$5,082,980
Upper Little Sugar Creek	24	531	168 (107)	$28,517,365	108	$17,355,708	$34,364,797
TOTALS	160	2646	1006	$513,496,619	640	$477,815,864	$113,353,407

(*) Number of structures within the community encroachment (0.1 foot) floodway.

3. STUDY WATERSHEDS COMPREHENSIVE RANKING

As described above, the 10 preliminary engineering studies provide specific planning-level improvement project recommendations for each problem area in which flood mitigation is cost-effective (or otherwise pertinent) and overall feasible. However, recommended projects are not specifically prioritized or ranked within a given watershed report nor among other reports. Given that the primary objective of this report is to provide an overall strategy for flood hazard mitigation within the Study Watersheds, this section will provide a preliminary ranking scheme that considers recommendations from all 10 Study Watersheds.

Due to the number of problem areas in which mitigation improvements are recommended, and the variability between different problem areas (e.g. geographic extent, number of buildings, number of different improvements, etc.) a specific numerical ranking of every group is not practical. Instead, a system was developed that classifies problem areas into one of two priority groups – high priority or low priority. The primary factors that were used in categorizing the problem areas were the flood damages removed by the proposed improvements and the overall B:C ratio for the problem area recommendations. However, other factors, such as public safety (e.g. whether structure is inhabited), flood depth, and secondary benefits (e.g. water quality, aesthetics, etc.) were also considered. In general, high priority problem areas had both a higher flood damage reduction and a higher B:C ratio. Conversely, low priority was assigned to groups with lower flood damage removal potential and lower B:C ratios. Since there is an emphasis on flood mitigation of buildings in the community encroachment floodway, the problems areas are subdivided and are presented in two separate ranking lists. Tables 3 and 4 represent the comprehensive ranking system for floodway structures and non-floodway structures, respectively, within each problem area. Problem areas within each priority category are listed in alphabetical order by watershed name and problem area identifier. It is important to note that the individual reports for Studies 1 – 6 (as described in Table 1) do not provide damage/mitigation cost information for floodway and non-floodway structures separately – this information is only provided for each problem area as a whole. The itemized values presented in Tables 3 and 4 below for Studies 1 – 6 are prorated from the total values provided in the individual reports. Figure 2 is a map which shows the locations of the problems areas.

Table 3. Flood Hazard Mitigation Improvement Ranking – FLOODWAY STRUCTURES

Watershed	Problem Area ID	Description	# Bldgs	Flood Damage Reduction	Mitigation Costs	B:C Ratio	Recommended Improvements	Comments
HIGH PRIORITY FLOOD HAZARD MITIGATION IMPROVEMENT AREAS – FLOODWAY STRUCTURES								
Briar	BR03***	Sharon Road and Chilton Place	2	$463,967	$315,707	1.5	Acquisition	
Briar	BR06	Meadowbrook Road and Placid Place	7	$1,552,101	$1,125,328	1.4	Acquisition	
Briar	BR14***	Between the Eastway Drive and Country Club Drive stream crossings	24	$3,479,624	$2,045,770	1.7	Acquisition	
Briar	BR16***	Thames Apartment Drive	12	$20,598,166	$2,665,525	7.7	Acquisition/Water Quality Enhancements	No record of significant past flooding. Additional review of flood study required
Briar	BR17	Thames Apartment Drive	3	$4,605,406	$807,772	5.7	Acquisition/Water Quality Enhancements	No record of significant past flooding. Additional review of flood study required
Briar	BR18	Purser Drive and Jennie Linn Drive	10	$3,227,884	$412,708	7.8	Acquisition	
Briar	BR20	Dolphin Lane and Kildare Drive	23	$1,848,665	$1,897,136	1.0	Acquisition/Water Quality Enhancements	
Briar	BR21***	Dolphin Lane, Kinsale Lane, and Ruth Drive	12	$945,613	$936,872	1.0	Acquisition	
Briar	BT2-1***	Shannonhouse Drive	5	$1,036,477	$440,154	2.4	Acquisition	
Briar	EDB1*	Commonwealth Avenue	5	$369,446	$364,167	1.0	Acquisition	
Irwin	IRW12	Andrill Terrace	11	$1,162,009	$397,962	2.9	Acquisition/Water Quality Enhancements	
Irwin	ST2-2	Gallagher St	1	$66,547	$57,040	1.2	Acquisition	
Irwin	ST2-3***	Barlowe Road and Dewolfe Street	3	$156,859	$141,714	1.1	Acquisition/No Action	
Lower Little Sugar	LLS-G*	Towne Centre Boulevard and NC 51	4	$4,378,236	$1,036,171	4.2	Levee	Post-FIRM Office Buildings - Acquisition Unlikely
McMullen	MM08	Carmel Acres Drive	2	$2,744,292.20	$481,288.00	5.7	Acquisition	
McMullen	MM16	Willhaven Drive and Strawberry Hill Drive	5	$1,273,712	$871,148	1.5	Acquisition	
Upper Little Sugar	LSC19*	36th Street,Tryon Street Cullman Avenue and Benard Avenue	15	$5,640,765	$2,195,030	2.6	Acquisition/No Action	
Upper Little Sugar	LSC20***	Raleigh Street and Sugar Creek Road	1	$1,916,786	$1,568,526	1.2	Acquisition	Additional study needed for this area. Bldg is open structure housing concrete curing kilns.
TOTALS	**18 Groups**		**145**	**$55,466,555**	**$17,760,018**	**3.1**		

Watershed	Problem Area ID	Description	# Bldgs	Flood Damage Reduction	Mitigation Costs	B:C Ratio	Recommended Improvements	Comments
LOW PRIORITY FLOOD HAZARD MITIGATION IMPROVEMENT AREAS – FLOODWAY STRUCTURES								
Briar	BR05***	Scotland Avenue, Twiford Place, Museum Drive, and Providence Road.	6	$477,602	$3,605,459	0.1	Acquisition	
Briar	BR07	Museum Drive	1	$90,340	$802,475	0.1	Acquisition/Water Quality Enhancements	
Briar	BR08	Fannie Circle	3	$11,579	$141,312	0.1	Acquisition	
Briar	BR09***	Between Monroe Road and Independence Boulevard	5	$629,052	$1,938,624	0.3	Acquisition	
Briar	BR10***	Near Commonwealth Avenue and Morningside Drive	8	$1,182,269	$2,126,875	0.6	Acquisition	
Briar	BR11	Commonwealth Avenue and Central Avenue	3	$191,472	$452,259	0.4	Acquisition	
Briar	BR12*	Arnold Drive,Masonic Drive, and Central Avenue	3	$435,952	$718,487	0.6	Acquisition/No Action	
Briar	BR13	Harbinger Court	2	$121,253	$186,492	0.7	Acquisition/No Action	
Briar	BR22*	Cutshaw Court and Ilford Street	1	$15,664	$102,066	0.2	Acquisition	
Briar	EDB2	East Independence Boulevard	2	$350,539	$1,639,206	0.2	Acquisition	
Briar	EDB3	East Independence Boulevard	2	$82,101	$1,130,533	0.1	Acquisition	
Briar	EDB4***	Dresden Drive and Woodland Drive	2	$107,811	$191,940	0.6	Acquisition	
Briar	EDB5	Winfield Drive and Sheffield Drive	6	$184,406	$556,703	0.3	Acquisition	
Briar	EDB6	Tarrington Avenue and Sheffield Drive	1	$25,380	$89,389	0.3	Acquisition	
Irwin	IKB1	Slater Road	1	$9,730	$51,938	0.2	Acquisition	
Irwin	IRW02	Whitehurst Road and Crestridge Drive	9	$351,091	$575,729	0.6	Acquisition	
Irwin	IRW04	Barringer Drive	2	$139,857	$210,735	0.7	Acquisition	
Irwin	IRW08***	Morehead Street and Bryant Street	1	$317,528	$576,600	0.6	Acquisition	
Irwin	IRW11	Sycamore Street	1	$38,835	$54,806	0.7	Acquisition	
Lower Little Sugar	LLS-A***	Birmingham Drive and Burnt Mill Road	2	$284,036	$354,875	0.8	Acquisition	Original mitigation plans recommends elevation. This report recommends acquisition of 2 floodway buildings in project area. Mitigation Costs are based on tax value + 25% Flood Damage reduction is proportioned from original watershed report.
Lower Little Sugar	LLS-I***	Non Clustered	2	$345,292	$3,344,500	0.1	Acquisition	Original mitigation plan recommended elevation of these "non-clustered" individual floodway buildings. This report recommends acquisition. Mitigation costs are based on tax value + 25%. Flood Damage reduction is proportioned from original watershed report.
Mallard	MLD-E		2	$66,300	$145,125	0.5	Acquisition	Original mitigation plan recommended elevation of these "non-clustered" individual floodway buildings. This report recommends acquisition. Mitigation costs are based on tax value + 25%. Flood Damage reduction is proportioned from original watershed report.
McAlpine	MA-McAlp Trib 3*	Cedar Croft,Cool Springs,Kirkstall,Knightswood, Providence Ln,Providence Rd	2	$122,733	$304,305	0.4	Elevation	

McAlpine	MA-River Ridge*	River Ridge,Sentinel Post and Southridge	2	$88,709	$1,169,000	0.1	Acquisition	Original mitigation plans recommends elevation. This report recommends acquisition of 2 floodway buildings in project area. Mitigation Costs are based on tax value + 25%. Flood Damage reduction is proportioned from original watershed report.
McMullen	MM10*	Mountainbrook Road and Johnny Cake Lane	2	$349,200	$444,112	0.8	Acquisition	
McMullen	MM14	Abingdon Road	1	$44,977	$371,552.00	0.12	Acquisition	
McMullen	MM18	Addison Drive, Lincrest Place, and Emory Lane	8	$265,940	$1,215,210	0.2	Acquisition	
McMullen	MMT1	Stratford Circle and Emory Lane	4	$195,860.19	$602,157.00	0.33	Acquisition	
Sugar	SGR-A***	Mounting Rock Road	6	$569,748	$988,500	0.6	Acquisition	Original mitigation plans recommends levee. This report recommends acquisition of 6 floodway Bldgs in project area. Mitigation Costs are based on tax value + 25%. Flood Damage reduction is proportioned from original watershed report.
Upper Little Sugar	DRY1	Cumberland Avenue	1	$92,424	$178,184	0.5	Acquisition	
Upper Little Sugar	LHC1	Wedgewood Drive and Mockingbird Lane	10	$115,071	$1,122,916	0.1	Acquisition/Water Quality Enhancements	
Upper Little Sugar	LSC01*	Park Road	1	$239,195	$2,915,977	0.1	Acquisition	
Upper Little Sugar	LSC02	Park Road and Hedgemore Drive	3	$328,485	$1,316,786	0.2	Acquisition	
Upper Little Sugar	LSC03	Wakefield Drive	2	$414,657	$515,528	0.8	Acquisition	
Upper Little Sugar	LSC04*	Wakefield Drive	2	$542,632	$1,229,970	0.4	Acquisition	
Upper Little Sugar	LSC05***	Brandywine Road,Hillside Avenue and Reece Road	29	$2,234,920	$3,790,321	0.6	Acquisition/No Action	
Upper Little Sugar	LSC06*	Princeton Avenue and Hillside Avenue	22	$1,071,835	$4,364,449	0.2	Acquisition	
Upper Little Sugar	LSC08	Charlotte-Mecklenburg Hospital/Blythe Boulevard	2	$938,754	$12,403,903	0.1	Acquisition	
Upper Little Sugar	LSC10	Morehead Street and Kings Drive	1	$21,998	$461,540	0.1	Acquisition	
Upper Little Sugar	LSC14	Willis Street	3	$377,644	$565,632	0.7	Acquisition	Piedmont Courts is under study for revitalization. Buildings may be removed as part of that project
Upper Little Sugar	LSC15	Eveningside Drive and Belmont Avenue	1	$4,872	$23,180	0.2	Acquisition/No Action	
Upper Little Sugar	LSC16	16th Street	1	$7,245	$31,490	0.2	Acquisition	
TOTALS	**42 Groups**		**168**	**$13,484,987**	**$53,010,840**	**0.3**		

* Flood group has associated "Low Priority" non-floodway buildings (Table 4)
*** Flood group has associated "High Priority" non-floodway buildings (Table 4)

NOTES:
- overall B:C ratio for all floodway structures is 1.0 (= $68.9M Benefits / $70.8M Costs)

Table 4. Flood Hazard Mitigation Improvement Ranking – NON-FLOODWAY STRUCTURES

Watershed	Problem Area ID	Description	# Bldgs	Flood Damage Reduction	Mitigation Costs	B:C Ratio	Recommended Improvements	Comments
HIGH PRIORITY FLOOD HAZARD MITIGATION IMPROVEMENT AREAS – NON-FLOODWAY STRUCTURES								
Briar	BR02	Myers Park County Club golf course	1	$683,454	$60,000	11.4	Flood Proofing	
Briar	BR03***	Sharon Road and Chilton Place	3	$1,369,006	$446,970	3.1	Acquisition/Elevation/No Action	
Briar	BR04	Hanson Drive and Hampton Avenue	16	$3,348,889	$1,720,507	1.9	Acquisition/Elevation/No Action	
Briar	BR05***	Scotland Avenue, Twiford Place, Museum Drive, and Providence Road	4	$2,460,852	$1,705,129	1.4	Acquisition/Elevation/No Action	
Briar	BR09***	Between Monroe Road and Independence Boulevard	28	$314,467,462	$12,179,595	25.8	Acquisition/Elevation/Flood Proofing/No Action	
Briar	BR10*	Near Commonwealth Avenue and Morningside Drive	7	$3,138,442	$1,436,156	2.2	Acquisition/No Action	
Briar	BR14***	Between the Eastway Drive and Country Club Drive stream crossings	8	$2,793,616	$688,578	4.1	Acquisition/Elevation/No Action	
Briar	BR15	Shamrock Drive and Eastway Drive	2	$410,200	$132,370	3.1	Acquisition/Flood Proofing	
Briar	BR16***	Thames Apartment Drive	11	$17,356,729	$2,791,382	6.2	Acquisition/Water Quality Enhancements	
Briar	BR21***	Dolphin Lane, Kinsale Lane, and Ruth Drive	1	$485,427	$87,282	5.6	Acquisition	
Briar	BT2-1***	Shannonhouse Drive	5	$2,066,758	$459,880	4.5	Acquisition	
Briar	BT2-3	Galway Drive	1	$2,101,481	$89,254	23.5	Acquisition	
Briar	EDB4*	Dresden Drive and Woodland Drive	1	$536,394	$146,605	3.7	Acquisition/No Action	
Irwin	IRW08*	Morehead Street and Bryant Street	6	$4,567,398	$3,205,986	1.4	Acquisition/No Action	
Irwin	IRW13	McArthur Avenue	2	$625,864	$109,514	5.7	Acquisition	
Irwin	ST1-2	Freedom Drive	1	$1,346,042	$695,660	1.9	Acquisition	
Irwin	ST2-1	Norwood Drive and October Court	2	$374,925	$60,573	6.2	Acquisition/Elevation/No Action	
Irwin	ST2-3***	Gallagher Street	1	$110,737	$53,052	2.1	Acquisition/No Action	
Lower Little Sugar	LLS-A*	Birmingham Drive and Burnt Mill Road	12	$747,064	$372,257	2.0	Elevation	
Lower Little Sugar	LLS-B	Sharon Oaks Lane	10	$2,787,600	$455,700	6.1	Floodwall	
Lower Little Sugar	LLS-C	Avondale Avenue and Hanover Trail	5	$349,000	$150,000	2.3	Elevation	
Lower Little Sugar	LLS-D	Pineville Road	13	$3,154,200	$107,000	29.5	Floodwall	
Lower Little Sugar	LLS-E	Polk Street	3	$5,189,600	$109,700	47.3	Levee	
Lower Little Sugar	LLS-H	Meadow Creek Lane and Sabal Point Drive	15	$3,621,400	$3,435,300	1.1	Levee	
Lower Little Sugar	LLS-I*	Not Clustered	10	$736,808	$352,526	2.1	Elevation	
Mallard	MLD-A	David Taylor Road	1	$1,507,800	$274,700	5.5	Levee	
Mallard	MLD-B	Kittansett Drive	7	$1,471,500	$685,300	2.1	Levee	
Mallard	MLD-D	Perdido Street	4	$255,500	$120,000	2.1	Elevation	
Mallard	MLD-F	Dekalb Place	3	$557,300	$90,000	6.2	Elevation	
Mallard	MLD-G	Not Clustered	7	$1,529,100	$210,000	7.3	Elevation	
McAlpine	MA-Bentway	Bentway Dr and Green Rea Rd	1	$2,496,255	$121,629	20.5	Levee	
McAlpine	MA-Landing View	Landing View Lane	1	$120,594	$36,642	3.3	Levee	
McMullen	MM06	Standing Stone Court	1	$336,766	$150,000	2.2	Elevation/No Action	
McMullen	MM12	Sharon View Road and Colony Road	3	$1,428,474	$570,532	2.5	Acquisition/Levee and Stream Restoration/No Action	
Sugar	SGR-A*	Mounting Rock Road	20	$2,463,852	$1,966,154	1.3	Levee	
Sugar	SGR-E	Whitehall Estates Drive	5	$4,091,600	$371,700	11.0	Floodwall	
Sugar	SGR-F	Arrowcreek and Yager Creek Drive	9	$4,411,500	$444,700	9.9	Floodwall	
Sugar	SGR-G	Arrow Pine Drive	1	$1,006,600	$177,300	5.7	Floodwall	
Sugar	SGR-J	Downs Road and Downs Circle	12	$2,470,700	$330,000	7.5	Elevation	
Sugar	SGR-K***	Main Street	8	$616,986	$186,667	3.3	Elevation	
Upper Little Sugar	LSC05*	Brandywine Road and Hillside Avenue	2	$108,018	$40,502	2.7	Elevation/No Action	
Upper Little Sugar	LSC07	Sterling Road	1	$594,785	$60,000	9.9	Flood Proofing	
Upper Little Sugar	LSC18	Tryon Street/28th Street	2	$709,745	$276,169	2.6	Acquisition/Flood Proofing/No Action	
Upper Little Sugar	LSC20***	Raleigh Street and Sugar Creek Road	1	$293,252	$60,000	4.9	Flood Proofing	
TOTALS	**44 Groups**		**257**	**$401,299,675**	**$37,222,971**	**10.8**		
Watershed	**Problem Area ID**	**Description**	**# Bldgs**	**Flood Damage Reduction**	**Mitigation Costs**	**B:C Ratio**	**Recommended Improvements**	**Comments**
LOW PRIORITY FLOOD HAZARD MITIGATION IMPROVEMENT AREAS – NON-FLOODWAY STRUCTURES								
Briar	BR12*	Arnold Drive and Masonic Drive, and Central Avenue	3	$151,408	$117,455	1.3	Acquisition/Elevation/No Action	

Briar	BR19	Dora Drive and Purser Drive	3	$280,045	$193,805	1.4	Acquisition/Elevation/No Action	
Briar	BR22***	Cutshaw Court and Ilford Street	1	$137,276	$88,808	1.5	Acquisition/No Action	
Briar	EDB1***	Commonwealth Avenue	1	$50,566	$45,198	1.1	Elevation/No Action	
Irwin	IRW03	Reid Avenue	1	$36,586	$23,239	1.6	Elevation	
Irwin	IRW06	Spruce Street/Merriman Avenue	8	$445,667	$323,841	1.4	Acquisition/Elevation/No Action	
Irwin	IRW09	Thrift Road/Freedom Drive	2	$220,564	$120,000	1.8	Flood Proofing	
Irwin	IRW10	Westbrook Drive/Greenleaf Avenue/Elliott Street	5	$231,259	$179,870	1.3	Acquisition/Elevation/Flood Proofing/No Action	
Irwin	SCK1	Gardener Avenue	1	$96,191	$51,541	1.9	Levee	
Irwin	SCK2	Seldon Drive	5	$208,502	$152,429	1.4	Acquisition/Water Quality Enhancements/Elevation/No Action	
Irwin	SCK4	Prince Street	3	$268,218	$237,150	1.1	Acquisition	
Irwin	ST2-4	Blenhein Road	2	$69,583	$55,074	1.3	Elevation/No Action	
Lower Little Sugar	LLS-G***	Towne Centre Boulevard and NC 51	3	$908,364	$777,129	1.2	Levee	
McAlpine	MA-Eveningwood	Eveningwood,Five Cedars,Kapplewood and Smoke Tree	1	$49,804	$46,250	1.1	Elevation	
McAlpine	MA-McAlp Trib 3***	Cedar Croft,Cool Springs,Kirkstall,Knightswood, Providence Ln,Providence Rd	3	$672,746	$456,457	1.5	Elevation	
McAlpine	MA-River Ridge*	River Ridge,Sentinel Post, and Southridge	1	$39,387	$31,897	1.2	Elevation	
McMullen	MM10*	Johnny Cake Lane and Mountainbrook Road	3	$430,901	$274,463	1.6	Acquisition/Elevation/No Action	
McMullen	MM15	Pinehurst Apartments Drive	1	$165,554	$102,518	1.6	Flood Barrier	
Sugar	SGR-B	Flooden Field Court and Yorkdale Drive	10	$559,400	$339,300	1.6	Floodwall	
Sugar	SGR-C	Bangor Road	5	$840,000	$498,400	1.7	Floodwall	
Upper Little Sugar	LSC01***	Park Road	1	$456,032	$346,938	1.3	Acquisition/No Action	
Upper Little Sugar	LSC04***	Wakefield Drive	1	$252,968	$259,480	1.0	Acquisition	
Upper Little Sugar	LSC06***	Hillside Avenue and Princeton Avenue	1	$54,458	$53,833	1.0	Elevation/No Action	
Upper Little Sugar	LSC13	4th Street and Elizabeth Avenue	1	$69,073	$60,000	1.2	Flood Proofing/No Action	
Upper Little Sugar	LSC19***	Cullman Avenue,36th Street and Tryon Street	4	$870,096	$524,443	1.7	Acquisition/Flood Proofing/No Action	
TOTALS	**26 Groups**		**137**	**$7,850,875**	**$5,582,667**	**1.4**		

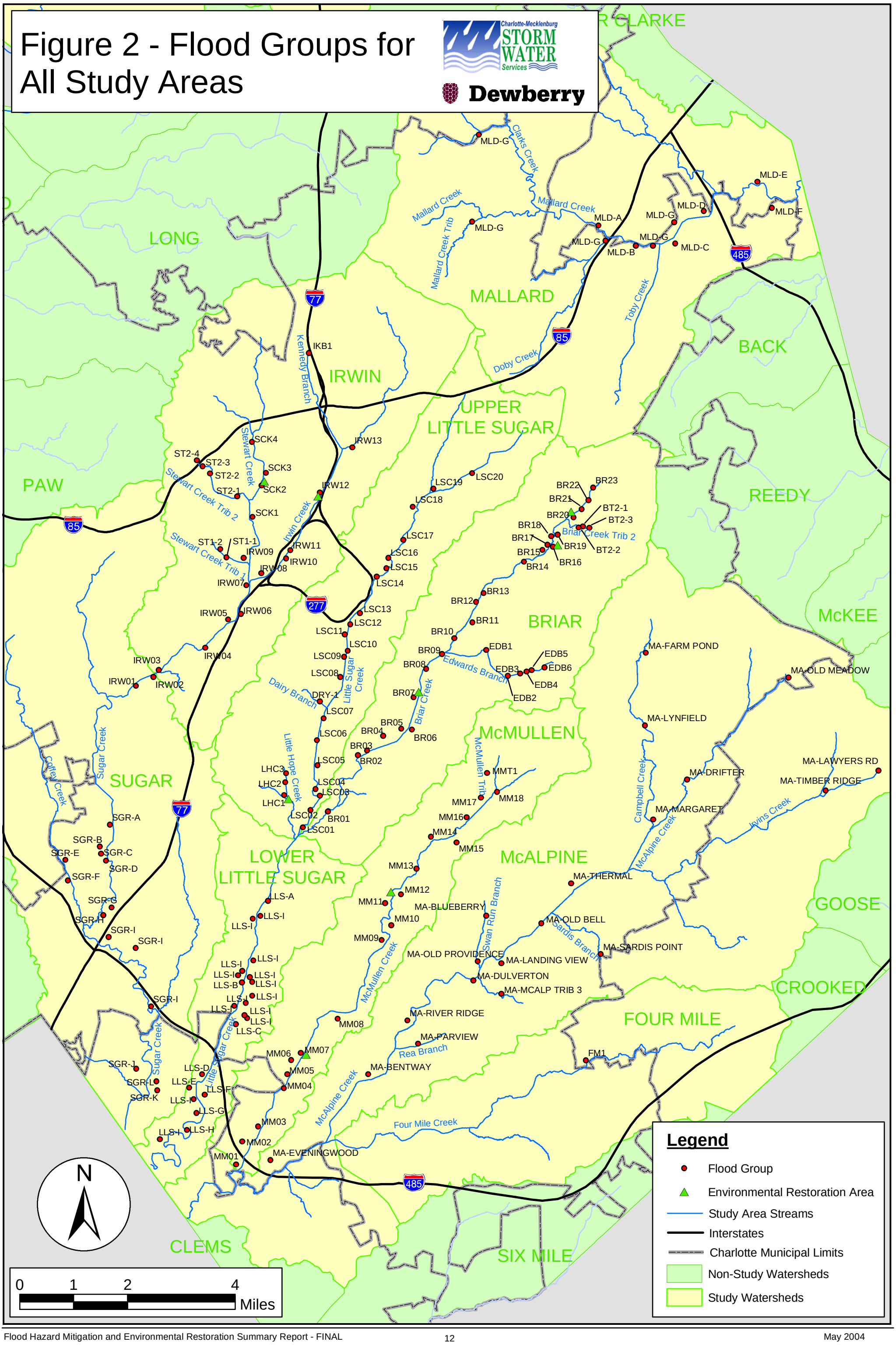
* Flood group has associated "Low Priority" floodway buildings (Table 3)
*** Flood group has associated "High Priority" floodway buildings (Table 3)

NOTES:
- overall B:C ratio for all floodway structures is 9.6 (= $409M Benefits / $42.6M Costs)

Figure 2 - Flood Groups for All Study Areas

Charlotte-Mecklenburg STORM WATER Services

Dewberry



4. ENVIRONMENTAL RESTORATION SUMMARY

Environmental restoration was a secondary objective of the preliminary engineering studies. Each Study report contains a section on general watershed conditions which includes a cursory review and assessment of development trends/characteristics, available water quality monitoring, stream characterization, and bank stability identification. Recommendations for environmental restoration tended to be general in nature and were not evaluated in detail. Thus, the environmental restoration projects were not analyzed in detail nor ranked. Recommended locations for potential water quality enhancement/environmental restoration are shown in Figure 2. Due to the general and secondary emphasis, environmental restoration is not further discussed in this report. The reader is referred to the individual Study reports for additional information.

5. CONCLUSIONS AND SUMMARY

Mecklenburg County Storm Water Services (MCSWS) has recently completed preliminary engineering studies that investigated flood hazard mitigation (primary focus) and environmental restoration (secondary focus) strategies for ten (10) of the most urbanized watersheds in Mecklenburg County, North Carolina. This report has summarized the findings and recommendations of the 10 watershed study reports, and presented a comprehensive ranking system for flood hazard mitigation.

The proposed ranking system classified flood hazard mitigation projects recommended in the Study reports as high or low priority, based on a combination of flood damage reduction potential, cost-effectiveness, and overall feasibility. It is estimated that implementing the recommended mitigation improvements at a cost of approximately $113 million will eliminate approximately $478 million (93%) of the total $513 million in estimated flood damages.

REFERENCES

ABSG Consulting, 2003. *Determination of Financial Impacts from Flood Studies* April 2003.

Dewberry, 2003. *Watershed Study No. 7 / Briar Creek Watershed*. December 2003

Dewberry, 2003. *Watershed Study No. 8 / Irwin Creek Watershed*. November 2003

Dewberry, 2003. *Watershed Study No. 9 / McMullen Creek Watershed*. October 2003

Dewberry, 2003. *Watershed Study No. 10 / Upper Little Sugar Creek Watershed*. November 2003

HDR Engineering, 2002. *Watershed Study No. 1 / Lower Little Sugar Creek Watershed*. August 2002

HDR Engineering, 2001. *Watershed Study No. 2 / Mallard Creek Watershed*. October 2001

HDR Engineering, 2001. *Watershed Study No. 3 / Sugar Creek Watershed*. October 2001

Watershed Concepts, 2001. *Watershed Study No. 4 / Four Mile Creek Watershed*. November 2001

Watershed Concepts, 2002. *Watershed Study No.5 / McAlpine Creek Watershed*. March 2002

Watershed Concepts, 2002. *Watershed Study No. 6 / McDowell Creek Watershed*. January 2002

APPENDIX A

Roadway Overtopping Summary Table

Watershed	Crossing Name	Crossing Type	Top of Road Elevation	FC 100-yr WSE	FC 100-yr Overtoppting Depth
BRIAR CREEK					
Briar	Unnamed Stream Crossing	Bridge	640.47	659.0	18.5
Briar	East of Bay Street	Bridge	642.59	659.0	16.4
Briar	Bramlet Road	Bridge	644.1	658.9	14.8
Briar	Unnamed Stream Crossing	6-2' RCP	648.65	661.1	12.5
Briar	Unnamed Stream Crossing	Bridge	662.11	672.2	10.1
Briar	Unnamed Stream Crossing	Bridge	661.48	669.6	8.1
Briar	Independence Boulevard	3-12'x15' Box	651.01	659.0	8.0
Briar	Unnamed Stream Crossing	Bridge	675.13	682.8	7.7
Briar	Unnamed Stream Crossing	Bridge	675.51	683.2	7.6
Briar	Golf Course Crossing	Bridge	610.46	617.6	7.1
Briar	Unnamed Stream Crossing	Bridge	663.79	670.8	7.0
Briar	Golf Course Crossing	Bridge	610.12	617.1	6.9
Briar	Unnamed Stream Crossing	Bridge	662.21	668.6	6.3
Briar	Golf Course Crossing	Bridge	612.13	618.3	6.2
Briar	Golf Course Crossing	Bridge	616.25	622.0	5.7
Briar	Golf Course Crossing	Bridge	618.19	623.4	5.3
Briar	Golf Course Crossing	Bridge	612.63	617.8	5.2
Briar	Unnamed Stream Crossing	Bridge	664.84	670.0	5.2
Briar	Central Avenue	3-12'x9.5' Box	654.21	659.4	5.1
Briar	Commonwealth Avenue	3-12'x12' Box	654.12	659.1	5.0
Briar	Unnamed Stream Crossing	Bridge	680.71	685.7	5.0
Briar	Country Club Drive	2-16'x9' RCPE	671.02	675.7	4.7
Briar	Golf Course Crossing	Bridge	614.88	619.6	4.7
Briar	Unnamed Stream Crossing	Bridge	663.62	667.9	4.3
Briar	Unnamed Stream Crossing	Bridge	658.62	662.9	4.2
Briar	Golf Course Crossing	Bridge	617.61	621.4	3.8
Briar	Shamrock Drive	3-12'x11' Box	680.13	683.8	3.6
Briar	Sharon Road	4-11.5'x12' Box	620.71	624.3	3.6
Briar	Eastway Drive	3-12'x11' Box	679.05	682.3	3.2
Briar	Shannonhouse Road	2-8'x6.3' Box	694.88	696.4	1.5
Briar	Ruth Drive	2-8'x6.3' Box	699.55	700.3	0.8
Briar	Providence Road	2-9.5'x15' Box & 2-11'x15' Box	626.01	626.0	0.0
Briar	CSX Railroad	1-12.1'x15' Box & 1-10' RCP	660.01	658.8	-1.2
Briar	Park Road	Bridge	596.05	594.4	-1.6
Briar	Monroe Road	Bridge	640.29	638.4	-1.9
Briar	Randolph Road	Bridge	635.8	633.8	-2.0
Briar	Plaza Road	3-10'x9' Box	711.05	706.9	-4.1
Briar	Colony Road	1-34'x20.4' CMPA	620.8	616.2	-4.6
Briar	Michael Baker Place	Bridge	604.35	597.0	-7.4
Briar	Runnymeade Lane	4-12'x15' Box	611.55	599.3	-12.2
Briar	Norfolk Southern Railroad	Bridge	704.48	690.0	-14.5
EDWARDS BRANCH					
Briar	Old Briar Creek Road	Bridge	649.79	659.0	9.2
Briar	Footbridge	Bridge	653.75	659.0	5.2
Briar	Woodland Drive	1-12.5'x7.5' CMPA	688.17	692.8	4.6
Briar	Commonwealth Avenue	3-10' RCP	661.73	665.9	4.1
Briar	Footbridge	Bridge	655.41	659.0	3.5
Briar	Service Road	2-7'x7' Box	689.08	692.6	3.5
Briar	Parking Deck	Bridge	655.62	659.0	3.3
Briar	Eastway Drive	3-7'x9' Box	673.71	676.2	2.5
Briar	Independence Boulevard	2-9'x10' RCPE	660.79	663.2	2.4
Briar	Sheffield Drive	1-9'x6.5' CMPA	696.51	698.3	1.8
Briar	Parking Driveway	Bridge	658.94	659.0	0.0
Briar	New Briar Creek Road	Bridge	681.06	659.0	-22.1
BRIAR CREEK TRIBUTARY 1					
Briar	Unnamed Stream Crossing	Bridge	596.5	603.0	6.5
Briar	Unnamed Stream Crossing	Bridge	597.0	603.1	6.2
Briar	Colony Road	1-16.6'x6.7' CMPA	614.8	617.7	2.9

Briar	Runnymeade Lane	Runnymeade Lane	601.6	603.0	1.4
BRIAR CREEK TRIBUTARY 2					
Briar	Galway Drive	3-7'x5' Box	704.51	707.0	2.5
Briar	Grafton Drive	2-7.5'x8' Box	695.09	697.5	2.4
STEWART CREEK					
Irwin	Unnamed Stream Crossing	Bridge	668.12	674.68	6.6
Irwin	Southwest Boulevard	Bridge	674.18	676.48	2.3
Irwin	Capps Hill Mine Road	1-9' RCP	725.31	727.53	2.2
Irwin	Morehead Street	Bridge	632.57	633.84	1.3
Irwin	State Street	1-25.5'x16' CMPA	645.96	646.64	0.7
Irwin	Freedom Drive	4-9'x12' Box	636.24	636.57	0.3
Irwin	Hoskins Road	3-12'x8' Box	692.79	692.41	-0.4
Irwin	LaSalle Street	Bridge	674.32	673.48	-0.8
Irwin	I-277	3-12'x11' Box	672.58	670.2	-2.4
Irwin	I-85 Service Road	2-11'x11' Box	687.78	685.08	-2.7
Irwin	Rozelles Ferry Road	3-9.5'x14' Box	657.7	654.68	-3.0
Irwin	West Trade Street	Bridge	662.59	659	-3.6
Irwin	Tuckaseegee Road	Bridge	647.5	641.53	-6.0
Irwin	Railroad	1-22'x14.5' CMPA & 2-13' RCP	658.24	648.05	-10.2
Irwin	Unnamed Stream Crossing	2-8'x8' Box	691.99	668.06	-23.9
STEWART CREEK TRIBUTARY 1					
Irwin	Berryhill Drive	2-8'x6' RCPE	649.8	654.79	5.0
Irwin	Unnamed Stream Crossing	Bridge	656.4	661.22	4.8
Irwin	Unnamed Stream Crossing	1-4' RCP & 1-5' RCP	654.9	658.31	3.5
Irwin	Railroad	3-5' RCP	637.4	639.42	2.0
STEWART CREEK TRIBUTARY 2					
Irwin	Barlowe Road	Bridge	697.7	703.14	5.4
Irwin	Lakewood Avenue	1-15'x9' RCPE	677.0	680.68	3.6
Irwin	Gallagher Street	1-15'x9' RCPE	679.5	683.1	3.6
Irwin	Lannder Street	1-15'x9.3' RCPE	689.3	692.78	3.5
Irwin	Coronet Way	1-20'x8.5' Box	655.5	658.45	2.9
Irwin	Railroad	Bridge	707.3	702.66	-4.7
Irwin	Railroad	2-15'x8' RCPE	709.7	701.44	-8.3
Irwin	Parkway Avenue	Bridge	677.5	663.24	-14.2
Irwin	I-85	2-7'x7' Box	729.0	707.91	-21.1
STEWART CREEK TRIBUTARY 3					
Irwin	Hoskins Road	2-6' RCP	718.6	723.73	5.2
Irwin	Railroad	2-6' RCP	722.6	723.72	1.1
Irwin	I-85	2-7'x7' Box	706.5	693.99	-12.5
IRWIN CREEK					
Irwin	Footbridge	Bridge	632.32	653.35	21.0
Irwin	Footbridge	Bridge	637.22	653.52	16.3
Irwin	Ramp to I-77	4-13'x15' Box	631.81	644.27	12.5
Irwin	Ramp to I-77	4-13'x16' Box	634.64	646.76	12.1
Irwin	4th Street Ext	4-13.2'x15.4' Box	643.54	653.39	9.9
Irwin	West Trade Street	4-13'x15' Box	644.51	653.71	9.2
Irwin	Unnamed Stream Crossing	Bridge	615.1	624.17	9.1
Irwin	Westmont Drive	Bridge	604.46	613.5	9.0
Irwin	Unnamed Stream Crossing	Bridge	617.16	625.33	8.2
Irwin	Unnamed Stream Crossing	Bridge	705.23	712.78	7.5
Irwin	I-77	4-13'x15.2' Box	649.37	656.58	7.2
Irwin	Unnamed Stream Crossing	Bridge	620.92	628.1	7.2
Irwin	Barringer Drive	Bridge	618.32	623.84	5.5
Irwin	West Boulevard	Bridge	628.38	633.56	5.2
Irwin	I-277	4-16'x15' Box	639.51	644.14	4.6
Irwin	Unnamed Stream Crossing	Bridge	673.48	677.47	4.0
Irwin	Nevin Road	1-10'x13' CMPA	724.45	727.11	2.7
Irwin	Dalecrest Drive	1-10'x8' Box	705.65	708.15	2.5
Irwin	Remount Road	Bridge	629.37	631.57	2.2
Irwin	Ramp from Wilkinson	Bridge	640.55	642.21	1.7
Irwin	Railroad	Bridge	651.67	653.29	1.6
Irwin	Railroad	3-12.5'x18' Box	651.35	652.36	1.0
Irwin	West Morehead Street	4-13'x16' Box	650.1	649.73	-0.4
Irwin	I-77	4-12'x13' Box	662.03	661.18	-0.9
Irwin	Norfolk Southern Railroad	1-44'x28' CMPA	641.91	638.4	-3.5

Irwin	I-77 to West Boulevard	Bridge	638.05	634.43	-3.6
Irwin	Clanton Road	Bridge	623.71	619.69	-4.0
Irwin	Starita Road	4-9'x9' Box	704.76	700.65	-4.1
Irwin	I-77 Off Ramp	Bridge	663.97	658.78	-5.2
Irwin	Statesville Avenue	Bridge	675.76	669.43	-6.3
Irwin	Oaklawn Avenue	Bridge	667.11	659.42	-7.7
Irwin	Ramp to I-77	4-13'x15' Box	654.91	646.7	-8.2
Irwin	I-85	3-10'x11' Box	705.58	697.34	-8.2
Irwin	5th Street	4-13'x15.5' Box	667.22	655.98	-11.2
Irwin	LaSalle Street	4-12'x13' Box	678.77	666.84	-11.9
Irwin	I-277	Bridge	679.16	658.05	-21.1
Irwin	I-277	Bridge	681.27	658.59	-22.7
Irwin	Railroad	Bridge	682.88	657.29	-25.6
Irwin	Norfolk Southern Railroad	Bridge	648.01	610.59	-37.4
UPPER LITTLE SUGAR CREEK					
Upper Little Sugar	Unnamed Stream Crossing	Bridge	618.99	633.12	14.1
Upper Little Sugar	Unnamed Stream Crossing	Bridge	616.34	630.02	13.7
Upper Little Sugar	Unnamed Stream Crossing	Bridge	613.84	627.30	13.5
Upper Little Sugar	Unnamed Stream Crossing	Bridge	648.23	658.05	9.8
Upper Little Sugar	Baxter Street	Bridge	631.05	639.62	8.6
Upper Little Sugar	Unnamed Stream Crossing	Bridge	611.07	618.48	7.4
Upper Little Sugar	Unnamed Stream Crossing	Bridge	632.81	639.35	6.5
Upper Little Sugar	Unnamed Stream Crossing	Bridge	617.36	623.63	6.3
Upper Little Sugar	East 36th Street	2-10'x9' Box	686.35	692.56	6.2
Upper Little Sugar	Norfolk Southern Railroad	1-15'x17' CMPA	686.73	692.56	5.8
Upper Little Sugar	12th Street	3-12'x12' Box	652.21	657.97	5.8
Upper Little Sugar	Unnamed Stream Crossing	Bridge	664.51	670.16	5.6
Upper Little Sugar	Unnamed Stream Crossing	Bridge	663.04	668.19	5.2
Upper Little Sugar	Unnamed Stream Crossing	Bridge	630.54	634.98	4.4
Upper Little Sugar	Unnamed Stream Crossing	Bridge	607.35	611.53	4.2
Upper Little Sugar	Hillside Avenue	Bridge	609.31	612.92	3.6
Upper Little Sugar	East Morehead Street	1-30'x13' RCPE	631.00	634.47	3.5
Upper Little Sugar	I-277 Ramp	3-12'x12' Box	654.13	657.48	3.4
Upper Little Sugar	Unnamed Stream Crossing	Bridge	618.01	621.10	3.1
Upper Little Sugar	Unnamed Stream Crossing	Bridge	658.31	661.38	3.1
Upper Little Sugar	Elizabeth Avenue	3-12'x14' Box	644.72	647.64	2.9
Upper Little Sugar	Wellingford Street	Bridge	707.65	710.36	2.7
Upper Little Sugar	Unnamed Stream Crossing	Bridge	662.54	664.90	2.4
Upper Little Sugar	East Sugar Creek Road	2-12'x8' RCPE	701.39	703.60	2.2
Upper Little Sugar	Unnamed Stream Crossing	Bridge	638.46	640.61	2.1
Upper Little Sugar	Unnamed Stream Crossing	Bridge	616.51	618.49	2.0
Upper Little Sugar	I-277	3-12'x12' Box	652.62	654.51	1.9
Upper Little Sugar	Medical Center Drive	Bridge	630.31	632.10	1.8
Upper Little Sugar	Unnamed Stream Crossing	Bridge	660.16	661.91	1.8
Upper Little Sugar	Brevard Street	1-25'x11' CMPA	677.01	678.67	1.7
Upper Little Sugar	4th Street	3-12'x14' Box	645.71	647.30	1.6
Upper Little Sugar	Unnamed Stream Crossing	1-42'x16' Box	636.32	637.88	1.6
Upper Little Sugar	Princeton Avenue	Bridge	616.51	617.72	1.2
Upper Little Sugar	Kentbrook Drive	Bridge	717.61	718.56	0.9
Upper Little Sugar	East Boulevard	Bridge	626.01	626.92	0.9
Upper Little Sugar	Belmont Avenue	3-12'x12' Box	659.22	659.90	0.7
Upper Little Sugar	Davidson Street	3-12'x10' Box	670.78	671.43	0.6
Upper Little Sugar	Independence Boulevard	Bridge	640.83	641.12	0.3
Upper Little Sugar	West Craighead Road	3-9'x9' Box	695.33	695.50	0.2
Upper Little Sugar	East 3rd Street	3-12'x14' Box	644.81	644.76	0.0
Upper Little Sugar	18th Street	Bridge	667.26	666.92	-0.3
Upper Little Sugar	Brandywine Road	Bridge	608.78	608.06	-0.7
Upper Little Sugar	Park Road	Bridge	596.71	595.66	-1.1
Upper Little Sugar	Tyvola Road	Bridge	596.41	593.40	-3.0
Upper Little Sugar	East 30th Street	2-4.7'x11.2' Box & 2-10'x12' Box	695.51	692.33	-3.2
Upper Little Sugar	Parkwood Avenue	3-11'x12' Box	673.21	669.70	-3.5
Upper Little Sugar	East Woodlawn Road	4-12'x15' Box	611.14	606.50	-4.6
Upper Little Sugar	Norfolk Southern Railroad	1-15'x16' CMPA	697.16	690.25	-6.9
Upper Little Sugar	North Tryon Street	2-9'x9' Box	716.91	709.46	-7.4
Upper Little Sugar	CSX Railroad	Bridge	690.01	658.62	-31.4

DERITA BRANCH					
Upper Little Sugar	Unnamed Stream Crossing	1-10'x6' Box	687.15	690.50	3.4
Upper Little Sugar	West Craighead Road	3-10'x4' Box	710.93	712.93	2.0
Upper Little Sugar	North Tryon Street	1-13'x8' Box	687.56	689.44	1.9
DAIRY BRANCH					
Upper Little Sugar		1-16'x7' CMPA	618.57	622.07	3.5
Upper Little Sugar	Unnamed Stream Crossing	Bridge	642.79	644.94	2.2
Upper Little Sugar	Cumberland Avenue	3-6' RCP	625.77	627.62	1.9
Upper Little Sugar	Scott Avenue	1-11'x12' Box	656.50	657.34	0.8
LITTLE HOPE CREEK					
Upper Little Sugar	Mockingbird Lane	3-7'x6' Box	611.70	615.81	4.1
Upper Little Sugar	Woodlawn Road	1-10'x10' Box	625.85	627.27	1.4
Upper Little Sugar	Montford Drive	1-8'x6' Box	617.53	618.83	1.3
Upper Little Sugar	Seneca Place	Bridge	614.01	610.48	-3.5
Upper Little Sugar	Tyvola Road	3-10'x10' Box	600.27	593.28	-7.0
LITTLE HOPE CREEK TRIBUTARY					
Upper Little Sugar	Bradbury Drive	1-8'x7' Box	621.53	622.84	1.3
MCMULLEN CREEK					
McMullen	Lincrest Place	3-4' RCP	662.23	667.68	5.4
McMullen	Addison Drive	2-4' RCP	664	667.81	3.8
McMullen	Randolph Road	2-11'x11' Box	656.21	659.18	3.0
McMullen	Arborway	3-10'x10' Box	633.28	635.88	2.6
McMullen	Mountainbrook Road	3-12'x12' Box	593.62	595.5	1.9
McMullen	Colony Road	2-22'x11.5' CMPA	613.03	613.83	0.8
McMullen	Fariview Road	1-13'x7' Box & 3-11'x13' Box	626.11	626.58	0.5
McMullen	Providence Road	2-12'x14' Box	653.87	652.34	-1.5
McMullen	Pineville-Matthews Road	4-12'x12' Box	544.71	543.18	-1.5
McMullen	I-485 West	Bridge	537.91	536.15	-1.8
McMullen	Sharon View Road	3-12'X14' Box	611.25	608.15	-3.1
McMullen	Johnston Road	Bridge	551.11	545.92	-5.2
McMullen	Quail Hollow Road	Bridge	580.1	568.74	-11.4
MCMULLEN CREEK TRIBUTARY					
McMullen	Private Church Drive	2-4' RCP	676.51	679.8	3.3
McMullen	Addison Drive	2-6' RCP	668.01	670.83	2.8
McMullen	North Sharon Amity Road	1-11.5'x6.5' CMPA	685.41	687.19	1.8
FOUR MILE CREEK					
Four Mile	Raintree Lane	Culvert 4@14x8.5 Box	563.0	566.0	3.0
Four Mile	Providence Rd	Culvert 5@8X13.5 Box	574.5	574.9	0.4
MCALPINE CREEK					
McAlpine	Carmel Cntry Cl #1	Culvert 1 Irregular	546.0	549.0	3.0
McAlpine	Marlwood Cir	Culvert 1@ 3.5 Cir	681.8	683.9	2.1
McAlpine	Lawyers Rd	Culvert 3@ 9X12	667.5	669.0	1.5
McAlpine	Carmel Cntry Cl #3	Culvert 1 Irregular	548.6	550.0	1.4
MCALPINE TRIB 3					
McAlpine	Cedar Croft Dr	Culvert 1@ 8 Cir	589.0	592.8	3.8
McAlpine	Rea Road	Culvert 2@ 7 Cir	572.1	574.5	2.4
McAlpine	Heatherford Rd	Culvert 1@22.8X8.5Arch	565.2	566.1	0.9
REA BRANCH					
McAlpine	Rea Road	Culvert 2@ 7 Cir	558.0	560.0	2.0
McAlpine	N Parview Dr	Culvert 2@ 14X8.5	556.0	556.2	0.2
SARDIS BRANCH					
McAlpine	Sardis Rd	Culvert 1 @ 8.5X6Arch	565.8	576.0	10.2
McAlpine	8302 Rittenhouse Cir	Culvert 2@ 3.5 Cir	596.0	599.1	3.1
McAlpine	Sardis Road	Culvert 2@ 7.5X7.5	635.5	635.9	0.4
IRVINS CREEK					
McAlpine	Beaver Dam Ln	Culvert 5@ 5.5 Cir	668.3	671.1	2.8
McAlpine	Apple Creek Dr	Culvert 3@ 7.5 Cir	677.7	680.0	2.3
McAlpine	Timber Ridge Dr	Culvert 2@ 5 Cir	672.0	674.0	2.0
IRVINS TRIB 1					
McAlpine	Sam Newell Rd (1-7)	Culvert 1@ 5 Cir	638.2	644.0	5.8
McAlpine	Sam Newell Rd (1-2)	Culvert 1 @ 16X7.5Arch	639.9	643.3	3.4
MCDOWELL CREEK					
McDowell	Sam Furr Road	Bridge	701.3	702.3	1.0
TORRENCE CREEK					
McDowell	Farm Bridge	Bridge	669.5	674.8	5.3
TORRENCE CREEK TRIB 1					

McDowell	Foot Bridge	Bridge	669.3	674.1	4.8
McDowell	Stumptown Road	Culvert 2@6 Cir	705.8	707	1.2
McDowell	Gilead Road	Culvert 2@ 8X7.5Box	679.5	680	0.5
MCDOWELL CREEK TRIB 1					
McDowell	McIlwaine Road	Bridge	661.8	668.1	6.3
CALDWELL STATION CREEK					
McDowell	Statesville Road	Culvert 3@8X7 Box	718.7	718.9	0.2
LOWER LITTLE SUGAR CREEK					
Lower Little Sugar	Highway 51	Bridge	552.6	560.6	8.0
Lower Little Sugar	Rockledge Drive	Bridge	565.1	572.8	7.7
Lower Little Sugar	Wastewater Treatment Plant	Bridge	584.0	591.4	7.4
Lower Little Sugar	Sharon Road West	Bridge	566.0	569.0	3.0
Lower Little Sugar	South Polk Street	Bridge	558.5	559.1	0.6
MALLARD CREEK					
Mallard	Mallard Creek Church Road	Bridge	594.0	600.7	6.7
Mallard	Interstate 85	Bridge	608.2	613.2	5.0
Mallard	Pavillion Blvd.	Bridge	588.2	592.4	4.2
Mallard	N. Tryon Street	Bridge	598.0	601.9	3.9
Mallard	David Taylor Drive	Culvert 4-15' x 12' Box	611.0	614.3	3.3
Mallard	Sugar Creek Road	Bridge	714.5	715.6	1.1
Mallard	Old Potters Road	Culvert 8' RCP	731.5	732.6	1.1
MALLARD CREEK TRIBUTARY					
Mallard	Hubbard Road	Culvert 2-6' RCP	679.0	680.1	1.1
CLARKS CREEK TRIBUTARY 1					
Mallard	Hucks Road	Bridge	729.0	730.7	1.7
Mallard	Browne Road	Culvert 2-8' RCP	724.8	726.3	1.5
STONEY CREEK TRIBUTARY					
Mallard	Mallard Creek Road	Culvert 10' x 7' RCPE	692.1	693.2	1.1
Mallard	Homewood Drive	Culvert 2-7' RCP	650.4	651.2	0.8
TOBY CREEK					
Mallard	Chancellor Park Drive	Culvert 5-10' x 10' Box	621.4	623.1	1.7
Mallard	Rock River Road	Culvert 2-11' x 8' RCPE	638.6	639.7	1.1
Mallard	Hwy 49	Culvert 2-10' x 11' Box	622.2	622.7	0.5
SUGAR CREEK					
Sugar	Arrowood Road	Bridge	577.4	582.1	4.7
Sugar	Interstate 77	Bridge	572.5	574.5	2.0
Sugar	Nations Ford Road	Bridge	567.9	568.6	0.7
Sugar	Highway 51	Bridge	543.8	544.2	0.4
COFFEY CREEK					
Sugar	Arrowood Road Ext.	Culvert 4-12'x10' Box	583.7	586.0	2.3
KINGS BRANCH					
Sugar	Old Nations Ford Road	Culvert 1-7' RCP	548.6	550.9	2.3
Sugar	Kings Branch Court	Bridge	611.8	613.9	2.1
Sugar	Archdale Drive	Culvert 3-8.5'x7.5'RCPE	618.0	619.9	1.9
Sugar	Deanna Lane	Culvert 3-7' RCP	600.4	601.8	1.4
Sugar	E. Arrowood Road	Culvert 16.4'x10.2' CMPA	594.8	595.6	0.8
TAGGART CREEK					
Sugar	Mulberry Church Road	Culvert 2-8' RCP	678.2	681.1	2.9

NOTES:
FC = Future Condition
WSE = Water Surface Elevation