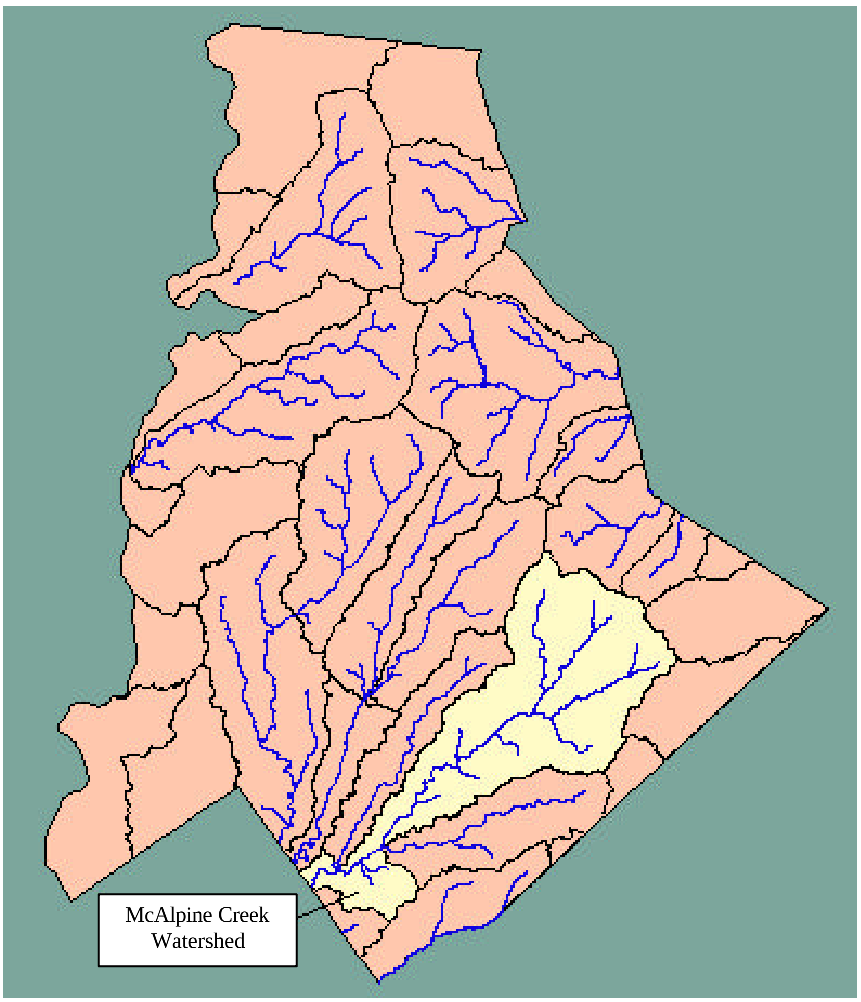
Watershed Study No. 5

McAlpine Creek Watershed

Preliminary Engineering Report

MCSWS Project No. 26005



March 2002

Prepared For:

Charlotte-Mecklenburg Storm Water Services

Prepared By:

WatershedConcepts
A Total Water Resource
6201 Fairview Rd., Suite 400
Charlotte, NC 28210

MECKLENBURG COUNTY
STORM WATER SERVICES

PRELIMINARY ENGINEERING REPORT
FOR
MECKLENBURG COUNTY MITIGATION PLANS

MCALPINE CREEK WATERSHED

ACKNOWLEDGEMENT

The project staff of Watershed Concepts, a Division of HSMM, Inc., would like to give thanks to Mecklenburg County Storm Water Services (MCSWS) for its assistance and support during this project.

DISCLAIMER

This watershed-wide study 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 Preliminary Engineering Report for Mecklenburg County Mitigation Plans was prepared by me or under my direct supervision.

Signed, sealed, and dated this _28th_ day of March 2002.

Joseph B Chapman

By: ______________________________
Joseph B. Chapman, P.E.
Senior Vice President

NORTH CAROLINA
PROFESSIONAL
SEAL
20506
ENGINEER
JOSEPH B. CHAPMAN

Mecklenburg County
Storm Water Services

Preliminary Engineering Report
for
Mecklenburg County Mitigation Plans

McAlpine Creek Watershed

Table of Contents

List of Tables

List of Figures

GLOSSARY

Term used in this report	Definition
100-year Flood	The flood that has a 1% probability of being equaled or exceeded in any given year (1% annual chance flood).
Base Flood Elevation (BFE)	Water surface elevation for the 1% probability flood (100-year flood).
Existing Conditions	The land use condition of the watershed based on the state of development as of the date of this study.
Existing Condition Floodplain (ECF)	The floodplain delineated for the 1% probability flood (100-year flood) using the current land use conditions in the watershed (existing conditions). The boundaries of this floodplain correspond to 100-year floodplain to be shown on the Flood Insurance Rate Maps (FIRMs).
Flood Fringe Areas	A buffer area bounded by the ECF (elevation of the BFE) and a point where the land elevation is 2 ft above the BFE.
Future Conditions	The land use condition of the watershed based on the projected ultimate buildout in the watershed. It was previously defined in Floodplain Land Use Maps (FLUMs) of Mecklenburg County.
Future 100-year Flood	The flood that has a 1% probability of being equaled or exceeded in any given year based on the future conditions land use information.
Future Condition Floodplain (FCF)	The floodplain delineated for the 1% probability flood (future 100-year flood). The boundaries of this floodplain correspond to the future 100-year floodplain to be shown on the Flood Insurance Rate Maps (FIRMs)

EXECUTIVE SUMMARY

MCALPINE CREEK WATERSHED

This Preliminary Engineering Report briefly describes a study of McAlpine Creek morphology, bank stability problems, flood hazard areas, and potential mitigation measures. Public records from the Mecklenburg County website, aerial photographs, and specific references listed at the end of this report have been consulted in preparation of this report. The gathering of information has been supplemented by several field visits, surveys, and photography of the areas under study.

Currently, the McAlpine Creek basin is highly developed, with about 88% of the lots in residential category and less than 10% of the lots vacant or under unspecified development. The watershed crosses the City of Charlotte in Mecklenburg County from east to west (Figure E1). Further development is expected in the watershed, and the ultimate fully developed condition of the watershed may be reached in the near future. The watershed of McAlpine Creek includes the tributaries of McAlpine Trib 1, McAlpine Trib 1A, Rea Branch, McAlpine Trib 3, Swan Run Branch, Sardis Branch, Irvins Creek (including Irvins Trib 1 and 2), Campbell Creek, and McAlpine Trib 6. McAlpine Creek and its tributary system are in a reasonably stable condition due to four main factors:

1. Stabilized banks to protect a shallow sewer main line extending along the creek. A second sewage trunk line will be installed deeper along the stream, also protected against washout.

2. Heavily vegetated banks and floodplains

3. Numerous road crossings and other man-made structures, including physical stabilization measures, that form grade controls and limit bank erosion, head cutting, and stream scour

4. Past stabilization efforts along the creek

Flooding potential within the current 100-year floodplain exists in 27 general neighborhoods on McAlpine Creek. A total of 109 buildings are affected, of which 30 experience inundation, and 79 are located in the flood fringe areas. A list of the affected buildings is given in Table E1. The flooded areas have been divided into 5 general reaches of the stream along McAlpine Creek, and shown in Figures E2 to E6 for a summary view of problem areas. Detailed discussions about all 27 areas are given in Section 3.5 of the report. Three mitigation measures are considered as viable alternatives for the 27 neighborhoods shown in Table E1 and Figures E2-E6: Elevating the structures above flood levels, floodwall construction, and acquisition of the property.

McAlpine Creek is approximately 21.5 miles long with an additional 24 miles of tributaries flowing into the main stem. The system extends in a general northeast to southwest direction south of downtown Charlotte, and crosses the city, county, and state lines south of the City of Charlotte. The banks and floodplains of McAlpine Creek and its tributaries are densely vegetated and occasionally heavily wooded, creating a stable stream. Flow is mostly shallow, wide, and tranquil in a well-defined floodway with relatively steep banks. McAlpine Creek watershed is highly urbanized, and will probably achieve its ultimate developed state some time within the decade. The greatest majority of development in the watershed is residential.

Table E1. Buildings within Existing 100 Year Floodplain							
No. of Struc-tures	Project Neighborhood/Area	No. Flooded	No. Not Flooded but within 2 ft	Ave Flood Depth*	Median Flood Depth*	Highest Flood Depth*	Lowest Flood Depth*
McAlpine Creek							
4	Vista Grande Cr/Vista Haven Dr	0	4	-1.08	-0.85	-0.7	-1.9
8	Eveningwood/Five Cedars/Kapplewood/Smoke Tree	1	7	-0.48	-1.20	4.10	-1.40
5	Bevington Woods/Stanton Green	0	5	-1.50	-1.60	-0.70	-1.80
2	Ryder Av/Shannon Willow Rd	0	2	-1.70	-1.70	-1.50	-1.90
2	Bentway Dr/Green Rea Rd	1	1	2.00	2.00	5.30	-1.30
8	River Ridge/Sentinel Post/Southridge	3	5	0.41	-0.60	3.30	-1.50
11	Dulverton Dr/Lancer Dr	3	8	-0.85	-1.20	0.30	-1.80
2	Old Providence Rd (just north of Lancer Dr)	1	1	0.30	0.30	1.60	-1.00
13	McAlp Trib 3: Cedar Croft/Cool Springs/Kirkstall/Knightswood/Providence Ln/Providence Rd/Rea/Rugby (Area is adjacent to Lancer area)	5	8	0.08	-0.40	3.20	-1.80
1	Landing View	1	0	4.50	4.50	4.50	4.50
4	Old Bell/Valleybrook/via Romano	2	2	1.13	1.00	4.20	-1.70
2	Thermal Rd/Terrace	1	1	2.35	2.35	5.50	-0.80
4	Margaret Wallace/Whitfield Dr	2	2	0.12	0.15	1.50	-1.10
1	Drifter Dr	1	0	1.00	1.00	1.00	1.00
Campbell Creek							
9	Lynfield/Idlebrook/Idlewild/Springfield	4	5	-0.36	-0.60	1.30	-1.90
2	Farm Pond Ln/Honeysuckle Ln	1	1	0.20	0.20	1.60	-1.20
Irvins Creek							
3	Gold Wagon	0	3	-0.67	-0.70	-0.10	-1.20
1	Pine Lake	0	1	-1.70	-1.70	-1.70	-1.70
6	Timber Ridge Dr	6	0	1.02	1.15	1.60	0.01
1	Apple Creek Dr	0	1	-1.40	-1.40	-1.40	-1.40
2	Lawyers Rd	2		1.75	1.75	3.40	0.10
Sardis Branch							
8	Beverly Cr/Cornwallis Ln/Sardis Rd	1	7	-1.00	-1.40	0.90	-1.8
1	Sardis Pointe	1	0	0.40	0.40	0.40	0.40
Swan Run Branch							
1	Blueberry Ln	1	0	1.20	1.20	1.20	1.20
1	Brookbury	0	1	-0.80	-0.80	-0.80	-0.80
Rea Branch							
1	Parview Dr	1	0	1.20	1.20	1.20	1.20
McAlpine Trib 6							
6	Old Meadow Rd/Riverton Ct	1	5	-0.95	-1.05	0.10	-1.90

* If flood depth <0, the building is above BFE but in flood fringe areas. Flood depth =(- 2).

The Rosgen stream classification system is utilized to provide an initial assessment of the morphology of McAlpine Creek. The majority of McAlpine Creek and its major tributaries are classified as type G channels with some reaches possibly being classified as type F. Generally, the channels display a low width/depth ratio, low sinuosity and relatively low channel slope. Evidence of a new bankful flow line were occasionally observed below the indicators that mark the historic top-of-bank, which implies that the channel has incised within the historic floodplain. This has most likely resulted from a combination of urbanization of the watershed and manual re-grading of the channel. The historic floodplain, which was formed as an alluvial plain bounded by gentle slopes of upland soils, currently forms a terrace that confines the channel.

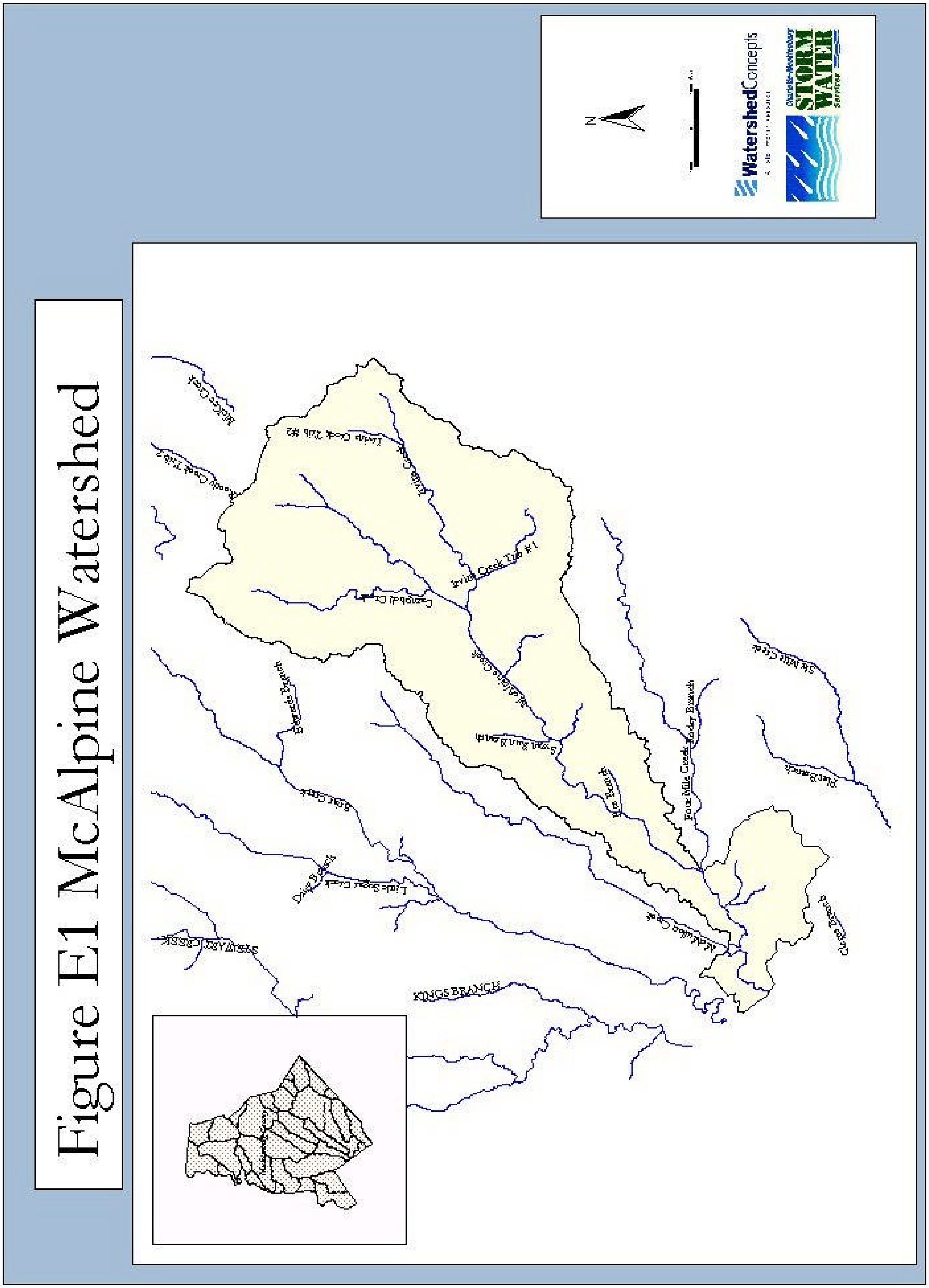


Figure E1 McAlpine Watershed

Mecklenburg County Department of Environmental Protection (MCDEP) maintains several monitoring stations along McAlpine Creek and its tributaries. While the Macroinvertebrate Taxa Richness sampling and the Fish Bioassesment sampling have included Poor and Fair ratings since 1995, the overall Water Quality Index has been ranking as Average to Excellent. The overall water quality has remained generally consistent in the watershed since 1996. There are two USGS maintained stream gages on McAlpine Creek and two additional gages on its tributaries.

Presently, there are several capital improvement projects in the watershed. These projects include two roadway improvements, several miles of greenway trail construction, addition of a second sanitary sewer line along the main stem of the creek, and many stormwater projects. Except for the roadway improvements of Albemarle Road at Campbell Creek, other projects are expected to have minimal impacts on the hydraulics of the creek. It is not known when the roadway improvement projects will be undertaken. A Letter of Map Revision may be needed before undertaking the Albemarle Road improvement project.

Three flood mitigation alternatives and a no-action alternative are considered as viable options for the affected buildings in the McAlpine Creek watershed. In order to determine the feasibility of any of these alternatives, a benefit:cost ratio analysis is performed. Whenever this ratio is less than 1.0, the no action alternative is recommended, and where the ratio exceeds 1.0, the respective alternative is recommended. Cases where the ratio is high but below 1.0 are pointed out for further analysis at a later date. Within the group of buildings of a mitigation project area, individual buildings with benefit:cost ratios above 1.0 are also identified for consideration for individual mitigation measures.

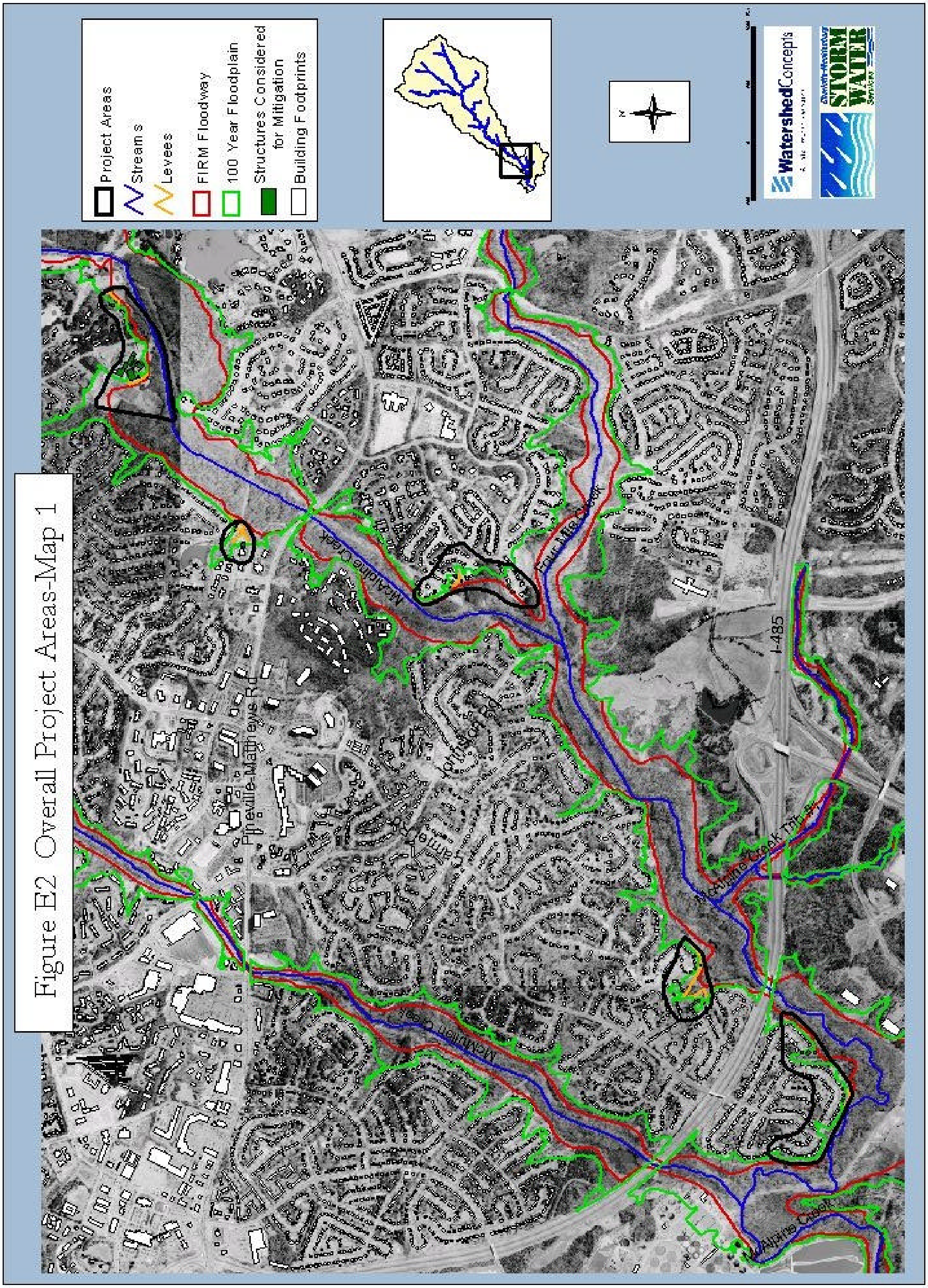


Figure E2 Overall Project Areas-Map 1
Project Areas
Streams
Levees
FIRM Floodway
100 Year Floodplain
Structures Considered for Mitigation
Building Footprints
McAlpine Creek
Four Mile Creek
Pineville-Matthews Rd
I-485
WatershedConcepts
STORM WATER

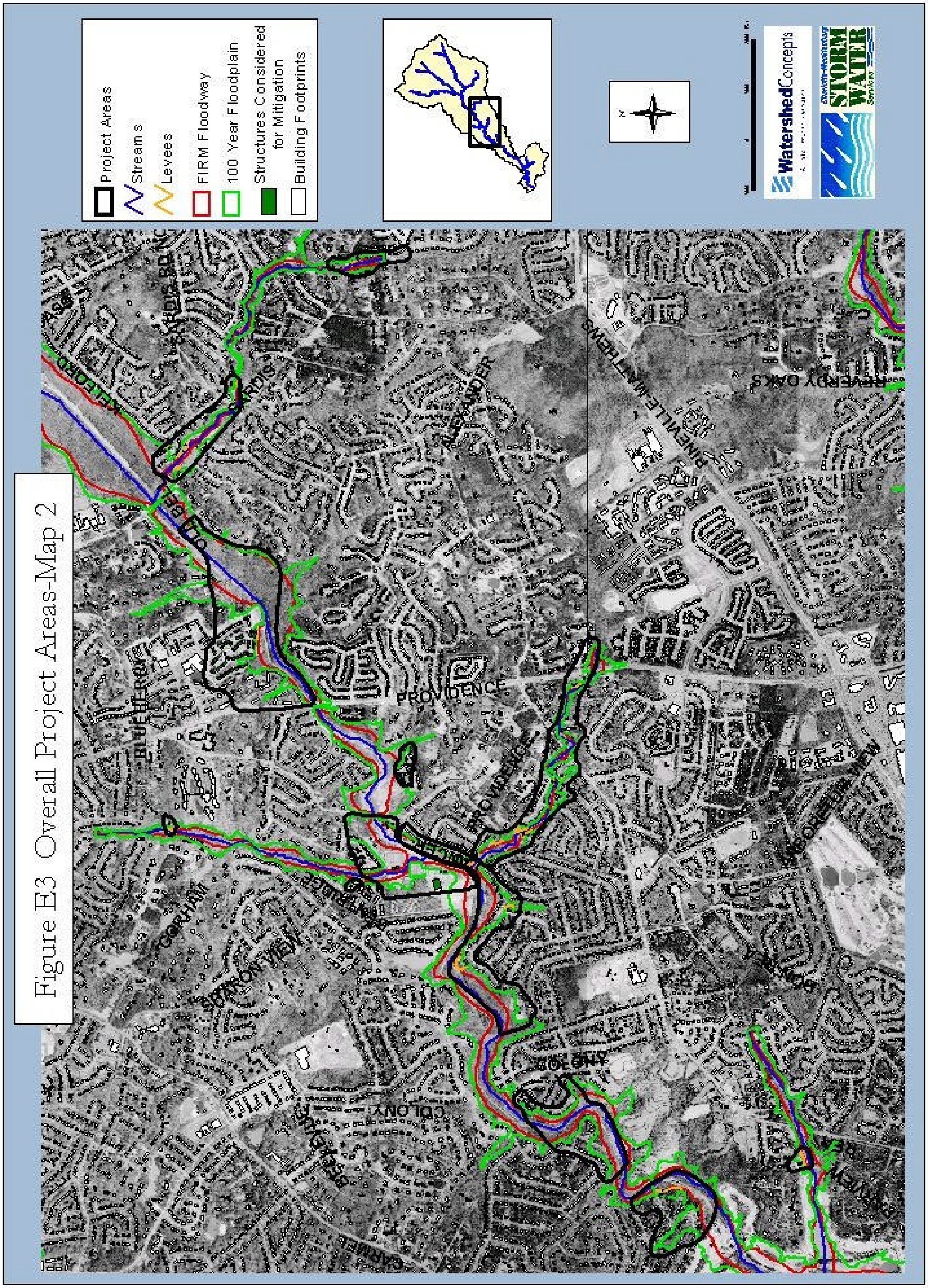


Figure E3 Overall Project Areas-Map 2

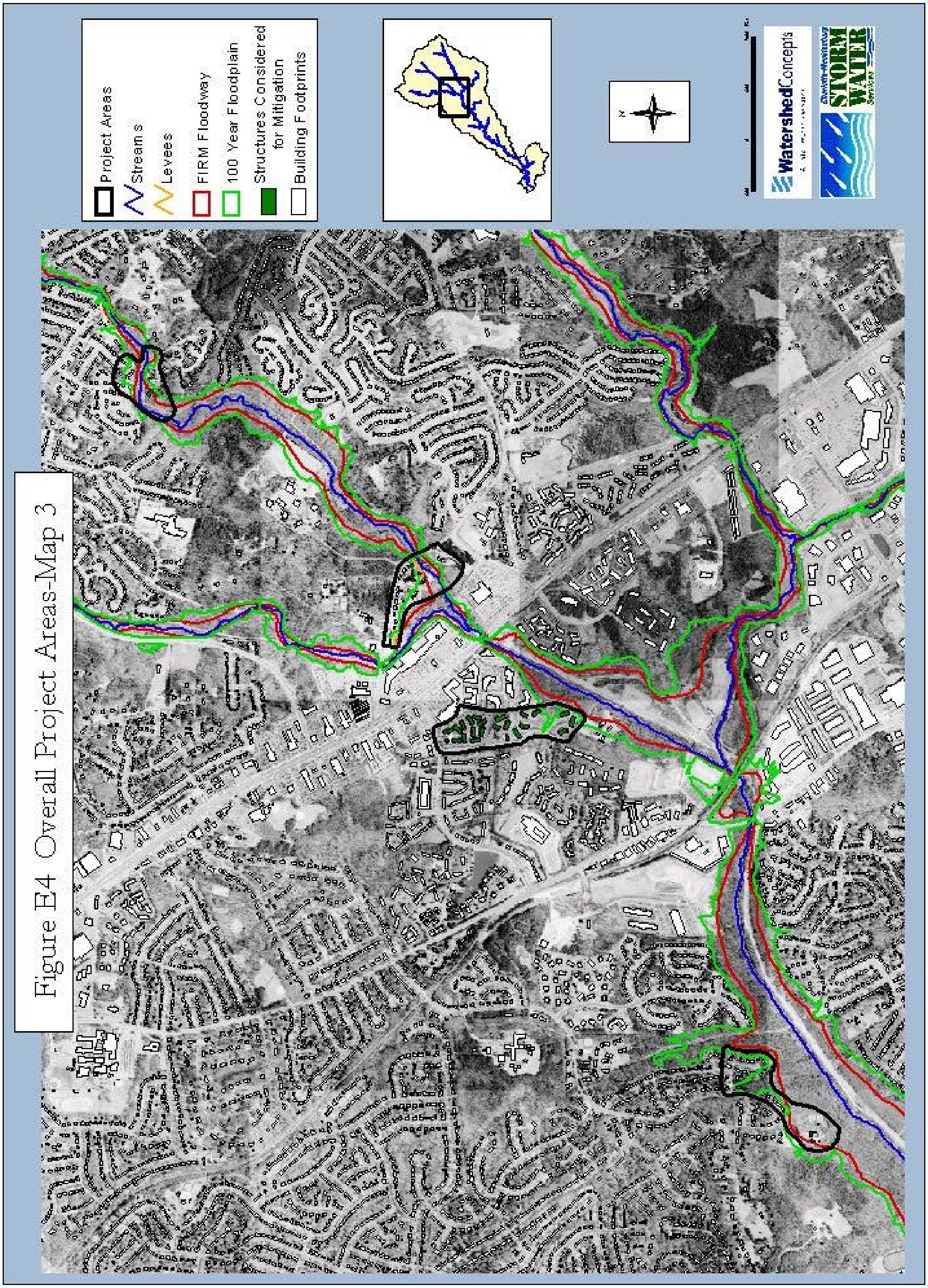


Figure E4 Overall Project Areas-Map 3

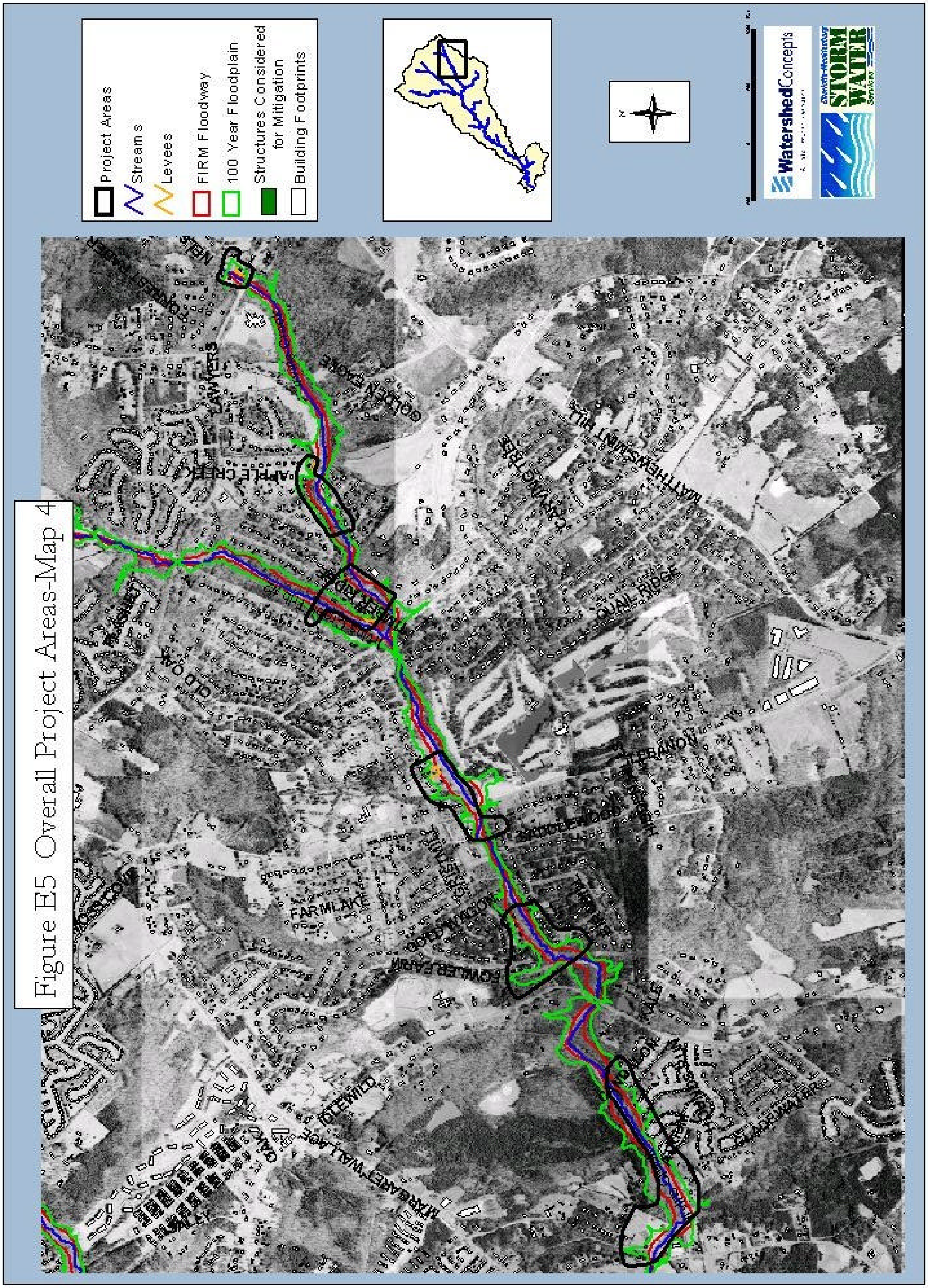


Figure E5 Overall Project Areas-Map 4

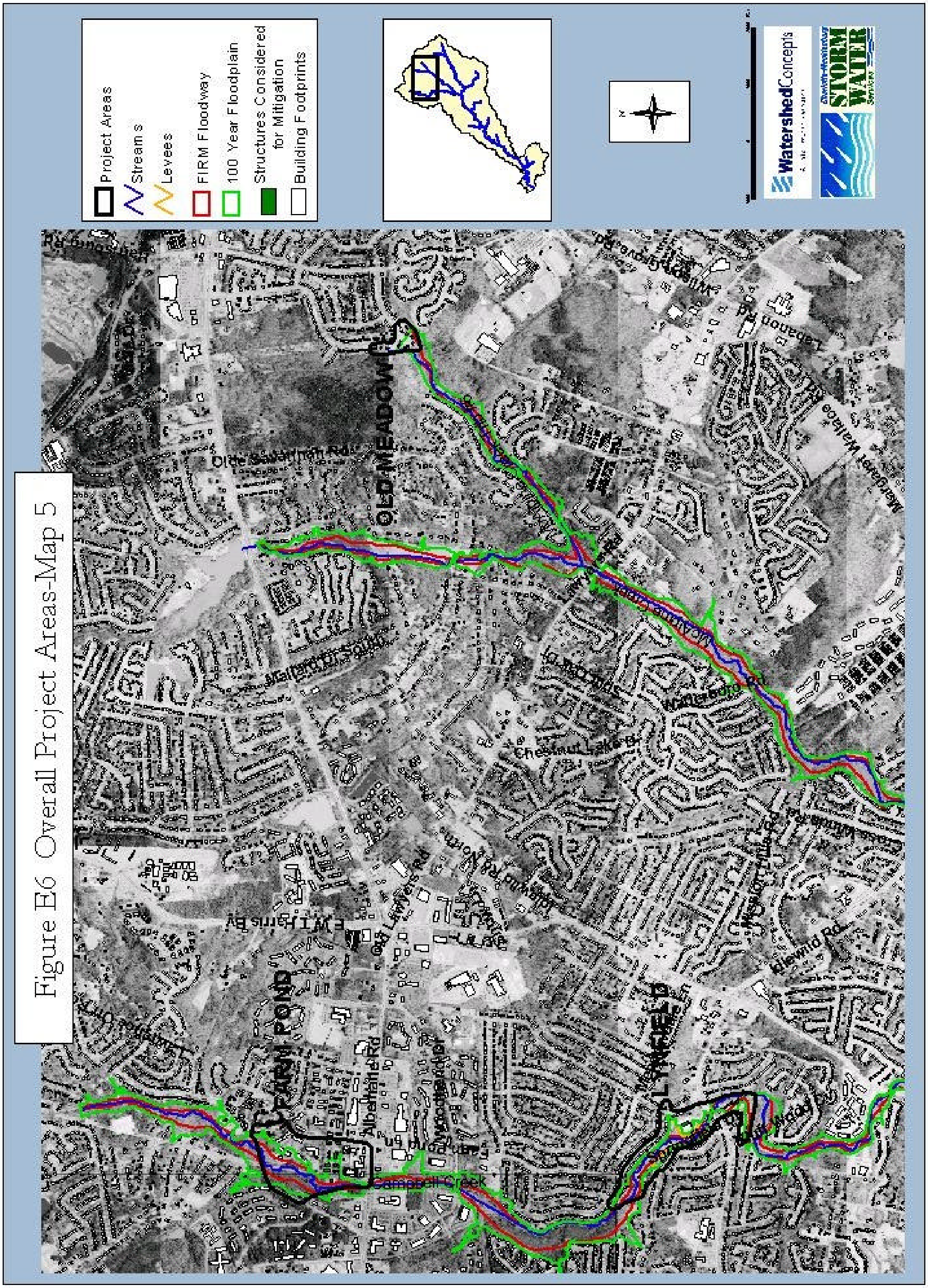


Figure E6 Overall Project Areas-Map 5

1. GENERAL WATERSHED CONDITIONS

1.1 Watershed Characteristics

The McAlpine Creek watershed is approximately 59.2 mi^2 in size which contains 21.5 miles of the main stem of McAlpine Creek, with an additional 24 miles of tributaries consisting of McAlpine Trib 1, McAlpine Trib 1A, Rea Branch, McAlpine Trib 3, Swan Run Branch, Sardis Branch, Irvins Creek (including Irvins Trib 1 and 2), Campbell Creek, and McAlpine Trib 6. The system flows in a general northeast to southwest direction through the City of Charlotte. McAlpine Creek joins McMullen Creek southwest of the city about 0.3 miles downstream of I-485. About 2.7 miles upstream of this confluence, Four Mile Creek flows into McAlpine Creek approximately 0.9 miles downstream of Pineville-Matthews Road crossing.

McAlpine Creek

Due to heavy development along McAlpine Creek, the stream is confined to a number of relatively straight segments in most of its reaches. The banks and floodplains are densely vegetated and in many parts heavily wooded. Figure 1 shows the stream at Lancer Drive, downstream of the confluence with McAlpine Trib 3. Figure 2 shows the creek east of Sardis Road, upstream of its confluence with Sardis Branch. At this location there is a greenway trail along the stream. Soil compaction, placement of riprap, and construction of concrete crossings for the greenway trail help stabilize the channel. There is also a sanitary sewer trunk line along the creek. In a typical section, the sanitary sewer trunk line is installed at or above the elevation of the bankful flow. To protect the sewer line against erosion and washout, soil has been compacted, channel has been realigned, banks have been re-graded, riprap has been placed on the toes, and vegetation has been established, all of which result in a stable channel at these locations. Remnants of the riprap, graded and vegetated banks are evident in Figure 1. This type of stabilization is present in most of the stream, from about Monroe Road to its end at the state line.

Fig. 1 Downstream of Trib 3 Confluence at Lancer Dr

Fig. 2 Upstream of Sardis Road

Rosgen classification of McAlpine Creek is presented in Section 1.4 of this report. Qualitative descriptions of the creek and its

Fig. 3 Upstream of Irvins Creek Confluence

Fig. 4 Near Riley Ridge Road

Fig. 5 Upstream of Trib 3 Confluence

tributaries are given in the following paragraphs. Under the base flow conditions, the flow is mostly tranquil as shown in Figures 1 to 4. Secondary sanitary sewer lines adjoining the main trunk line frequently cross the main stream as shown in Figure 4. Current plans are to eliminate these crossings, and to place them under the creek bed. In addition, from Sardis Road to Independence Road crossings there is a greenway trail along the creek, which helps stabilize the banks for reasons given above.

Heavy development along the stream limits the formation of a wide floodway and development of meanders and bends. However, occasionally the main channel bed tends to widen, allowing for the development of meanders and point bars in the bed as the stream attempts to form a new floodplain at a lower elevation. Figure 5 shows an example near Lancer Drive and Figure 6 shows the creek near Pineville-Matthews Road. The tendency to widen is more pronounced at the downstream reaches of the creek. It is the natural tendency of the stream to widen as the slopes decrease and flows increase due to adjoining tributaries.

The banks and floodplain of this stream are very well vegetated and stable. This is evident in the figures shown throughout this report. The main channel is entrenched. Banks generally have steep side slopes of about 1:1, held in place by trees, shrubs, grass, or other vegetation, or otherwise stabilized by human activity. The floodplain along most of this stream is gently sloping and generally heavily vegetated or wooded. Where human activity has eliminated or partially cleared the tree cover, the floodplain is fully grassed or is being gradually taken over by volunteer vegetation. Under the 100-year flood conditions, the water velocity near the fringes of the floodplain will be low, causing damage by inundation of the adjacent property rather than erosion or undercutting

Fig. 6 At Pineville-Matthews Road

Fig. 7 At Old Providence Road

Fig. 8 At Rileys Ridge Road

of the foundations. Figures 7 and 8 show the floodplain in two typical sections of the creek.

McAlpine Creek Tributaries

The tributaries of McAlpine Creek constitute longer total stream mileage than the McAlpine Creek main stem. The main tributaries are McAlpine Trib 1, McAlpine Trib 1A, Rea Branch, McAlpine Trib 3, Swan Run Branch, Sardis Branch, Irvins Creek (including Irvins Trib 1 and 2), Campbell Creek, and McAlpine Trib 6. The general geologic, hydrologic, climatologic and botanical conditions of these tributaries are very similar to those of McAlpine Creek. Therefore, the morphological characteristics of these streams also closely resemble those of McAlpine Creek. On two field visits on April 24, 2001 and June 29, 2001 the morphologic similarity of McAlpine Creek and its tributaries was studied and documented. In addition to similar morphology between the main stem and the tributaries, the general pattern of development along the streams is also very similar. Because of this similarity in behavior of the entire system, McAlpine Creek and its tributaries are treated as a single unit in this report.

1.2 Development in the Watershed

Intense development has occurred and is continuing along the entire length of McAlpine Creek and its tributaries. While construction is permitted only if built a minimum of 1 ft above the FCF, there are numerous previously existing homes or commercial buildings that are partially or entirely within the ECF or FCF. Figures 9 and 10 show two examples of homes currently lying within the ECF. The owner of the property in Figure 9 has attempted to protect the property by constructing a floodwall around the house, pool and the yard. Inspection of the property suggests that this dike would be inadequate for protection against

Fig. 9 At River Ridge Road

a 100-year flood. However, the levee will provide protection from smaller, more frequent storm events.

General statistics of development in the McAlpine Creek watershed are summarized in Table 1. The table includes temporal distribution of development in the watershed as well as the development type according to the information available as of the year 2000. Table 1 indicates that over 88% of the parcels in the basin are in single-family or other residential categories and less than 10% of the parcels are still undeveloped.

Table 1. Development in the McAlpine Creek Watershed*

	Year Developed					Total
	Before 1970	1970-1979	1980-1989	1990-2000	Not Specified	
Parcels	6,843	9,298	12,935	8,932	3,893	41,901
Percentage	16.3%	22.2%	30.9%	21.3%	9.3%	100%

	Land Use as of 2000				
	Single Family	Other Residential	Non-Residential	Vacant/ Unclassified	Total
Parcels	34,599	2,394	1,015	3,893	41,901
Percentage	82.6%	5.7%	2.4%	9.3%	100%

* Entire watershed, including all tributaries

Existing sanitary sewer trunk lines, completed in the mid 60's, are installed along the entire length of regulated portions of McAlpine Creek and its tributaries. Currently, CMUD has planned a second parallel relief sanitary sewer line for the main stem of McAlpine Creek, starting at Marlwood Circle, and extending to the confluence with McMullen Creek, about 0.3 miles downstream of I-485 crossing. Funds for this line have been identified, but construction has not started yet. A greenway trail will be constructed along the creek, which will be explained in more detail later. Developments of such trails are announced for public information, similar to the example shown in Figure 10.

A review of the capital improvement plans is completed for various City and County agencies including the following:

?? City and County Storm Water Services
?? Neighborhood Development
?? Charlotte Department of Transportation
?? Mecklenburg County Park and Recreation
?? Charlotte-Mecklenburg Planning Commission

A condensed view and lists of the capital improvement projects for Mecklenburg County is shown in Figure 11. A summary of the current CIP projects for the McAlpine basin is presented in Table 2. The exact effect of the CIP's listed in Table 2 cannot be known without a detailed study of each project. However, the expected effect of each project on the hydraulics of McAlpine Creek is given in Table 2 and briefly discussed below.

Table 2. Summary of Current CIP Projects for McAlpine Watershed

Type	Location		Impact on Hydraulics
Business Corridor Revitalization	Pence Road Streetscape		None – Outside of Study Area
	Albemarle Road Streetscape		Possible – At Campbell Creek Crossing
Roadway Improvements	20 Projects Scattered Over the Basin		None
Stormwater	Pence Pond Rehabilitation		Minimal for 100-year event
	Meadowdale SW CIP		Minimal for 100-year event
	Charleston/Monroe SW CIP		Minimal for 100-year event
	Kelly Street/Dallas Ave SW CIP		Minimal for 100-year event
	Braeburn Road SW CIP		Minimal for 100-year event
	Ronda Avenue SW CIP		Minimal for 100-year event
	Silver Stream/Windyrush SW CIP		Minimal for 100-year event
Neighborhood Development	Willora Lake		None
	Cityview		None
	Orchard Park		None
Greenway Trail	McAlpine Creek	16.8 mi	None
	Proposed	15 Mi	
	Completed	1.8	
	Under Construction	0.0	
	Campbell Creek	3.8 Mi	None
	Proposed	2.45	
	Completed	1.79	
	Under Construction	0.0	

The most significant impact on hydraulics of any of the CIP's listed in Table 2 is that of the Albemarle Road improvements. If modifications are proposed to the current twin 10-ft X 10-ft box culvert at Campbell Creek, there could be some impact. Enlargement of the culvert will increase conveyance, decrease upstream water surface elevations, but increase flooding downstream. Increasing the length of the culvert will have the opposite effect.

Next in importance to hydraulics of McAlpine Creek would be the various stormwater CIP's. These projects may have a more pronounced effect on the lower frequency, higher probability events. The significance of the stormwater improvement projects decrease as the recurrence interval of the storm event increases. As such, these projects are expected to have minimal effects on the 100-year or the 1% annual chance flood.

The greenway trails are next in significance of the CIP's listed in Table 2. These trails are typically created by clearing plants, stabilizing a pathway for pedestrians/bicyclists, and building structures for crossing over tributaries or depressions. While clearing and smoothing a trail result in higher conveyance for the stream, trail crossings obstruct flow and have an adverse effect on conveyance. However, most of the crossings are built low, and have minimal effects during large low-frequency storm events. For the purposes of this report, the effects of all CIP's on the hydraulics of McAlpine Creek are neglected. The effect of Albemarle Road improvements may be the subject of a Letter of Map Revision at the time of construction.

Fig. 10 Example of Proposed Greenway Trail

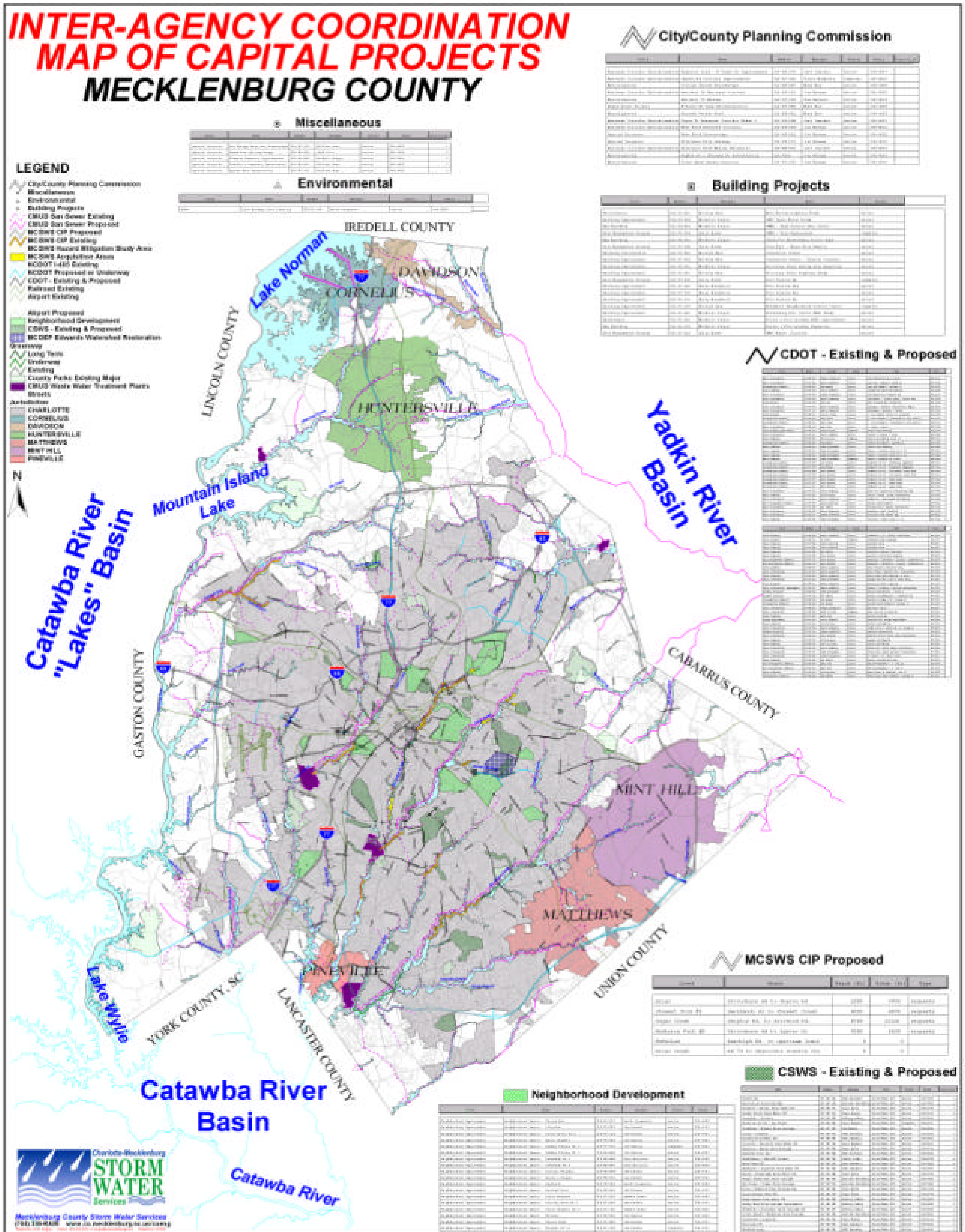


Fig. 11 Summary of the County Capital Improvement Projects

1.3 Aquatic Habitat and Environmental Monitoring

McAlpine Creek is subject to urban drainage, which includes fertilizers, domestic and industrial chemicals, oil and grease runoff from roads and railways, sediment inflows, and other materials that may steadily or accidentally enter the stream. The watershed may also experience cyclic or prolonged droughts lasting for weeks, months, or seasons. Under these conditions flows, may become very shallow with rapidly changing temperatures and constituent concentrations; the oxygen supply of the water may drop below the level to support aquatic life; and shallow rooted plants lining the banks and floodplains of the stream may die out, losing some of their trapping and filtering capacity. The combination of these factors result in an environment that is not conducive of a thriving fish population in the stream. However, other wildlife does exist in the watershed.

As shown in the photos of Figures 1-9 of this report, the heavy vegetation along the creek protects the banks from erosion and provides for a habitat for the survival of a variety of wildlife. In the visits to the stream in April and June 2001, numerous signs of the type and variety of riparian wildlife were observed. These included the singing of frogs, the teeth marks of beavers on trunks of smaller trees, footprints of small hoofed animals, and mammalian droppings that must have made the trip to the stream for their drinking needs. From these observations and the general environment of the watershed, the type of wildlife that could be expected to survive in the watershed can be deduced.

This report does not include a detailed study of the aquatic wildlife or land animals in the watershed. Aquatic wildlife in McAlpine Creek probably consists of certain species of fish that can survive in some reaches of the stream, especially in the lower reaches with higher flows, and certain invertebrate species or similar aquatic inhabitants of the creek. Other riparian wildlife includes frogs, lizards, turtles, and beavers. Because of the dense growth and the relative abundance of sanctuary, other types of wildlife that would survive in the watershed environment include birds, insects, rabbits, rodents, squirrels, and other dwellers of wooded areas. It is also natural to expect that other animals feeding on these creatures should be present. These would include snakes, foxes, birds of prey, and other small predators. From the field observations, it could also be concluded that deer still inhabit the McAlpine Creek watershed.

Mecklenburg County Department of Environmental Protection (MCDEP) maintains several monitoring stations along McAlpine Creek and its tributaries. A summary of the collected water quality data in 8 monitoring sites with relatively consistent records of data is shown in Table 3. The ratings shown in this table are based on scales used by MCDEP for assessing the quality of water in the streams of Mecklenburg County. Charlotte Mecklenburg Utilities also issues a yearly report outlining its water quality data. A reference for the year 2000 Water Quality Report is included in Section 5.

In reviewing Table 3, it should be noted that while the Macroinvertebrate Taxa Richness sampling and the Fish Bioassesment sampling include Poor and Fair ratings since 1995, the overall Water Quality Index has consistently ranked between Average and Excellent. The overall water quality has remained generally consistent in the watershed since 1995.

Table 3. MCDEP Water Quality Monitoring Summary									
NC Piedmont Macro-invertebrate Taxa Richness		1995		1996		1999		2000	
Site	Location	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating	S_{EPT}	WQ Rating
MC34	McAlpine Cr at Margaret Wallace Rd	9	Fair			5	Poor	2	Poor
MC35	Campbell Cr at Margaret Wallace Rd	3	Poor			5	Poor	1	Poor
MC36	Sam Newell Rd West of US Hwy 74					5	Poor	2	Poor
MC36A	Sam Newell Rd East of US Hwy 74					0	Poor	2	Fair
MC38	McAlpine Cr at Sardis Rd	4	Poor			5	Poor	1	Poor
MC39	McAlpine Cr at NC Hwy 51			2	Poor	5	Poor	2	Poor
MC45	McAlpine Cr at MC WWTP Hwy 521			5	Poor	5	Poor	2	Poor
MC45A	McAlpine Cr at Lancaster Hwy					5	Poor	2	Poor

Fish Bioassessment		June 1997	
Site	Location	NCIB I	WQ Rating
MC34	McAlpine Cr at Margaret Wallace Rd	42	Fair
MC35	Campbell Cr at Margaret Wallace Rd	46	Fair/Good
MC36	Sam Newell Rd West of US Hwy 74	44	Fair
MC36A	Sam Newell Rd East of US Hwy 74	42	Fair
MC38	McAlpine Cr at Sardis Rd	46	Fair/Good
MC39	McAlpine Cr at NC Hwy 51	48	Good
MC45	McAlpine Cr at MC WWTP Hwy 521	46	Fair/Good

Water Quality Index		May/Jun 96		May-97		May-98		Jul-99		Jun-00	
Site	Location	WQI	Rating	WQI	Rating	WQI	Rating	WQI	Rating	WQI	Rating
MC34	McAlpine Cr at Margaret Wallace Rd	74	Good	71	Good	70	Good	79	Good	72	Good/Exc.
MC35	Campbell Cr at Margaret Wallace Rd	72	Good	72	Good	80	Average	77	Good	70	Good/Exc.
MC36	Sam Newell Rd W of US Hwy 74	64	Good	65	Good/Exc.	66	Good/Exc.	61	Excellent	60	Excellent
MC36A	Sam Newell Rd E of US Hwy 74	70	Good	70	Good/Exc.	74	Good	70	Good	79	Good
MC38	McAlpine Cr at Sardis Rd	71	Good	74	Good	70	Good/Exc.	70	Good/Exc.	70	Good/Exc.
MC39	McAlpine Cr at NC Hwy 51	68	Good/Exc.	72	Good	68	Good/Exc.	74	Good	74	Good
MC45	McAlpine Cr at MC WWTP	63	Good/Exc.	72	Good	73	Good	73	Good/Exc.	81	Average
MC45A	McAlpine Cr at Lancaster Hwy	54	Excellent	54	Excellent	55	Excellent	51	Excellent	58	Excellent

There are four USGS maintained stream gages on McAlpine Creek as listed in Table 4. There are two additional USGS gages that monitor flows entering McAlpine Creek from McMullen and Four Mile Creeks. These gages are also listed in Table 4 for completeness.

Table 4. USGS Stream Gage sites at McAlpine Watershed

USGS Gage ID	Gage Location
02146562	Campbell Creek at Idlewild Rd
0214655255	McAlpine Creek at Idlewild Rd
0214657975	Irvins Creek at Sam Newell Rd
02146600	McAlpine Creek at Sardis Rd
02146750	McMullen Creek upstream of confluence with McAlpine
02146670	Four Mile Creek at Elm Lane

1.4. Rosgen Applied River Morphology Assessment

The Rosgen stream classification system is utilized to provide an initial assessment of the morphology of McAlpine Creek. The Rosgen system uses field measurements of stream features to describe a stream by morphologic type. An array of stream types is presented under the system that is delineated by slope, channel materials, width/depth ratio, sinuosity and entrenchment ratio. For the assessment of McAlpine Creek, the stream type is described at the geomorphic characterization level (Level I) of the hierarchical system of classification. At this level of inventory, the channel pattern, shape and slope are described (Rosgen, 1996). Information utilized as a part of this classification includes aerial photography, USGS Quadrangle maps, and other digital topographic information for investigation of the channel pattern and valley form. Additionally, field observations are made of the channel to identify geomorphic properties.

Table 5. Rosgen Level 1 Classification Parameters McAlpine Creek

Channel Length	113,542 ft
Downstream Invert	508.00 ft
Upstream Invert	682.75 ft
Channel Slope	0.15%
Valley Length	101,698 ft
Sinuosity	1.12
Average Bankful Depth	8 ft

The data for Rosgen classification of McAlpine Creek is summarized in Table 5. The majority of McAlpine Creek is classified as a type G channel with some reaches possibly being classified as a type F. Generally, the channel displays a low width/depth ratio, low sinuosity and relatively low channel slope. Evidence of a new bankful flow line were occasionally observed below the indicators that mark the historic top-of-bank, which implies that the channel has incised within the historic floodplain. This has most likely resulted from a combination of urbanization of the watershed and manual re-grading of the channel. The historic floodplain, which was formed as an alluvial plain bounded by gentle slopes of upland soils, currently forms a terrace that confines the channel.

The channel bank slopes are relatively steep with the slopes ranging from 1:1 to vertical. Despite these steep slopes the banks appear to be fairly stable. The cohesive bank material and dense riparian vegetation act to stabilize the banks and resist erosive forces. In some locations riprap has been placed along the toe of the banks to provide additional stability. Along reaches where riprap is not present and the bank material is less cohesive, channel widening processes are evident. This channel widening is resulting in an evolutionary transition to a type F channel. There are occasional reaches where the channel has developed sufficient belt width to begin to form a meandering pattern with stable point bars.

The channel profile is stable and not subject to excessive degradation or aggradation. There is evidence, however, of a significant sediment load that is being transported by the stream. Depositional features such as mid-channel bars, side bars and embryonic point bars are evident along many reaches of the stream. It is likely that the primary source of this depositional material is from construction activities within the watershed and that this material is being transported though the stream system without significant aggradation of the channel bed.

1.5 Bank Stability Problem Identification

As described before, the stream and its tributaries have wide densely vegetated floodplains for almost all of their lengths. Although there is still room for some new development along the stream (or the tributaries), there is fairly dense urban development elsewhere on the stream. The floodplains and the channels themselves are well vegetated and stabilized along such developed reaches of the streams. Typically, the main channel is stabilized by human activity such as riprap or other bank protection techniques and structures. The system is in a stable state.

As stated before, deposition of sediments was observed in field visits to McAlpine Creek in April and June 2001. Some of the deposition was in the form of alternate bars on the stream as shown in Figures 5 and 6. Most of the sediment load of the stream is likely caused by the construction activity, since there is good vegetative cover along the stream. In general, bank instability is not a major problem along McAlpine Creek.

2. BENEFIT:COST ECONOMIC ANALYSIS

2.1 Riverine Flood Model Overview

FEMA's Riverine Flood Model (Version 1.11, February 1996) is utilized to perform flood damage and benefit:cost analysis. This model is based on Quattro-Pro spreadsheet and its results are consistent with Mecklenburg County's previous analyses that used the same program. In this model, built-in probability based damages are calculated for a structure given the finished floor elevation along with the flood risk of that structure. The model calculates benefits (damages avoided by undertaking a certain mitigation measure) vs. the estimated cost of that particular mitigation measure.

Structures analyzed for potential flood damage are those buildings with finished floor elevations below, or within 2 ft of, the BFE (defined as flood fringe areas). There is a total of 109 buildings in the McAlpine Creek watershed that fit into these categories. The benefit:cost model estimates damages on the basis of the 10-, 50- 100- and 500-year floods and calculates damages for potentially flooded structures even when the finished floor elevation of a structure falls above the current BFE. The flood elevations are determined using the US Army Corps of Engineers model HEC-RAS (Version 2.2, March 1999). The future 100-year flood elevations are based on the County's projected land use estimates for the year 2020.

The benefit:cost model utilizes two levels of data input, a level 1 with minimal data requirements (using default values) and a level 2, with detailed data regarding a structure's type, use, replacement value, contents value, and relocation costs. For the purposes of this study, level 2 analysis is adopted for two reasons: 1) this level of analysis produces more realistic damage estimate information, and 2) the analyses are consistent with the County's previous benefit:cost analyses. The program uses the input flood elevations and flows to determine a probabilistic estimate of the damages to the structure based on the finished floor elevation of the structure.

2.2 Economic Data

To perform the level 2 benefit:cost analysis, the model utilizes several attributes and values for each structure. This type of information is gathered for each affected structure from the GIS data at the Mecklenburg County website. Information provided to the model includes:

Building Type: Structures are categorized as single story without basement, two-story with basement, etc. The structure type is used by the model for selecting the specific built-in lookup table for flood depth vs. damage.

Building Value: The building values as given in the Mecklenburg County GIS site are multiplied by 1.25 to reflect the building values in 2001 dollars. These values are used as the replacement values for the affected structures.

Content Value: The content value of each structure is assumed to be 25% of the current (2001) replacement value of the structure. This assumption is consistent with the previous benefit:cost analyses of Mecklenburg County.

Floor Elevation: For each affected structure, the elevation of the lowest finished floor is provided to the model. The model uses this parameter as the zero damage elevation for the structure. The finished floor elevation data are obtained from the Mecklenburg County GIS data and elevation certificates developed for Mecklenburg County over the past several years.

Relocation Cost: A constant relocation cost per household is used as the basis for economic analysis. This relocation cost is determined by Mecklenburg County and has been used in their previous benefit:cost analyses.

The present value of all benefit and cost figures are calculated using a 7.0% discount rate, a 30-year project life for the elevate and levee mitigation option, and a 100-year project life for the acquisition option. These assumptions are consistent with the specifications of the Riverine Flood Model (1996, p. 6-15).

2.3 Hydraulic Data

In order to determine the level of flooding at each structure, the model requires flow and elevation data to be entered for 10-, 50-, 100-, and 500-year floods. This information already exists for McAlpine Creek from HEC-RAS modeling of the creek performed earlier by Watershed Concepts. However, HEC-RAS output files list elevations at specific cross sections along the stream. Therefore, water surface elevations had to be interpolated for each individual structure by determining the location of the structure relative to nearby cross sections, and interpolating the water surface elevations and discharges between those cross sections. The flows and their corresponding water surface elevations are the required data for the model to determine flood damages to each structure.

2.4 Modeling Process

The benefit:cost model includes a series of default depth-damage curves based on nationwide flood loss information. Specific depth-damage curves for Mecklenburg County were developed and used for this analysis utilizing flood loss data from the storm event of July 1997. Damages to each structure are calculated by the model based on the flood depth above the finished floor elevation of the structure, and the probability (or frequency) of occurrence of that flood in a given span of time. Damages are annualized for the benefit:cost analysis.

2.5 Economic Analysis

For any mitigation measure considered, the *damages* as determined by the benefit:cost program become the *benefits* of adopting that mitigation measure. In other words, assuming the mitigation measure completely eliminates the flooding problem for a given structure, the *avoided* flooding damage is the benefit derived from that particular mitigation measure. This benefit, when compared to the cost of undertaking the mitigation measure, constitutes the basis for the benefit:cost analysis. A benefit to cost ratio of 1.0 or higher is considered cost-effective when evaluating projects for implementation. Ratios lower than 1.0 for a potential mitigation measure would not be cost-effective. In Section 3 of this report those structures for which the benefit:cost ratio is close to 1.0 are flagged so that they can be studied in more detail in the future.

Alterations to the drainage system (such as enlarging a culvert) are not considered as viable options due to the fact that they might resolve the flooding problem at an upstream location, but may create new flooding problems downstream. Such alternatives should not be considered without a full hydraulic analysis of the entire drainage system. The only structural mitigation measure considered in the McAlpine Creek basin is the construction of flood barrier levees, as described in the next section of the report.

After consultation with Mecklenburg County, it was determined that mitigation measures would be more effective if they protected a neighborhood or flooded area rather than individual buildings. The County preferred the concept of mitigation projects, whereby the mitigation measures were considered for the improvement of a logical "project area" or a neighborhood. On the basis of this concept, the mitigation measures are proposed for project areas (or problem neighborhoods). A total of 27 such project areas is identified for the McAlpine Creek basin as described in the next section of the report. Individual units within each group with a benefit:cost ratio larger than 1.0 for a particular mitigation measure are flagged. These buildings may be individually considered for flood damage mitigation.

2.6 Improvements

There are flooding problems (inundation) and potential flooding locations (buildings in the flood fringe areas) for 109 buildings in the McAlpine Creek basin. These buildings are grouped into 27 neighborhoods as presented in the next section of this report. Preliminary analyses indicated that only structural improvements in the affected areas to reduce or eliminate the flooding problem would be feasible, and the least expensive mitigation measures would be the only feasible ones. Therefore three basic mitigation measures are considered for this basin: Elevating the structure, acquisition, or flood barriers (levees). Acquisition proved not to be economically feasible for any of the identified neighborhoods. However, elevation of the structures or construction of flood barriers proved to be feasible solutions in a number of flooded neighborhoods. Detailed analysis of these improvement measures are presented in the next section of the report.

3. FLOOD HAZARD MITIGATION

3.1 FEMA Regulated Stream Service Requests

There have been 2389 service requests filed through the City/County Customer Service system hotline (336-RAIN) in the McAlpine Creek watershed. Table 6 summarizes the flood related service requests by the service type. A total of 70 of the service requests were for buildings that are identified in this study as having a flood potential, i.e., the building footprints are located within ECF. Out of that group, 10 of the service requests were for buildings that actually did have flooding potential i.e., they were flooded or were within the flood fringe areas. This group ias among the structures for which benefit:cost analysis is carried out.

Table 6. Service Requests in McAlpine Creek Basin

Type of Service Requested	Frequency	No. in Potential Flood Zone[1]	No. in B:C Analysis[2]
Critical Blow-out	25	0	0
Blow-out	180	8	0
Tail Ditching	187	3	0
Pipe Outlet Repair	36	2	0
Channel Cleaning	757	22	5
Channel Erosion Maintenance	718	20	3
Other Maintenance	90	0	0
Capital	58	0	0
Street Maintenance	19	0	0
Yard Flooding	76	1	0
Not Specified	243	14	2
Totals	**2389**	**70**	**10**

[1] Structures whose footprints intersected with the flood boundaries

[2] Structures that were analyzed for benefit:cost ratio for mitigation measures

3.2 Repetitive Loss Structures

Table 7. Repetitive Loss Data

No. of Properties	3
Total No. of Claims	28
Date Earliest Claim	March 23, 1979
Date Last Claim	July 23, 1997
No. of Claims Paid	22
Bldg. Damages Paid	21 for $186,323
Content Damages Paid	14 for $78,300
Total Damages Paid	$264,623

According to FEMA records, there are three repetitive loss sites in McAlpine Creek watershed, all of which are residential. A total of 28 claims were filed by the residents in the three houses from 1979 to 1997, of which 6 were denied. The repetitive loss data are summarized in Table 7. In 8 cases the paid damages were only for the building, and in one case the damage was only for the contents. Other claims were paid for both the building and the contents.

3.3 Permanent Storm Water Easements

There are no permanent Storm Water Easements in the McAlpine Creek watershed that provide access to the creek or its tributaries.

3.4 Roadway Overtopping Problem Locations

From HEC-RAS modeling results of McAlpine Creek basin, roadway overtopping locations are investigated based on the current and future 100-year flood conditions. Table 8 summarizes the roadway overtopping problem locations for the study streams and tributaries. Listed below are several conclusions and recommendations that can be derived from studying the flood depths shown in Table 8:

1. Considering the fact that a flow depth of 24 inches (2 ft) can sweep away a moving vehicle, there will be several problem locations in case of a 100-year flood. In Table 8, seven of the listed sites will have flood depths of 2 ft or higher under the ECF and an additional six sites will experience this problem under the FCF. Of particular notice is the gravel path near Sardis Road at Sardis Branch, which will be under 8 and 10.2 ft of water, respectively, for the two flood conditions due to backwater effects from McAlpine Creek. Fortunately, that road may not be a frequently traveled road by the general public. Noticeable in Table 8 are also several road crossings where the flood depths are 4 ft or higher. Except for the gravel path where the high water depth is due to backwater, other large flood depths will be associated with moving water, and a serious hazard, capable of sweeping vehicles off the road. Among measures to mitigate this hazard are warning signs for the approaching motorists and consideration for raising the elevation of the stream crossing as a future CIP for the Charlotte DOT. In other problem crossings where depths are below 2 ft, there are still considerable depths of flow, ranging from 1.3 to 1.9 ft of flowing water. Only in two of the crossings are depths within a fraction of a foot. In all problem areas listed in Table 8 warning signs would be highly recommended to alert motorists to avoid the crossing in case of a flood.

2. Flood hazards at road crossings could be minimized by making sure that the culverts and bridges along the entire stream system have the maximum capacity to pass the flood flows. Natural conditions in the McAlpine watershed favor rapid plant cover on sediment depositions both upstream and downstream of road crossings. This may result in stabilized soil, limiting the capacity of culverts and bridges. Regular maintenance schedules should be established at all stream crossings to assure that sediment and other debris such as fallen trees or urban trash do not collect at the upstream face of the culverts and bridges, compromising their flow capacity.

3. Guardrails (or other indicators) should be provided at all problem sites such that drivers could be guided away from the edge of the road in case of a flood. The protection should be adequate so that if a vehicle is stranded or swept away, it can be stopped by the guardrail, preventing the vehicle from entering deeper flow regions and allowing for rescue crews to reach the stranded vehicle.

4. Depth sensors and a relay system may be installed on or near the crossings such that it would alert emergency response teams to the high water depth and allow them to re-route traffic or prepare for emergencies at the site.

Table 8. Roadway Overtopping Problem Locations							
Stream/Road Crossing	**Crossing Structure Type**	**Culvert Size No. @ Size (ft)**	**Top of Road Elevation (ft NAVD)**	**100-Yr Flood Elevation Existing (ft NAVD)**	**Flood Depth Existing (ft)**	**100-Yr Flood Elevation Future (ft NAVD)**	**Flood Depth Future (ft)**
McAlpine Creek							
Carmel Cntry Cl #1	Culvert	1 Irregular	546.0	545.1	--	549.0	3.0
Carmel Cntry Cl #3	Culvert	1 Irregular	548.6	548.0	--	550.0	1.4
Lawyers Rd	Culvert	3@ 9X12	667.5	667.4	--	669.0	1.5
Marlwood Cir	Culvert	1@ 3.5 Cir	681.8	683.8	2.0	683.9	2.1
McAlpine Trib 3							
Heatherford Rd	Culvert	1@22.8X8.5 Arch	565.2	565.8	4.2	566.1	5.3
Rea Road	Culvert	2@ 7 Cir	572.1	574.0	1.9	574.5	2.4
Cedar Croft Dr	Culvert	1@ 8 Cir	589.0	592.4	3.4	592.8	3.8
Rea Branch							
N Parview Dr	Culvert	2@ 14X8.5	556.0	556.0	--	556.2	0.2
Rea Road	Culvert	2@ 7 Cir	558.0	559.9	1.9	560.0	2.0
Sardis Branch							
Gravel Path near Sardis Rd	Culvert	1 @ 8.5X6 Arch	565.8	573.8*	8.0	576.0*	10.2
8302 Rittenhouse Cir	Culvert	2@ 3.5 Cir	596.0	598.8	2.8	599.1	3.1
Sardis Road	Culvert	2@ 7.5X7.5	635.5	635.0	--	635.9	0.4
Irvins Creek							
Beaver Dam Ln	Culvert	5@ 5.5 Cir	668.3	669.8	1.5	671.1	2.8
Timber Ridge Dr	Culvert	2@ 5 Cir	672.0	673.7	1.7	674.0	2.0
Apple Creek Dr	Culvert	3@ 7.5 Cir	677.7	679.0	1.3	680.0	2.3
Irvins Trib 1							
Sam Newell Rd (1-2)	Culvert	1 @ 16X7.5 Arch	639.9	642.0	2.1	643.3	3.4
Sam Newell Rd (1-7)	Culvert	1@ 5 Cir	638.2	642.5	4.3	644.0	5.8

* Backwater from McAlpine Creek

3.5 Flood Mitigation Improvement Analysis

The McAlpine Creek basin is in a mature state of development. There are many buildings in this basin that have been built within the ECF prior to restrictions being put in place. Based on the latest county elevation certificate data and survey results, a total of 109 buildings in this basin would have a flooding potential (finished floor elevation below BFE or in flood fringe areas). The flooding information about these structures is summarized in Table 9. These structures are grouped into project areas as explained in Section 2 of this report. The highest flood depth shown in Table 9 is 5.5 ft and the lowest is –1.9 ft (i.e., finished floor elevation is 1.9 ft above the BFE).

Table 9. Summary of Data on Structures with Flooding Potential							
No. of Struc-tures	Project Neighborhood/Area	No. Flooded	No. Not Flooded but within 2 ft	Ave Flood Depth*	Median Flood Depth*	Highest Flood Depth*	Lowest Flood Depth*
McAlpine Creek							
4	Vista Grande Cr/Vista Haven Dr	0	4	-1.08	-0.85	-0.7	-1.9
8	Eveningwood/Five Cedars/Kapplewood/Smoke Tree	1	7	-0.48	-1.20	4.10	-1.40
5	Bevington Wood/Stanton Green	0	5	-1.50	-1.60	-0.70	-1.80
2	Ryder Av/Shannon Willow Rd	0	2	-1.70	-1.70	-1.50	-1.90
2	Bentway Dr/Green Rea Rd	1	1	2.00	2.00	5.30	-1.30
8	River Ridge/Sentinel Post/Southridge	3	5	0.41	-0.60	3.30	-1.50
11	Dulverton Dr/Lancer Dr	3	8	-0.85	-1.20	0.30	-1.80
2	Old Providence Rd (just north of Lancer Dr)	1	1	0.30	0.30	1.60	-1.00
13	McAlp Trib 3: Cedar Croft/Cool Springs/Kirkstall/Knightswood/Providence Ln/Providence Rd/Rea/Rugby (Area is adjacent to Lancer area)	5	8	0.08	-0.40	3.20	-1.80
1	Landin g View	1	0	4.50	4.50	4.50	4.50
4	Old Bell/Valleybrook/via Romano	2	2	1.13	1.00	4.20	-1.70
2	Thermal Rd/Terrace	1	1	2.35	2.35	5.50	-0.80
4	Margaret Wallace/Whitfield Dr	2	2	0.12	0.15	1.50	-1.10
1	Drifter Dr	1	0	1.00	1.00	1.00	1.00
Campbell Creek							
9	Lynfield/Idlebrook/Idlewild/Springfield	4	5	-0.36	-0.60	1.30	-1.90
2	Farm Pond Ln/Honeysuckle Ln	1	1	0.20	0.20	1.60	-1.20
Irvins Creek							
3	Gold Wagon	0	3	-0.67	-0.70	-0.10	-1.20
1	Pine Lake	0	1	-1.70	-1.70	-1.70	-1.70
6	Timber Ridge Dr	6	0	1.02	1.15	1.60	0.01
1	Apple Creek Dr	0	1	-1.40	-1.40	-1.40	-1.40
2	Lawyers Rd	2	0	1.75	1.75	3.40	0.10
Sardis Branch							
8	Beverly Cr/Cornwallis Ln/Sardis Rd	1	7	-1.00	-1.40	0.90	-1.8
1	Sardis Pointe	1	0	0.40	0.40	0.40	0.40
Swan Run Branch							
1	Blueberry Ln	1	0	1.20	1.20	1.20	1.20
1	Brookbury	0	1	-0.80	-0.80	-0.80	-0.80
Rea Branch							
1	Parview Dr	1	0	1.20	1.20	1.20	1.20
McAlpine Trib 6							
6	Old Meadow Rd/Riverton Ct	1	5	-0.95	-1.05	0.10	-1.90

* If flood depth <0, the structure is above BFE but in flood fringe areas. Flood depth =(- 2).

The claims filed by the property owners in the neighborhoods identified in Table 9 are summarized in Table 10. The total amount of damages paid as a result of these claims exceeds $500,000, as shown in Table 10.

Three flood mitigation measures are recognized as the only viable options for the structures shown in Tables 9 and 10. These measures are the acquisition option, elevating the finished floor of the structure two feet above the BFE, or construction of a berm or dike to contain the floodwater. The benefit:cost analysis for 27 project areas summarized in Figures E2 to E6, are performed using the standard methods described in FEMA's Manual 259, Engineering Principles and Practices for Retrofitting Flood Prone Residential Buildings (FEMA, January 1995), and the Riverine Flood model (Version 1.11, February 10, 1996) developed by FEMA. The summary of the benefit:cost analysis is shown in Table 11. More detailed discussion of project areas and individual structures are shown in greater detail in the remainder of this report.

Table 10. Flood Related Claims in McAlpine Creek Watershed					
Project Neighborhood/Area	No. of Structures	No. of Policies	No. of Claims Paid	No. of Claims Not Paid	Amount Paid (Dollars)
McAlpine Creek					
Vista Grande Cr/Vista Haven Dr	4	0	0	0	0.00
Eveningwood/Five Cedars/Kapplewood/Smoke Tree	8	0	0	0	0.00
Bevington Wood/Stanton Green	5	0	0	0	0.00
Ryder Av/Shannon Willow Rd	2	0	0	0	0.00
Bentway Dr/Green Rea Rd	2	1	0	0	0.00
River Ridge/Sentinel Post /Southridge	8	6	11	4	439,703.00
Lancer Dr/Dulverton Dr	11	5	4	2	39,296.00
Old Providence Rd (just north of Lancer Dr)	2	1	1	1	622.00
McAlp Trib 3: Cedar Croft/Cool Springs/Kirkstall/Knightswood/Providence Ln/Providence Rd/Rea/Rugby (Area is adjacent to Lancer area)	13	2	1	1	1,007.00
Landing View	1	0	0	0	0.00
Old Bell/Valleybrook/Via Romano	4	2	3	0	14,658.00
Thermal Rd/Terrace Dr	2	1	0	0	0.00
Margaret Wallace/Whitfield Dr	4	2	0	1	0.00
Drifter Dr	1	0	0	0	0.00
Subtotal McAlpine Creek					**495,286.00**
Campbell Creek					
Lynfield/Idlebrook/Idlewild/ Springfield	9	1	0	0	0.00
Farm Pond Ln/Honeysuckle Ln	0	0	0	0	0.00
Subtotal McAlpine Creek					**0.00**
Irvins Creek					
Gold Wagon	3	3	3	0	8,563.00
Pine Lake	1	1	0	0	0.00
Timber Ridge Dr	6	2	2	1	3,948.00
Apple Creek Dr	1	0	0	0	0.00
Lawyers Rd	1	0	0	0	0.00
Subtotal Irvins Creek					**12,511.00**
Sardis Branch					
Beverly Cr/Cornwallis Ln/Sardis Rd	8	1	0	0	0.00
Sardis Pointe	1	0	0	0	0.00
Subtotal Sardis Branch					**0.00**
Swan Run Branch					
Blueberry Ln	1	0	0	0	0.00
Brookbury	1	0	0	0	0.00
Subtotal Swan Run Branch					**0.00**
Rea Branch					
Parview Dr	1	0	0	0	0.00
Subtotal Rea Branch					**0.00**
McAlpine Trib 6					
Old Meadow Rd/Riverton Ct	6	0	0	0	0.00
Subtotal McAlpine Trib 6					**0.00**
Grand Total Mc Alpine Watershed					**507,797.00**

Table 11. Summary of the Benefit:Cost Analysis For the 27 Mitigation Project Areas										
		Mitigation Options*								
		Acquisition			**Elevation**			**Levee**		
No. of Structures	**Project Neighborhood/Area**	**Benefit**	**Cost**	**B:C**	**Benefit**	**Cost**	**B:C**	**Benefit**	**Cost**	**B:C**
McAlpine Creek										
4	Vista Grande Cr/Vista Haven Dr	12,797	553,032.	0.023	7,667	165,080	0.046	10,756	NA	NA
8	Eveningwood/Five Cedars/Kapplewood/Smoke Tree	115,872	1,026,335	0.113	60,974	306,420	0.199	98,671	204,049	0.484
5	Bevington Wood/Stanton Green	14,289	1,105,680	0.013	8,418	257,530	0.033	11,888	NA	NA
2	Ryder Av/Shannon Willow Rd	13,340	700,468	0.019	5,953	551,719	0.011	10,203	130,873	0.078
2	Bentway Dr/Green Rea Rd*	2,992,306	4,435,9	0.675	1,548,590	201,052	**7.702**	2,496,255	121,629	**20.52**
8	River Ridge/Sentinel Post*/Southridge	421,410	3,125,706	0.135	278,715	667,550	0.418	358,531	NA	NA
11	Dulverton Dr/Lancer Dr	78,768	2,225,538	0.035	41,522	599,231	0.069	62,902	344,626	0.183
2	Old Providence Rd (just north of Lancer Dr)	62,883	426,028	0.148	45,670	89,070	0.513	54,231	NA	NA
13	McAlp Trib 3: Cedar Croft*/Cool Springs/Kirkstall/Knightswood/Providence Ln/Providence Rd/Rea*/Rugby (Area is adjacent to Lancer area)	929,527	2,328,312	0.399	795,479	760,732	**1.046**	808,246	NA	NA
1	Landing View	143,200	224,741	0.637	68,274	55,200	**1.237**	120,594	36,642	**3.291**
4	Old Bell/Valleybrook/via Romano	354,816	7,093,858	0.050	210,862	748,679	0.282	NA	NA	NA
2	Thermal Rd/Terrace	304,284	669,643	0.454	147,652	505,611	0.292	255,098	NA	NA
4	Margaret Wallace*/Whitfield Dr	76,810	535,754	0.143	62,937	157,012	0.401	66,519	NA	NA
1	Drifter Dr	16,337	115,962	0.141	12,681	40,314	0.315	14,186	NA	NA
Campbell Creek										
9	Lynfield/Idlebrook/Idlewild/Springfield	93286	1358120	0.069	74893	788998	0.095	80942	NA	NA
2	Farm Pond Ln/Honeysuckle Ln*	57585	1872653	0.031	37305	1882353	0.020	48441	NA	NA
Irvins Creek										
3	Gold Wagon	9848	767855	0.013	7165	782405	0.009	8353	NA	NA
1	Pine Lake	5201	252827	0.021	2214	71490	0.031	3836	63217	0.061
6	Timber Ridge Dr*	328664	1230259	0.267	262342	1116301	0.235	NA	NA	NA
1	Apple Creek Dr	971	155989	0.006	623	43110	0.014	816	41136	0.020
2	Lawyers Rd*	54459	148811	0.366	40225	59275	0.679	43713	NA	NA
Sardis Branch										
8	Beverly Cr/Cornwallis Ln/Sardis Rd	40814	1144355	0.036	21630	825725	0.026	32762	NA	NA
1	Sardis Pointe	18158	406454	0.045	12028	77993	0.154	15588	35615	0.438
Swan Run Branch										
1	Blueberry Ln	50789	191708	0.265	40822	45220	0.903	44151	43703	**1.010**
1	Brookbury	2884	286370	0.010	2095	59670	0.035	2490	32021	0.078
Rea Branch										
1	Parview Dr	55528	639268	0.087	42685	115598	0.369	48265	59879	0.806
McAlpine Trib 6										
6	Old Meadow Rd/Riverton Ct	12117	699845	0.017	9979	202858	0.049	10562	NA	NA

*Benefits and costs are in dollars

The benefit and cost values in Table 11 are the present values of the annual benefits and costs of each mitigation option. Because only benefit:cost ratios greater than 1.0 are considered economically feasible, ratios for those areas are shown in bold in Table 11.

Alternative Evaluation

Within the McAlpine Creek basin there are 109 buildings which are in the flood fringes (within 2 ft of the BFE). These buildings are clustered into 27 project areas as shown in Tables 9-11. A total of four alternatives are analyzed for these project areas. Additional alternatives were considered, but ruled out because they are not cost effective after preliminary analyses.

Alternative 1 - Acquisition

In this alternative, the structure in danger of flooding is purchased and destroyed. FEMA regulations specify this alternative to be adopted if the benefit:cost ratio equals or exceeds 1.0. Calculations for determining the cost of this alternative are programmed into the benefit:cost program as described in Section 2 of this report. A return rate of 7% and project life of 100 years are used for this alternative. As indicated in Table 11, none of the project areas meets this requirement and hence this alternative is not selected.

Alternative 2 - Elevation

This alternative involves elevating the flooded structure 2 ft above the BFE. The costs of elevating structures in Mecklenburg County are programmed in the benefit:cost program as well. The adoption criteria for this alternative is also a benefit:cost ratio of 1.0 or higher. Table 11 shows that three of the project areas meet the limiting criteria of this alternative, and hence this alternative should be considered for these project areas.

Alternative 3 – Flood Barrier

In this alternative, the cost of the construction of an earthen levee as a flood barrier is considered. The levee is designed with a 3-ft freeboard, i.e., the elevation of the top of the levee is placed at 3 ft above the BFE. By its nature, this alternative is better suited to project areas or a cluster of structures than for individual units. Calculations for the cost of a levee are carried out outside the benefit:cost program, and involve estimations of material needed, haul distances, and equipment mobilization and demobilization. Results of the calculations are summarized in Table 11, and indicate that this alternative may be suitable for three of the project areas.

Alternative 4 – No Action

This is the default alternative, when the benefit:cost analysis shows that adopting any of the other mitigation measures results in more costs than benefits. Because of the six project areas shown in Tables 9 and 11 that meet the criteria for adoption of alternatives 2 and 3, and two out of the six qualifying for both alternatives, the remaining 23 project areas fall under this alternative of no action. However, closer examination of Table 11 indicates that in two cases the benefit:cost ratio is higher than 0.8. These cases may be studied further, for a closer examination of costs and/or benefits of the mitigation measure that produces the high B:C ratio. One of the cases already meets the criteria for adoption of alternative 3. Results of the benefit:cost analysis for the individual project areas are summarized below.

Vista Grande/Vista Haven — McAlpine Creek

The summary of the benefit:cost analysis for the Vista Grande Circle and Vista Haven Drive neighborhood is shown in Table 12. The highest benefit:cost ratio is 0.046 for the elevation alternative, well below the acceptable level of 1.0 for adoption of the mitigation measure. The 4 affected buildings and the proposed measures are shown in Figure 12. One of the marked structures is a storage shed. The flood barrier alternative cannot be used in this case because the levee would block drainage from the neighborhood, which is not a viable option. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 12. Mitigation Measures for Vista Grande/Vista Haven Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 12,797.00	$ 553,032.00	0.023	$ 7,667.00	$ 165,080.00	0.046	$ 10,756.00	N/A	N/A

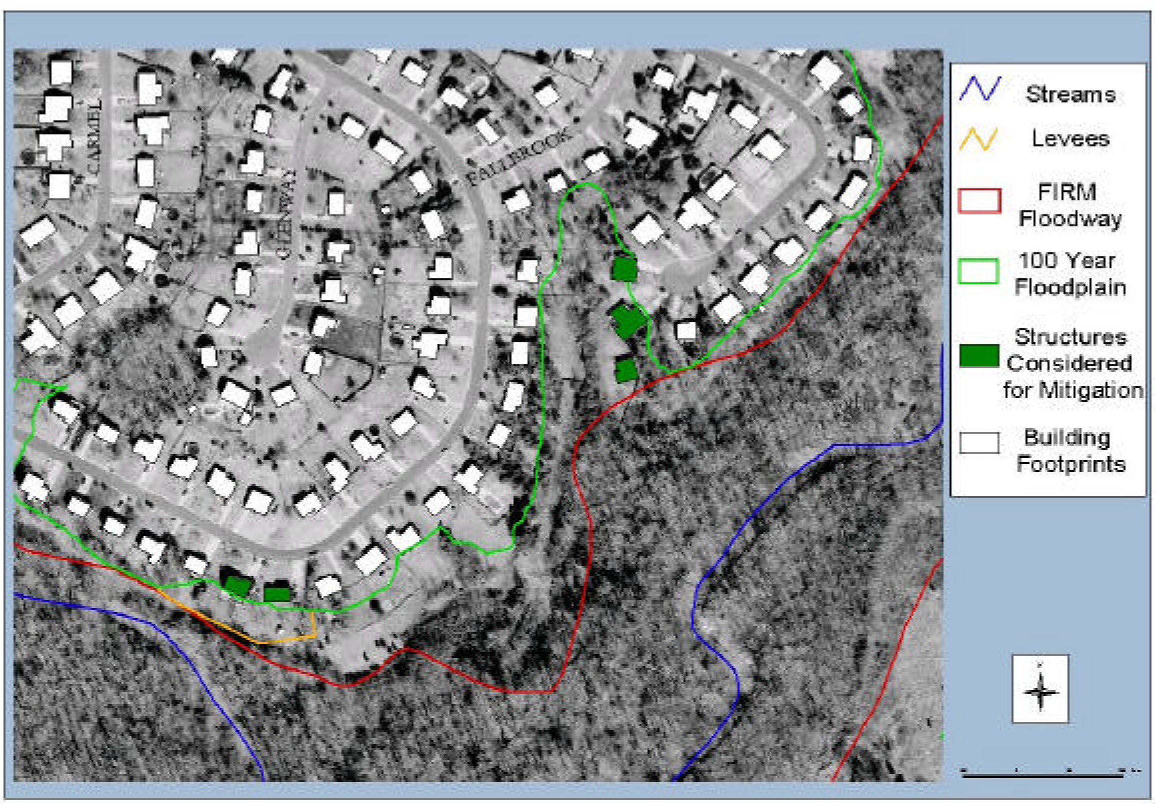


Fig. 12 Vista Grande/Vista Haven Neighborhood Mitigation Structures

Eveningwood/Five Cedars/Kapplewood/Smoke Tree – McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 13. The highest benefit:cost ratio is 0.484 for the levee alternative, which is below the acceptable level of 1.0 for adoption of the mitigation measure. The affected buildings and the proposed measures for this neighborhood are shown in Figure 13. None of the alternatives is cost effective, and no mitigation measures are proposed for this area. A total of 8 buildings have flooding potential in this area of which one has a benefit:cost ratio of 1.08 for the elevation option. More detailed study should be undertaken to verify eligibility of this building for mitigation.

Table 13. Mitigation Measures for Eveningwood and Vicinity Neighborhood

Possible Mitigation Project

	Acquisition			Elevation			Levee		
	Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
Project Area	$ 115,872.00	$ 1,026,335.00	0.113	$ 60,974.00	$ 306,420.00	0.199	$ 98,671.00	$ 204,049.95	0.484
11501 Five Cedars				$ 49804.00	$ 46250.00	**1.08**			

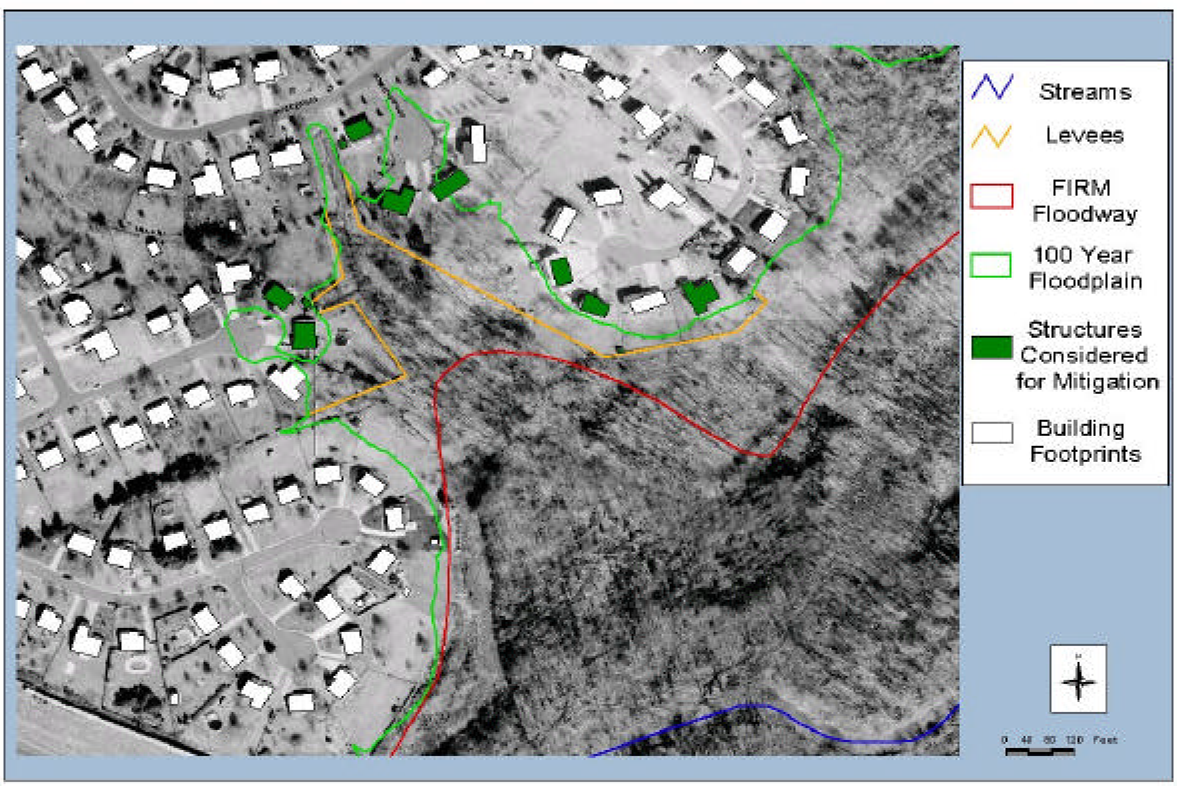


Fig. 13 Eveningwood and Vicinity Mitigation Structures

Bevington Wood/Stanton Green -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 14. The highest benefit:cost ratio is 0.033 for the elevation alternative, well below the acceptable level of 1.0 for adoption of the mitigation measure. The affected buildings and the proposed measures are shown in Figure 14. There is a total of 5 buildings in this neighborhood. The levee option could not be considered for this neighborhood because it would infringe on the 0.5 ft floodway. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 14. Mitigation Measures for Bevington Woods/Stanton Green Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 14,289.00	$ 1,105,680.00	0.013	$ 8,418.00	$ 257,530.00	0.033	$ 11,888.00	NA	NA

Fig. 14 Bevington Woods/Stanton Green Neighborhood Mitigation Structures

Ryder/Shannon Willow -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 15. The highest benefit:cost ratio is 0.078 for the levee alternative, well below the acceptable level of 1.0 for adoption of the mitigation measure. The affected buildings and the proposed measures are shown in Figure 15. Only two buildings are affected in this area. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 15. Mitigation Measures for Ryder/Shannon Willow Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 13,340.00	$ 700,468.00	0.019	$ 5,953.00	$ 551,719.00	0.011	$ 10,203.00	$ 130,873.35	0.078

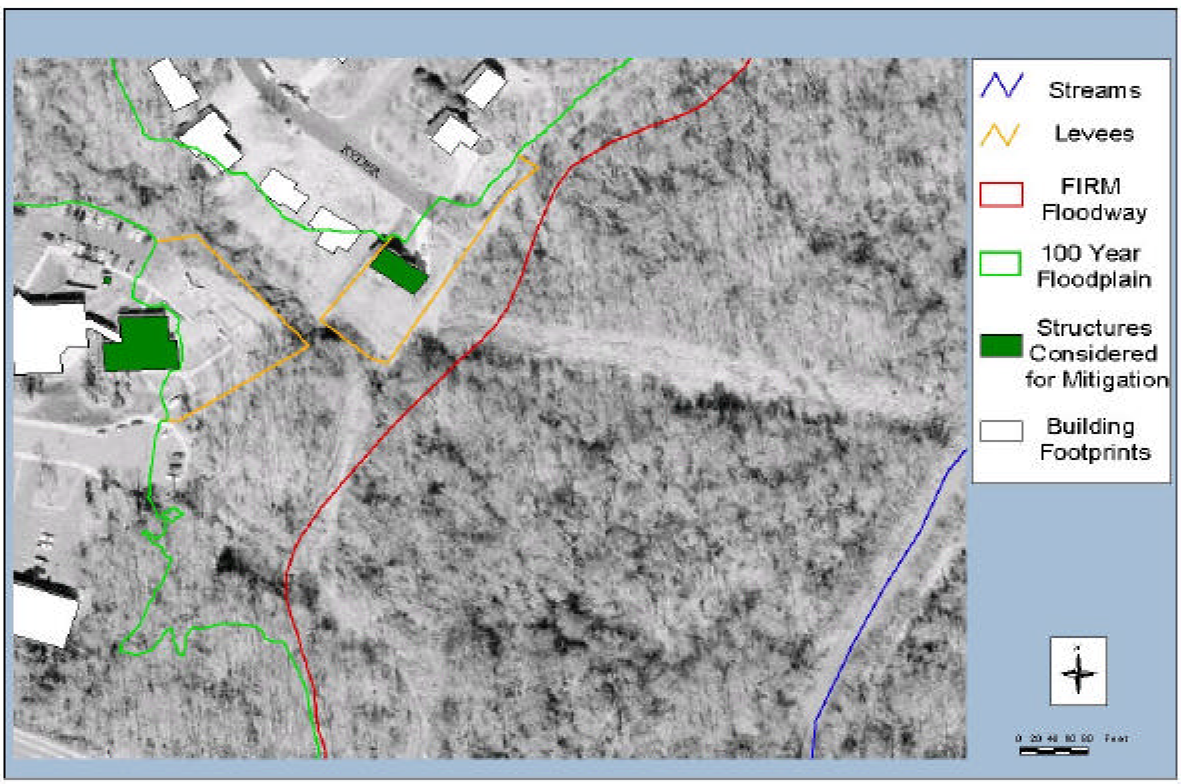


Fig. 15 Ryder/Shannon Willow Neighborhood Mitigation Structures

Bentway./Green Rea -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 16. The benefit:cost ratios for the elevation and levee options are 7.7 and 20.5, respectively. Both of these options are economically feasible, the levee option being the preferred economic choice. Additional study may be needed to determine which option would be more advantageous to adopt. The affected buildings and the proposed measures are shown in Figure 16. Of the two pieces of property involved in this area one has a benefit:cost ratio of 11.49 for the elevation option, which is included for completeness.

Table 16. Mitigation Measures for Bentway/Green Rea Neighborhood

Possible Mitigation Project

	Acquisition			Elevation			Levee		
	Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
Project Area	$ 2,992,306.00	$ 4,435,900.00	0.675	$ 1,548,590.00	$ 201,052.00	**7.702**	$ 2,496,255.00	$ 121,629.99	**20.523**
5936 Green Rea				$ 1,545,488	134,502	**11.49**			

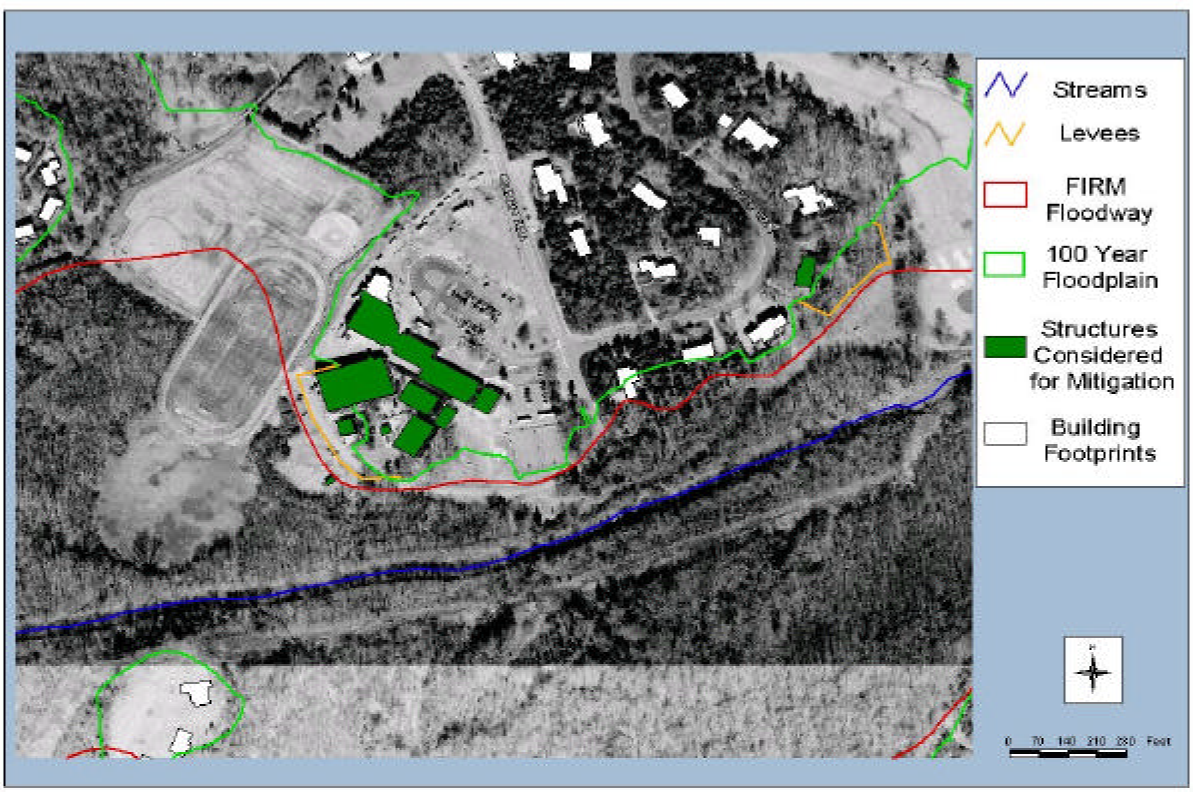


Fig. 16 Bentway/Green Rea Neighborhood Mitigation Structures

River Ridge/Sentinel Post/Southridge -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 17. The highest benefit:cost ratio is 0.418 for the elevation option, which is below the acceptable level of 1.0 to be economically feasible. None of the alternatives is cost effective, and no collective mitigation measures are proposed for this area. The affected buildings and the proposed measures are shown in Figure 17. A total of eight buildings have flooding potential in this area, of which one has a benefit:cost ratio of 1.34 for the elevation option. More detailed study will be necessary to determine eligibility of this building for mitigation. The levee option cannot be used for this neighborhood because the levee would block the drainage of the upper parts of the neighborhood.

Table 17. Mitigation Measures for River Ridge/Sentinel Post/Southridge Neighborhood

Possible Mitigation Project									
	Acquisition			Elevation			Levee		
	Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
Project Area	$ 421,410.00	$ 3,125,706.00	0.135	$ 278,715.00	$ 667,550.00	0.418	$ 358,531.00	NA	NA
5022 Sentinel Post				$ 128,096.00	$ 95,690	**1.34**			

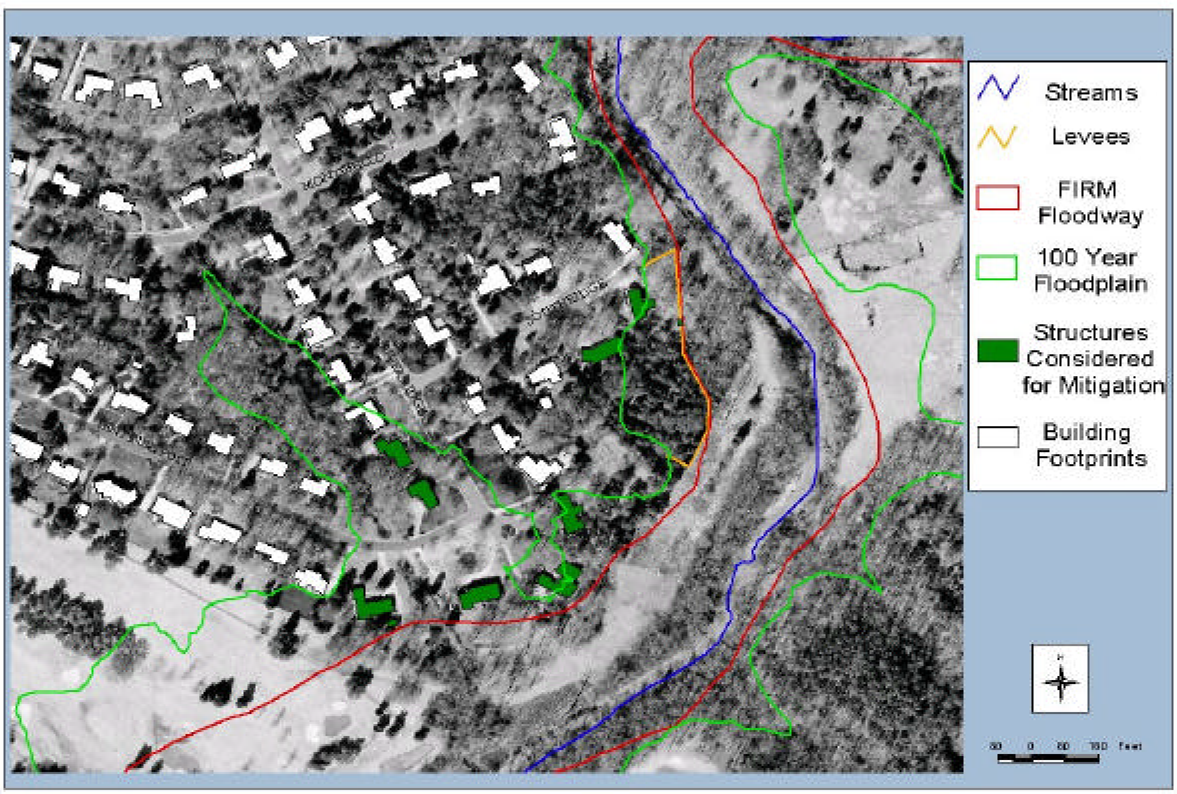


Fig. 17 River Ridge/Sentinel Post/Southridge Neighborhood Mitigation Structures

Dulverton/Lancer -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 18. The highest benefit:cost ratio is 0.069 for the elevation option, which is well below the acceptable level of 1.0 to be economically feasible. The affected buildings and the proposed measures are shown in Figure 18. There are 11 buildings in this neighborhood (south side of the stream). Additional marked buildings in Figure 18 are discussed as part of another neighborhood. A levee cannot be used in this case because it would block drainage from the upper portions of the neighborhood. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 18. Mitigation Measures for Dulverton/Lancer Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 78,768.00	$ 2,225,538.00	0.035	$ 41,522.00	$ 599,231.00	0.069	$ 62,902.00	N/A	N/A

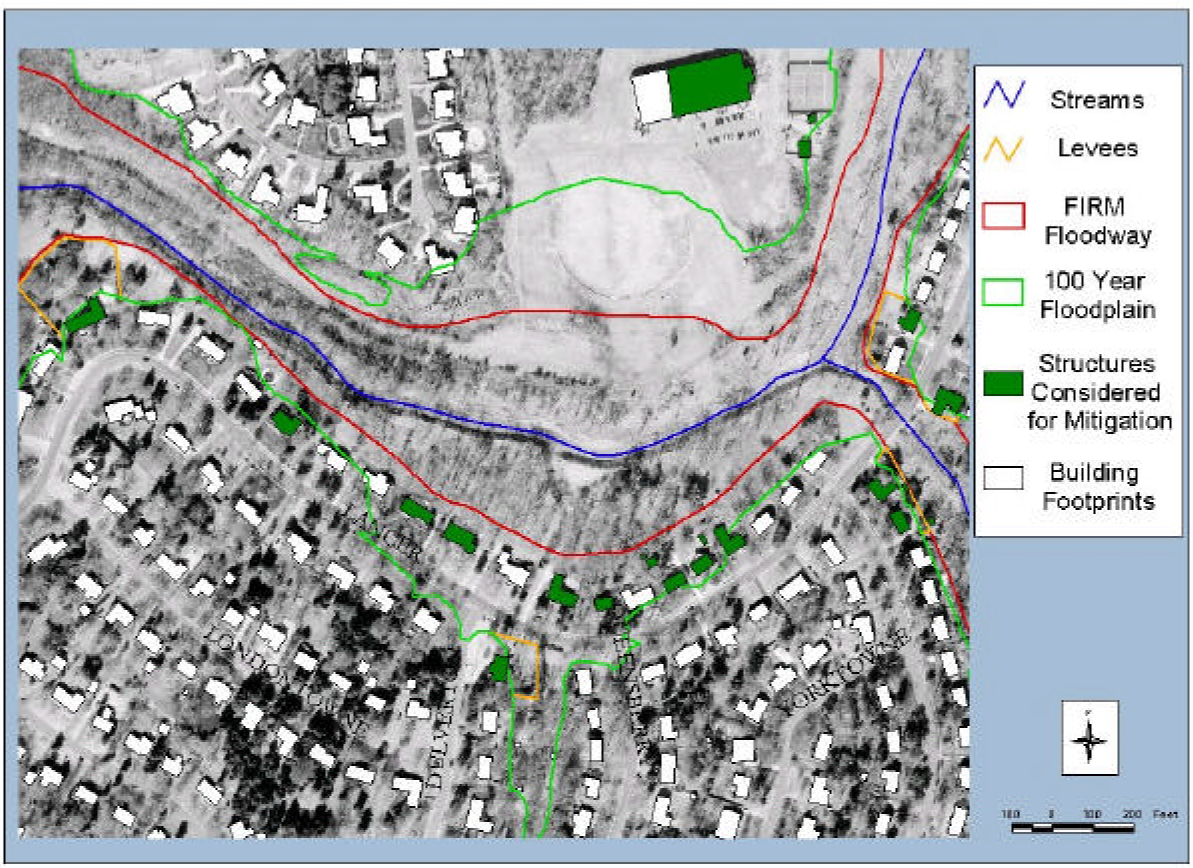


Fig. 18 Dulverton/Lancer Neighborhood Mitigation Structures

Old Providence -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 19. The highest benefit:cost ratio is 0.513 for the elevation option, which is below the acceptable level of 1.0 to be economically feasible. The two affected buildings in this area are shown in Figure 19. Other marked buildings are discussed as part of other project areas. A levee cannot be used in this case because of floodway infringement. None of the alternatives is cost effective, and no mitigation measures are proposed for this area. The benefit:cost ratio for the elevation option for one of the buildings is 1.10. However, the building is designated as “vacant” in the buildings database, and may be a clubhouse or a non-residential building. More detailed analysis may be needed for determining the eligibility of these buildings for mitigation.

Table 19. Mitigation Measures for Old Providence Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 62,883.00	$ 426,028.00	0.148	$ 45,670.00	$ 89,070.00	0.513	$ 54,231.00	NA	NA

Fig. 19 Old Providence Neighborhood Mitigation Structures

McAlpine and McAlpine Trib 3 Confluence Area

The summary of the benefit:cost analysis for this neighborhood is shown in Table 20. The benefit:cost ratio for the elevation option in this neighborhood is 1.046, indicating that this option is economically feasible. The 13 affected buildings in this neighborhood are shown in Figure 20. The levee option cannot be considered for all the affected buildings because of floodway infringement. Individual buildings with benefit:cost ratios above 1.0 are shown in Table 20 for additional more detailed study.

Table 20. Mitigation Measures for McAlpine Trib 3 Neighborhood

Possible Mitigation Project

	Acquisition			Elevation			Levee		
	Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
Project Area	$ 929,527.00	$ 2,328,312.00	0.399	$ 795,479.00	$ 760,732.00	**1.046**	$ 808,246.00	NA	NA
2731 Rea Rd				$ 88,080.00	22,701.00	**3.88**			
6118 Cedar Croft	$ 612,401.00	$ 265,987	**2.30**	$ 528,439.00	$ 95,138.00	**5.55**			
6117 Cedar Croft	$ 154,940.00	$ 130,973.00	**1.18**	$ 134,692.00	$ 45,790.00	**2.94**			

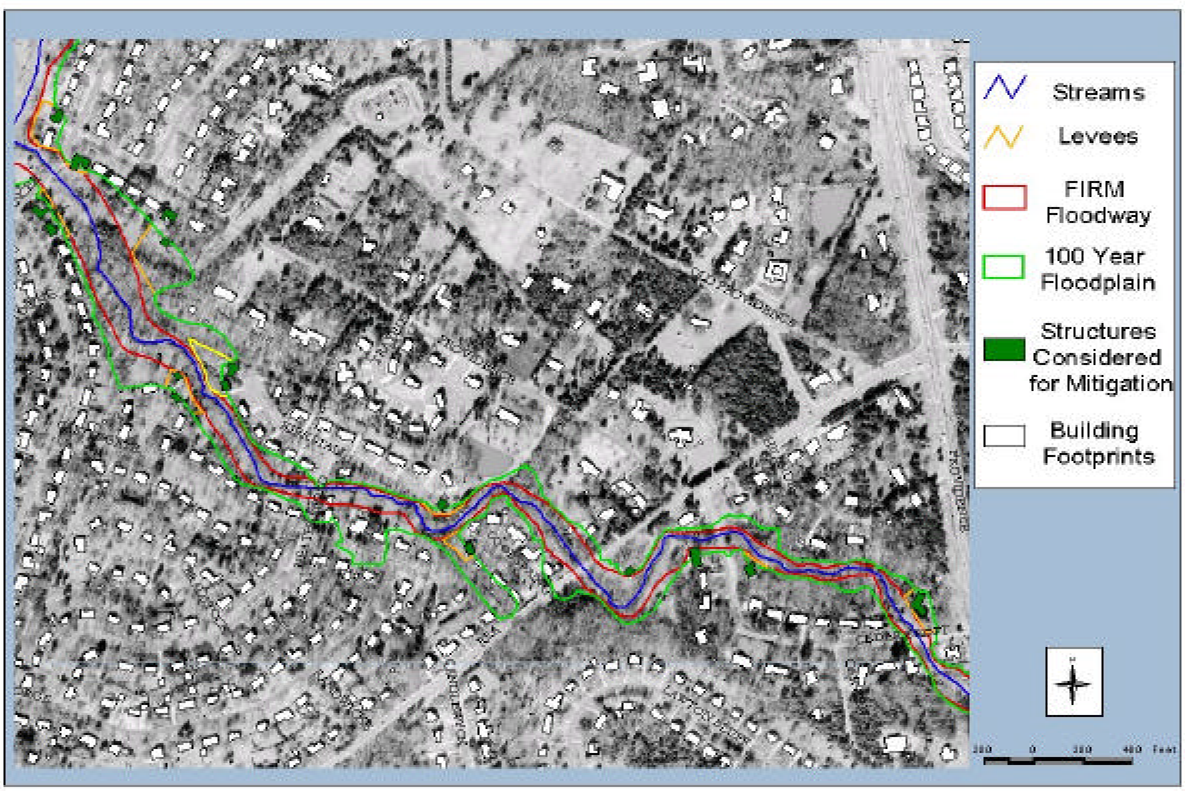


Fig. 20 McAlpine and McAlpine Trib 3 Confluence Neighborhood Mitigation Structures

Landing View -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 21. The only building involved in this area is 2536 Landing View. The benefit:cost ratios for the elevation and levee options are 1.24 and 3.29, respectively. Both of these options are economically feasible, with the levee option being the preferred one. Additional study will be needed to determine the exact alignment of a levee and to find out which option would be more advantageous to adopt. The single building affected in this area and the proposed measures are shown in Figure 21.

Table 21. Mitigation Measures for Landing View Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 143,200.00	$ 224,741.00	0.637	$ 68,274.00	$ 55,200.00	**1.237**	$ 120,594.00	$ 36,642.43	**3.291**

Fig. 21 Landing View Area Mitigation Structure

Old Bell/Valleybrook/Via Romano -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 22. The highest benefit:cost ratio is 0.282 for the elevation option, which is well below the acceptable level of 1.0 to be economically feasible. The affected buildings are shown in Figure 22. A total of four buildings are affected in this area (additional buildings are marked because they are on the same lot with a flooded building). A levee cannot be used in this case because it would have to be installed inside of a pond, and it would block the drainage flow from uplands in the neighborhood. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 22. Mitigation Measures for Old Bell/Valleybrook/Via Romano Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 354,816.00	$ 7,093,858.00	0.050	$ 210,862.00	$ 748,679.00	0.282	NA	NA	NA

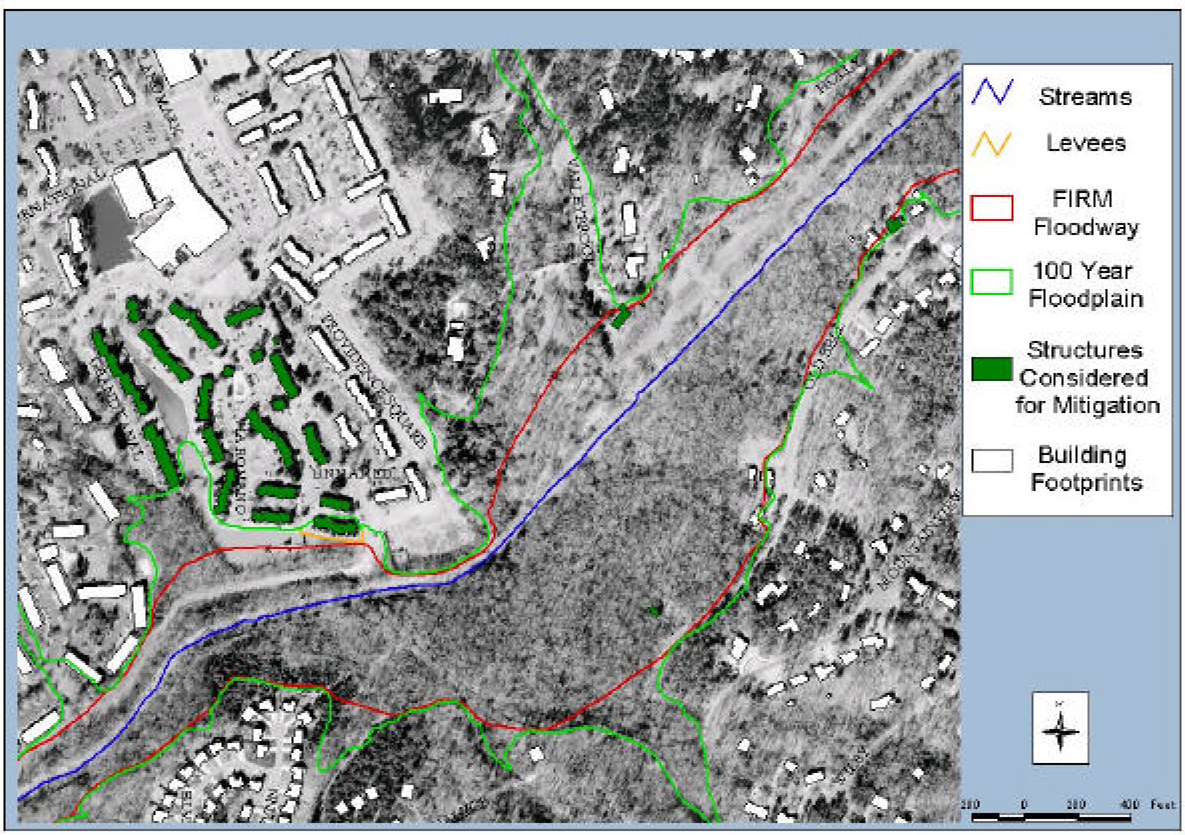


Fig. 22 Old Bell/Valleybrook/Via Romano Neighborhood Mitigation Structures

Thermal/Terrace -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 23. The highest benefit:cost ratio is 0.454 for the acquisition option, which is below the acceptable level of 1.0 to be economically feasible. The two affected buildings are shown in Figure 23. A levee cannot be used in this case because it would block the drainage flow from uplands in the neighborhood for some of the buildings, and it would infringe on the floodway for other buildings. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 23. Mitigation Measures for Thermal/Terrace Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 304,284.00	$ 669,643.00	0.454	$ 147,652.00	$ 505,611.00	0.292	$ 255,098.00	NA	NA

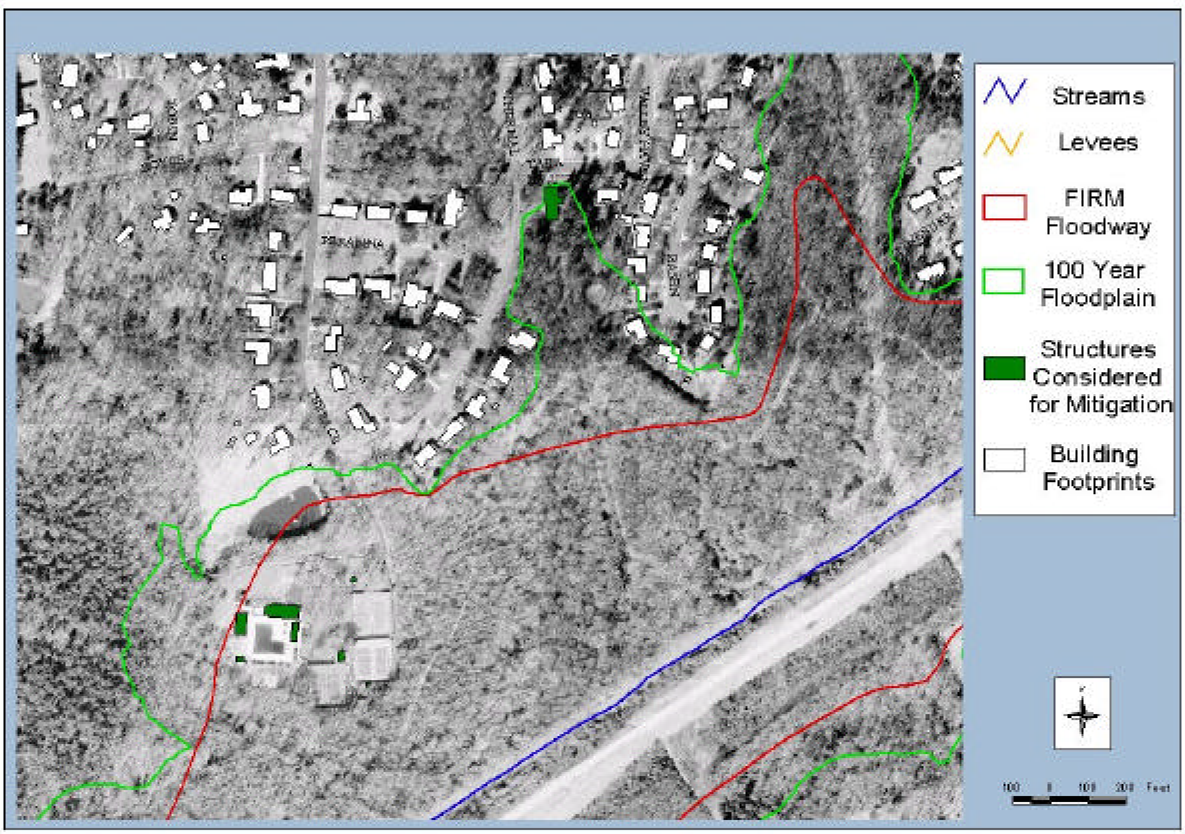


Fig. 23 Thermal/Terrace Neighborhood Mitigation Structures

Margaret Wallace/Whitfield -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 24. The highest benefit:cost ratio is 0.401 for the elevation option, which is below the acceptable level of 1.0 to be economically feasible. None of the alternatives is cost effective, and no mitigation measures are proposed for this area. The four affected buildings are shown in Figure 24 (additional buildings are marked on 4 flooded parcels). Not all of the buildings in this neighborhood can be protected by levees because of floodway infringement. However, the house on 2234 Margaret Wallace has a benefit:cost ratio of 1.15.and 1.215 for the elevation and acquisition options, respectively, and should be studied in more detail for possible mitigation measures.

Table 24. Mitigation Measures for Margaret Wallace/Whitfield Neighborhood

Possible Mitigation Project

	Acquisition			Elevation			Levee		
	Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
Project Area	$ 76,810.00	$ 535,754.00	0.143	$ 62,937.00	$ 157,012.00	0.401	$ 66,519.00	NA	NA
2234 Margaret Wallace				$ 48,082.00	$41,857.00	**1.15**	$ 50,304.00	$ 41,393.00	**1.215**

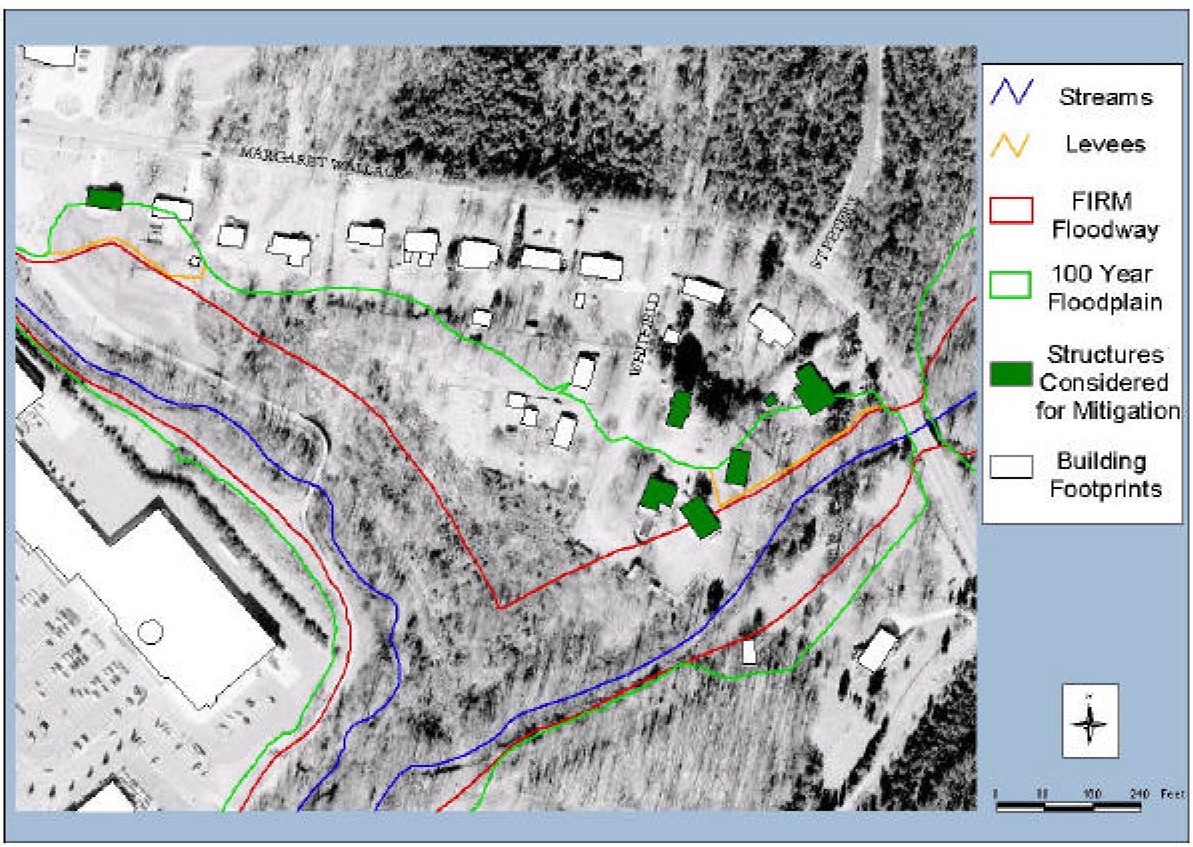


Fig. 24 Margaret Wallace/Whitfield Neighborhood Mitigation Structures

Drifter -- McAlpine Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 25. The highest benefit:cost ratio is 0.315 for the elevation option, which is well below the acceptable level of 1.0 to be economically feasible. The single affected building is shown in Figure 25 (two buildings are marked on one flooded lot). Levees cannot be used in this case because of floodway infringement. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 25. Mitigation Measures for Drifter Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 16,337.00	$ 115,962.00	0.141	$ 12,681.00	$ 40,314.00	0.315	$ 14,186.00	NA	NA

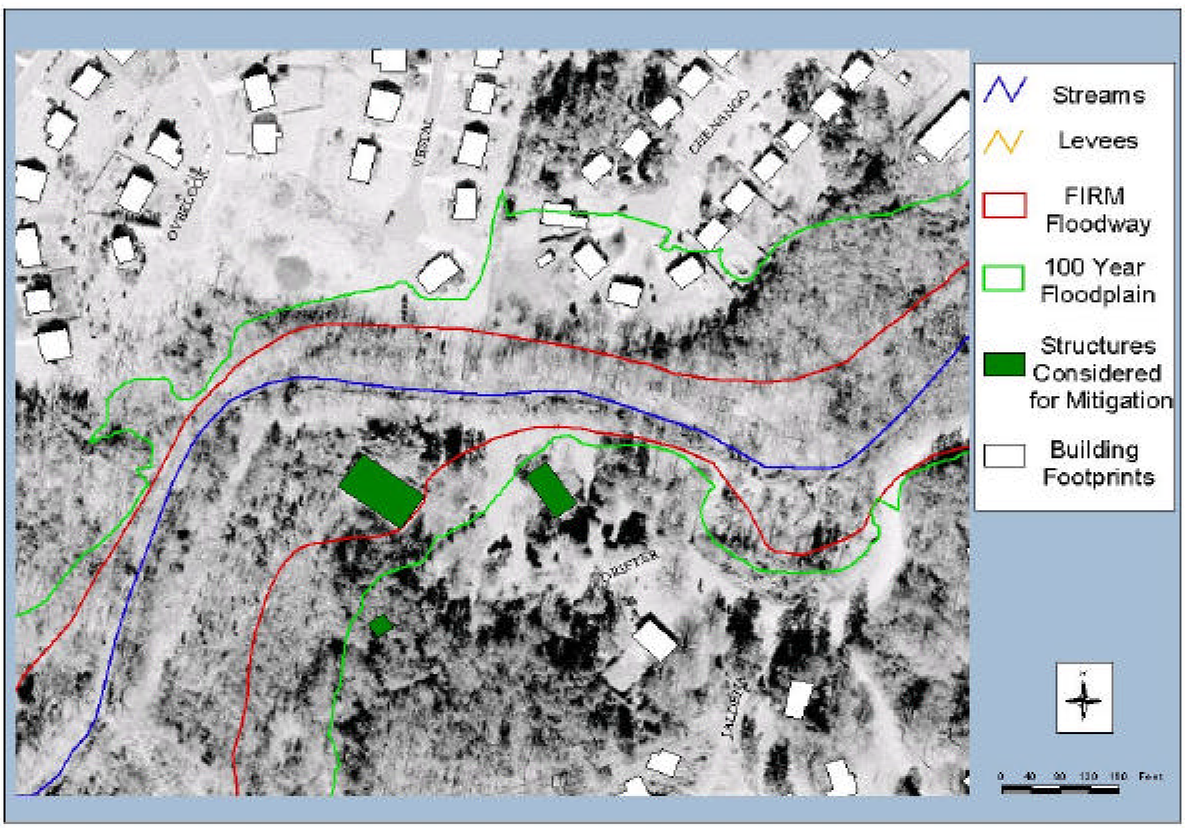


Fig. 25 Drifter Area Mitigation Structure

Lynfield/Idlebrook/Springfield -- Campbell Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 26. The highest benefit:cost ratio is 0.095 for the elevation option, which is well below the acceptable level of 1.0 to be economically feasible. The nine affected buildings in the neighborhood are shown in Figure 26 (additional structures marked on the flooded lots). Levees cannot be used in this neighborhood because of floodway infringement. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 26. Mitigation Measures for Lynfield/Idlebrook/Springfield Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 93,286.00	$ 1,358,120.00	0.069	$ 74,893.00	$ 788,998.00	0.095	$ 80,942.00	NA	NA

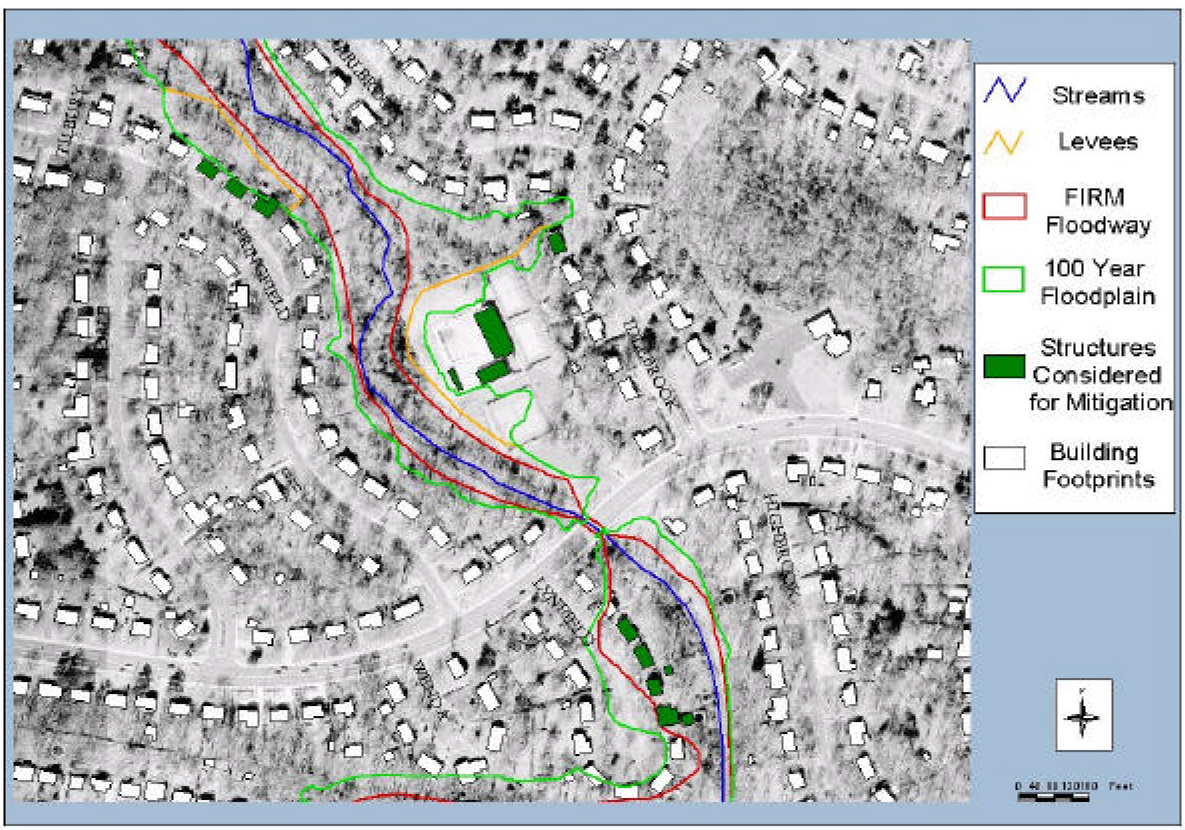


Fig. 26 Lynfield/Idlebrook/Springfield Neighborhood Mitigation Structures

Farm Pond/Honeysuckle -- Campbell Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 27. The highest benefit:cost ratio is 0.031 for the acquisition option, which is well below the acceptable level of 1.0 to be economically feasible. Levees cannot be used in this neighborhood because they would infringe on the floodway, or else cut off access to the community clubhouse. None of the alternatives is cost effective, and no mitigation measures are proposed for this area. The two affected buildings in this area are shown in Figure 27 (with additional structures marked on the flooded lot). The building on 6114 Honeysuckle has a benefit:cost ratio of 3.72 for an individual levee. This house should be studied in further detail for possible mitigation.

Table 27. Mitigation Measures for Farm Pond/Honeysuckle Neighborhood

	Possible Mitigation Project								
	Acquisition			Elevation			Levee		
	Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
Project Area	$ 57,585.00	$ 1,872,653.00	0.031	$ 37,305.00	$ 1,882,353.00	0.020	$ 48,441.00	NA	NA
6114 Honeysuckle							$ 26,929.00	$ 7,245.00	**3.72**

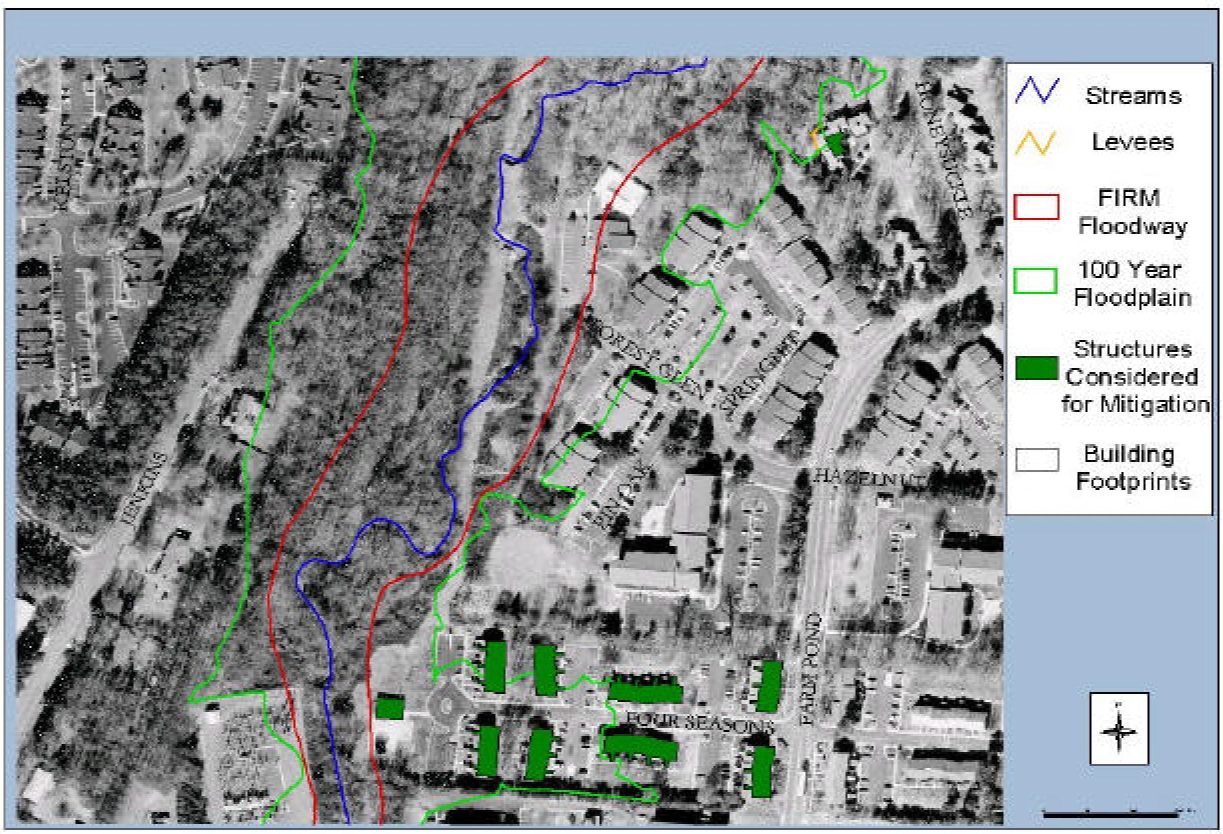


Fig. 27 Farm Pond/Honeysuckle Neighborhood Mitigation Structures

Gold Wagon -- Irvins Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 28. The highest benefit:cost ratio is 0.013 for the acquisition option, which is well below the acceptable level of 1.0 to be economically feasible. The three affected buildings are shown in Figure 28. Levees cannot be used in this neighborhood because of floodway infringement. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 28. Mitigation Measures for Gold Wagon Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 9,848.00	$ 767,855.00	0.013	$ 7,165.00	$ 782,405.00	0.009	$ 8,353.00	NA	NA

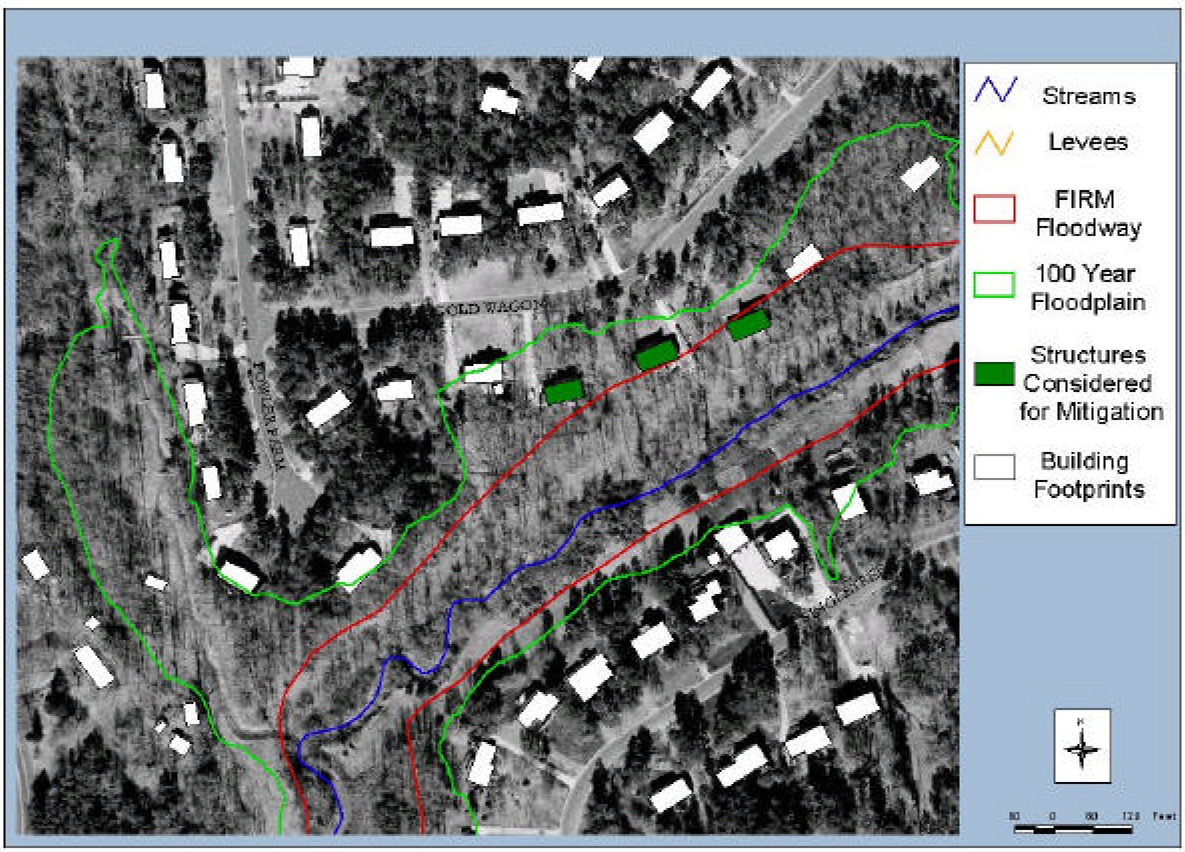


Fig. 28 Gold Wagon Neighborhood Mitigation Structures

Pine Lake -- Irvins Creek

The summary of the benefit:cost analysis for this area is shown in Table 29. The highest benefit:cost ratio is 0.061 for the levee option, which is well below the acceptable level of 1.0 to be economically feasible. There is only one building affected in this area, as shown in Figure 29. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 29. Mitigation Measures for Pine Lake Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 5,201.00	$ 252,827.00	0.021	$ 2,214.00	$ 71,490.00	0.031	$ 3,836.00	$ 63,217.09	0.061

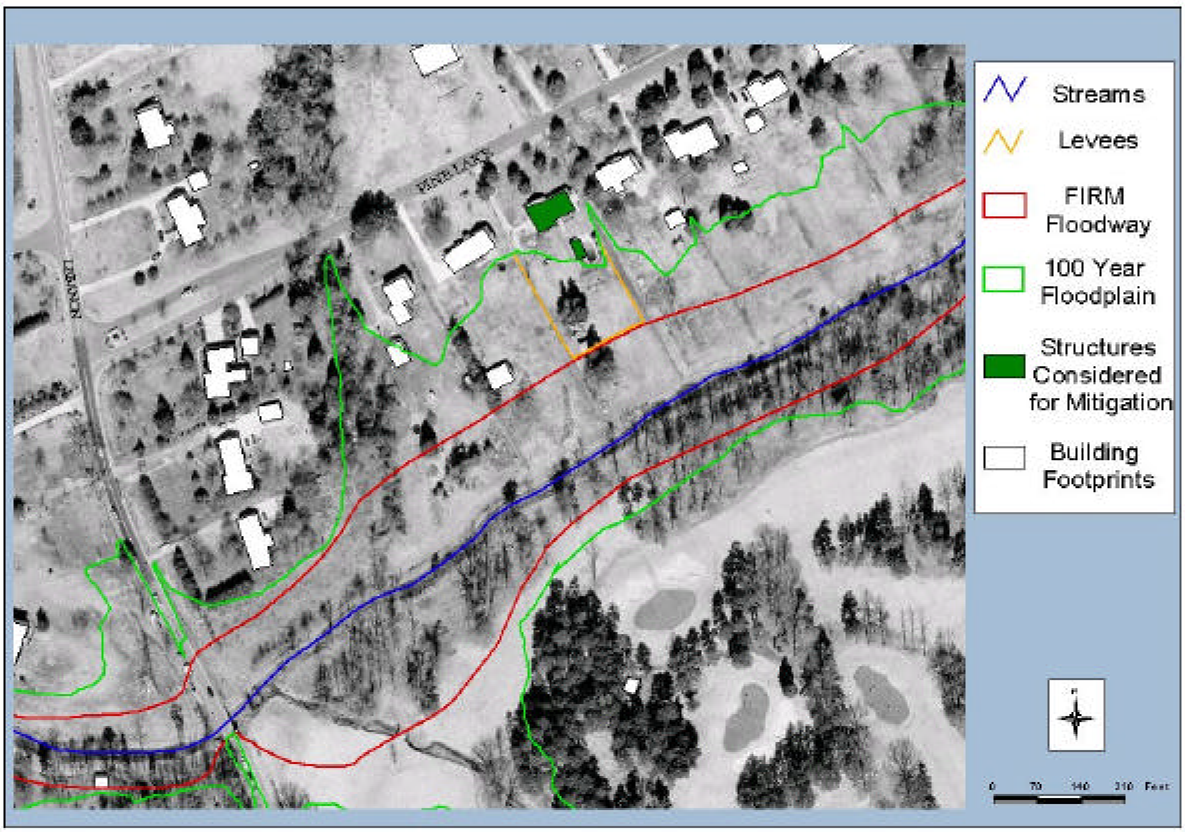


Fig. 29 Pine Lake Area Mitigation Structure

Timber Ridge -- Irvins Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 30. The highest benefit:cost ratio is 0.267 for the acquisition option, which is well below the acceptable level of 1.0 to be economically feasible. The six affected buildings are shown in Figure 30. Not all of the buildings in this neighborhood can be protected by levees because of floodway infringement. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 30. Mitigation Measures for Timber Ridge Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 328,664.00	$ 1,230,259.00	0.267	$ 262,342.00	$ 1,116,301.00	0.235	NA	NA	NA

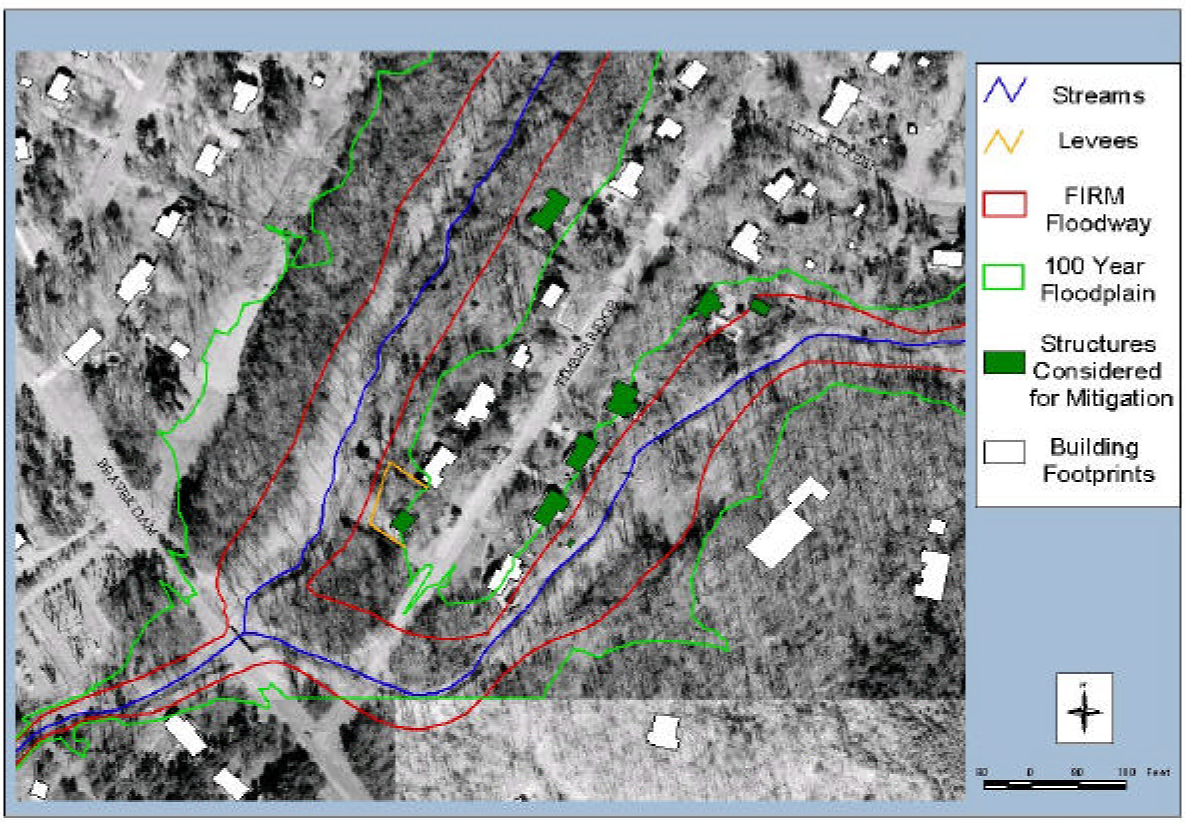


Fig. 30 Timber Ridge Neighborhood Mitigation Structures

Apple Creek -- Irvins Creek

The summary of the benefit:cost analysis for this area is shown in Table 31. The highest benefit:cost ratio is 0.020 for the elevation option, which is well below the acceptable level of 1.0 to be economically feasible. The single affected building is shown in Figure 31. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 31. Mitigation Measures for Apple Creek Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 971.00	$ 155,989.00	0.006	$ 623.00	$ 43,110.00	0.014	$ 816.00	$ 41,135.73	0.020

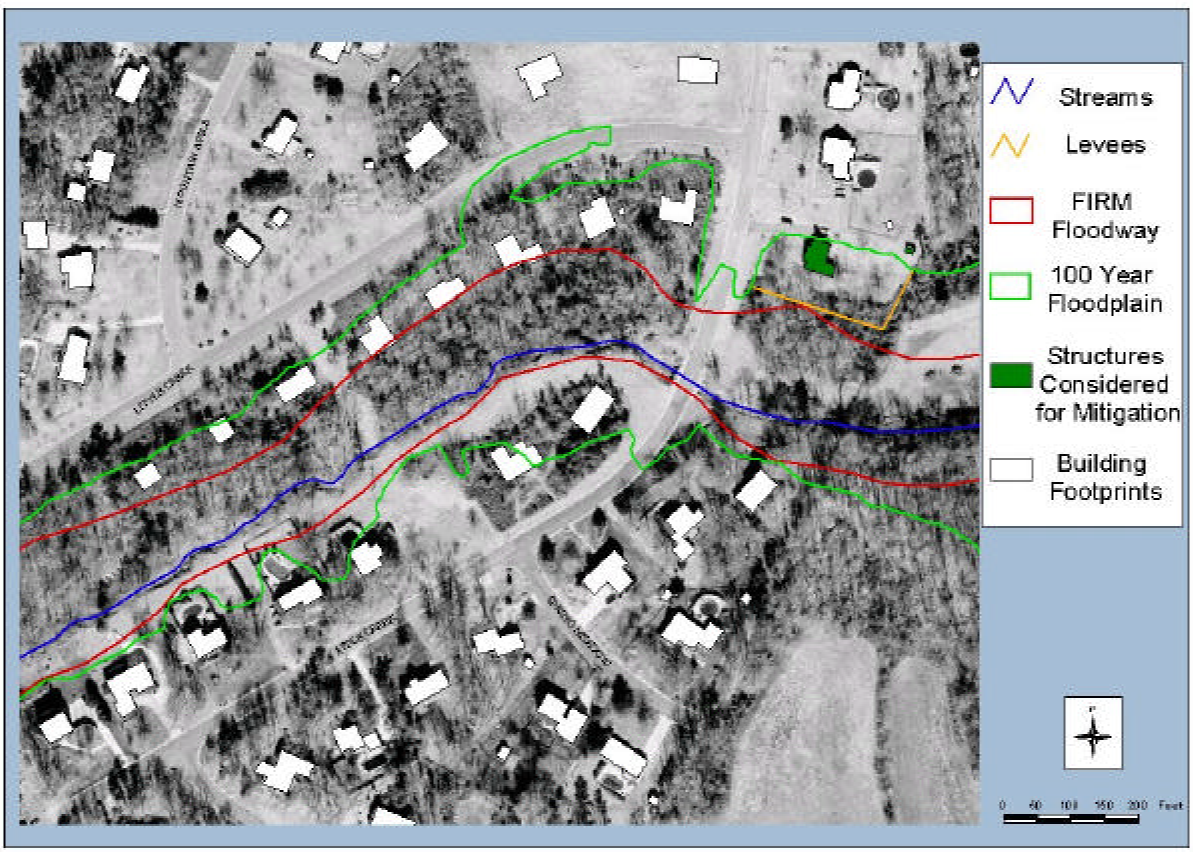


Fig. 31 Apple Creek Area Mitigation Structure

Lawyers -- Irvins Creek

The summary of the benefit:cost analysis for this neighborhood is shown in Table 32. The highest benefit:cost ratio is 0.679 for the elevation option, which is below the acceptable level of 1.0 to be economically feasible. The two affected buildings are shown in Figure 32. This area is located at the limit of the FEMA detailed study. A levee cannot be used in this neighborhood because of floodway infringement. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 32. Mitigation Measures for Lawyers Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 54,459.00	$ 148,811.00	0.366	$ 40,225.00	$59,275.00	0.679	$ 43,713.00	NA	NA

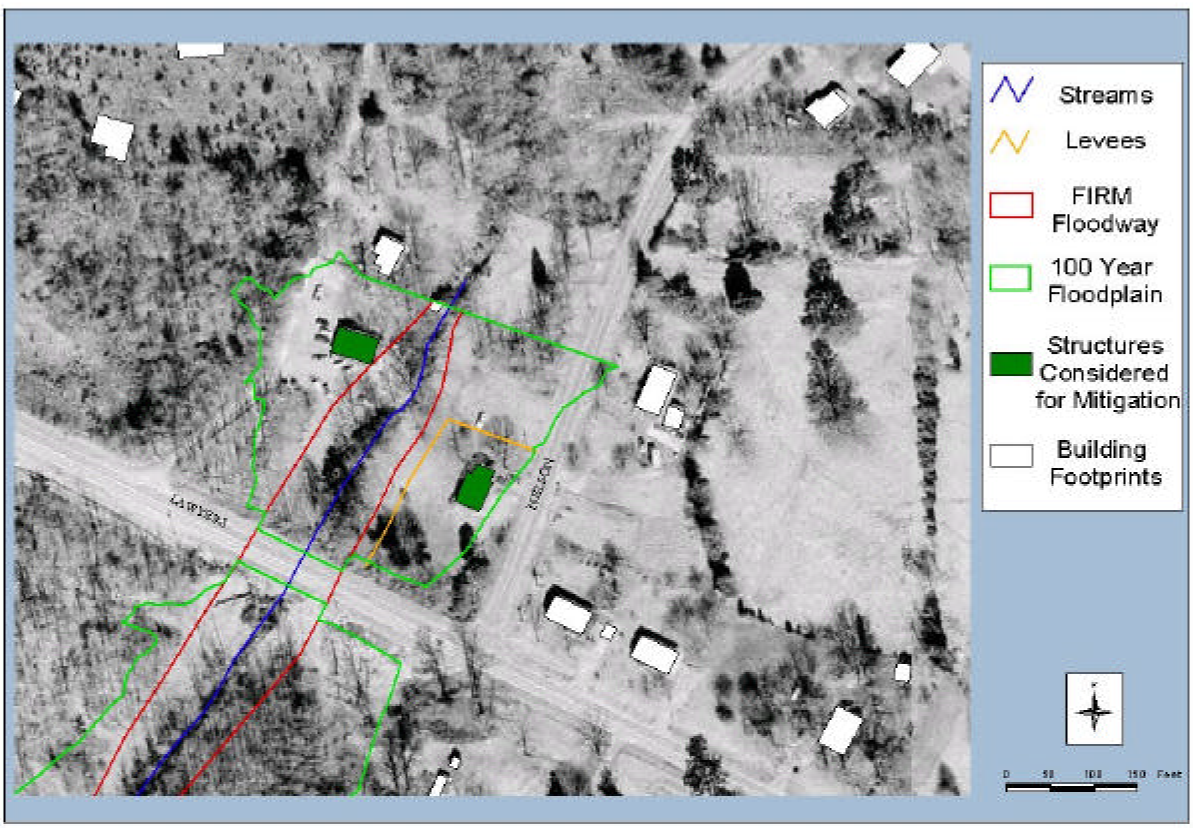


Fig. 32 Lawyers Neighborhood Mitigation Structures

__Beverly/Cornwallis/Sardis – Sardis Branch__

The summary of the benefit:cost analysis for this neighborhood is shown in Table 33. The highest benefit:cost ratio is 0.036 for the acquisition option, which is well below the acceptable level of 1.0 to be economically feasible. The 8 affected buildings are shown in Figure 33. Not all of the buildings in this neighborhood can be protected by levees because access would be cut off to parts of the neighborhood if levees were installed. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 33. Mitigation Measures for Beverly/Cornwallis/Sardis Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 40,814.00	$ 1,144,355.00	0.036	$ 21,630.00	$ 825,725.00	0.026	$ 32,762.00	NA	NA

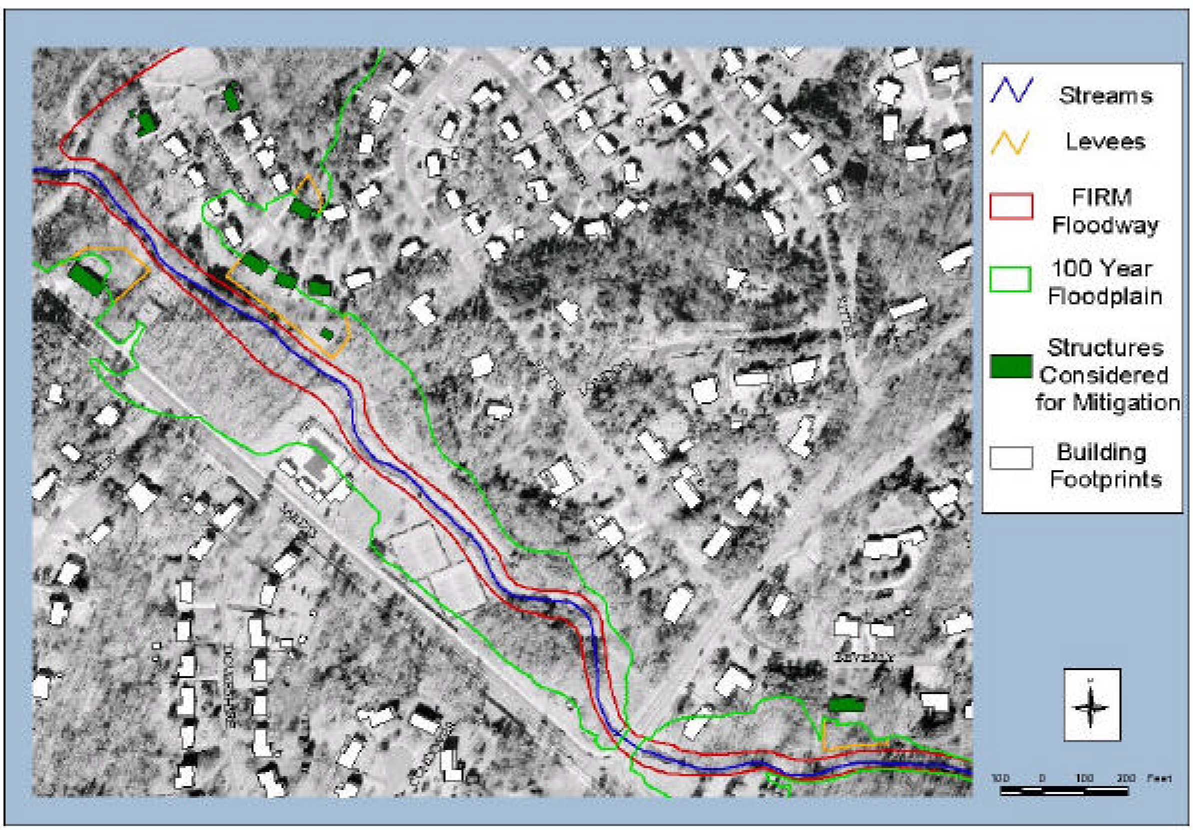


Fig. 33 Beverly/Cornwallis/Sardis Neighborhood Mitigation Structures

Sardis Pointe – Sardis Branch

The summary of the benefit:cost analysis for this area is shown in Table 34. The highest benefit:cost ratio is 0.438 for the levee option, which is well below the acceptable level of 1.0 to be economically feasible. The single affected building is shown in Figure 34. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 34. Mitigation Measures for Sardis Pointe Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 18,158.00	$ 406,454.00	0.045	$ 12,028.00	$ 77,993.00	0.154	$ 15,588.00	$ 35,615.39	0.438

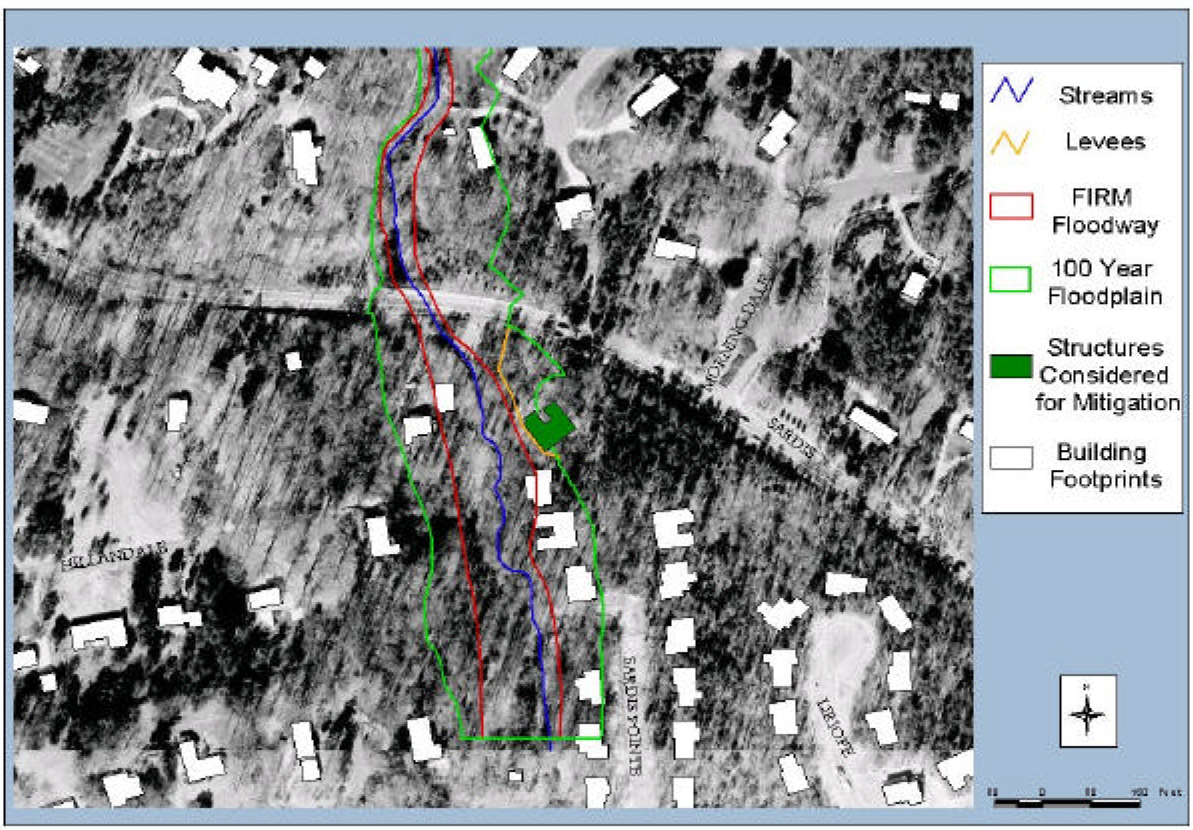


Fig. 34 Sardis Pointe Area Mitigation Structure

Blueberry – Swan Run Branch

The summary of the benefit:cost analysis for this area is shown in Table 35. The benefit:cost ratio for the levee option for the single affected building is 1.01, which meets the acceptable level of 1.0 to be economically feasible. Further study will be needed to accurately assess the costs of a levee, and determination of the resulting benefit:cost ratio. The affected building is shown in Figure 35. It is noticeable in this area that the benefit:cost ratio for the elevation option for this building is above 0.9, indicating that additional more detailed studies may be needed before a mitigation measure can be adopted for this building.

Table 35. Mitigation Measures for Blueberry Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 50,789.00	$ 191,708.00	0.265	$ 40,822.00	$ 45,220.00	0.903	$ 44,151.00	$ 43,703.33	1.010

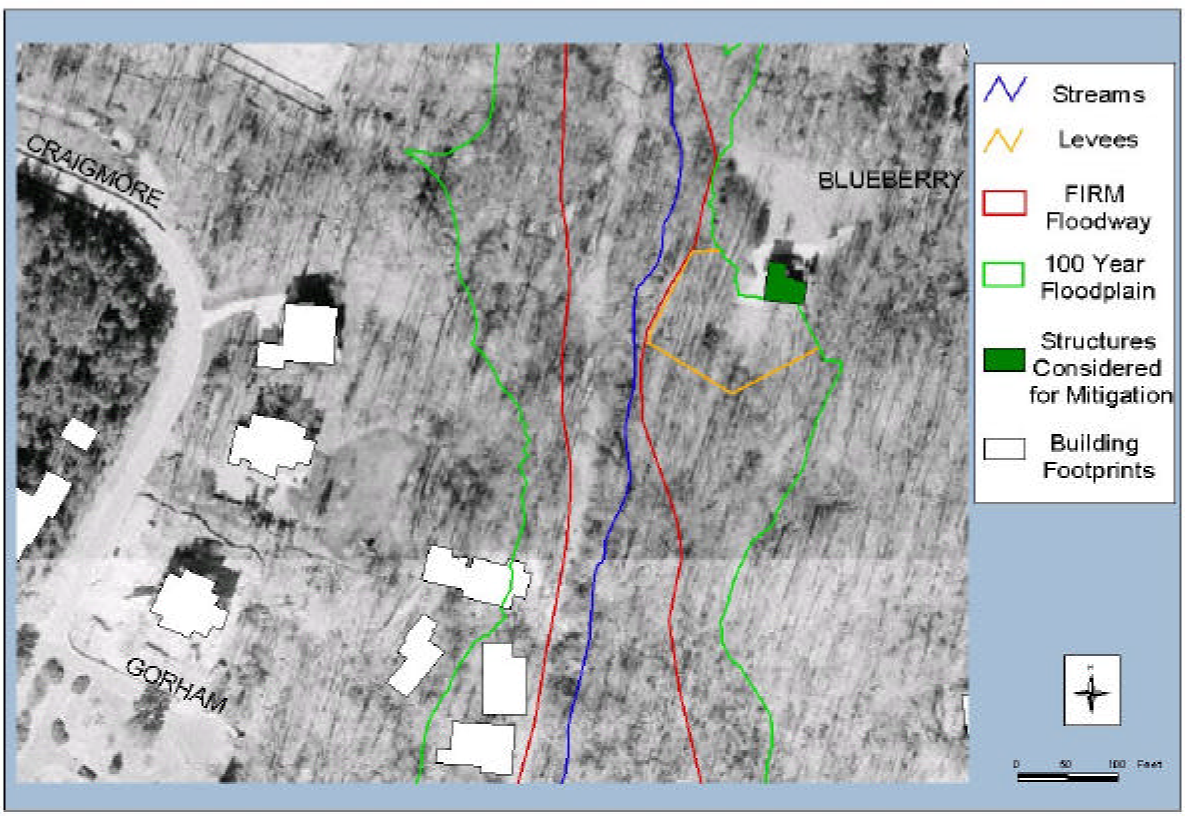


Fig. 35 Blueberry Area Mitigation Structure

Brookbury – Swan Run Branch

The summary of the benefit:cost analysis for this area is shown in Table 36. The highest benefit:cost ratio for the single affected building is 0.078 for the levee option, which is well below the acceptable level of 1.0 to be economically feasible. The affected building and vicinity are shown in Figure 36. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 36. Mitigation Measures for Brookbury Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 2,884.00	$ 286,370.00	0.010	$ 2,095.00	$ 59,670.00	0.035	$ 2,490.00	$ 32,020.75	0.078

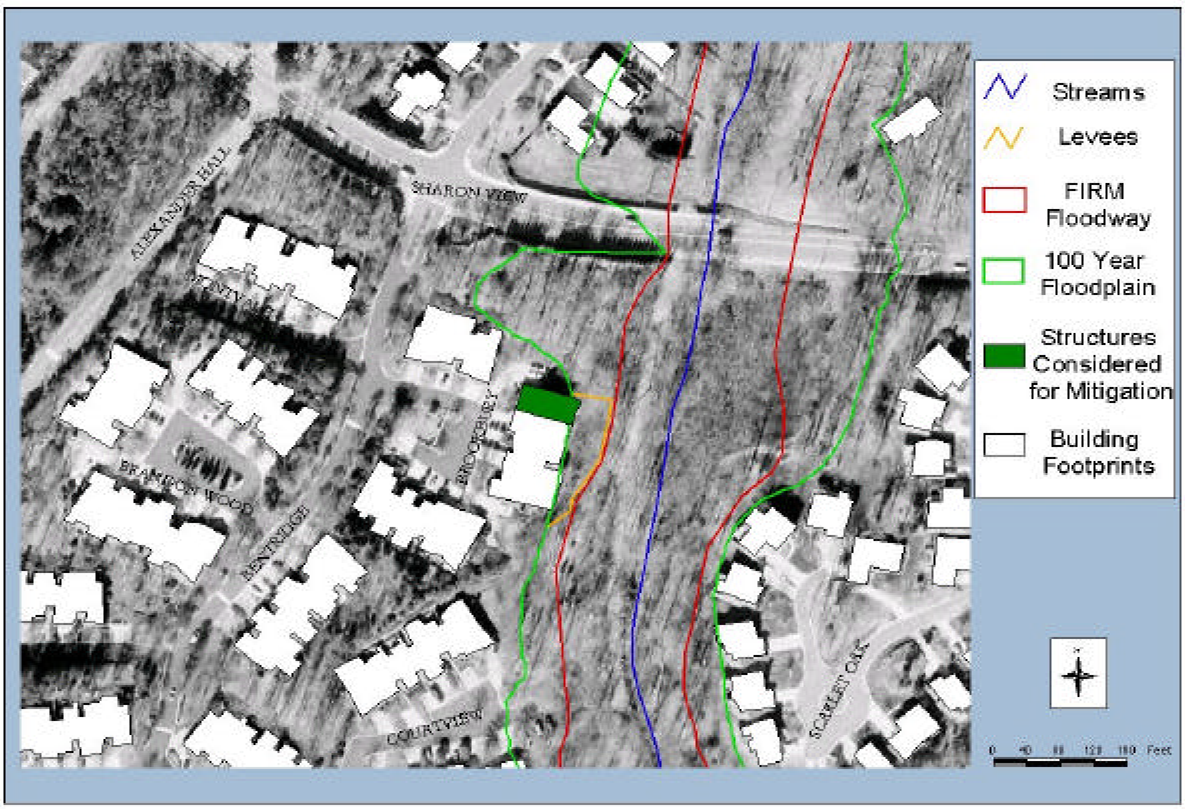


Fig. 36 Brookbury Area Mitigation Structure

Parview – Rea Branch

The summary of the benefit:cost analysis for this area is shown in Table 37. The highest benefit:cost ratio is 0.806 for the levee option. Although this ratio is below the acceptable level of 1.0 to be economically feasible, the value is relatively high. Additional study may reveal that the measure is cost-effective in protecting this building. The affected building is shown in Figure 37. At this time, none of the alternatives is cost effective, and no mitigation measures are proposed for this area..

Table 37. Mitigation Measures for Parview Area

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 55,528.00	$ 639,268.00	0.087	$ 42,685.00	$ 115,598.00	0.369	$ 48,265.00	$ 59,879.21	0.806

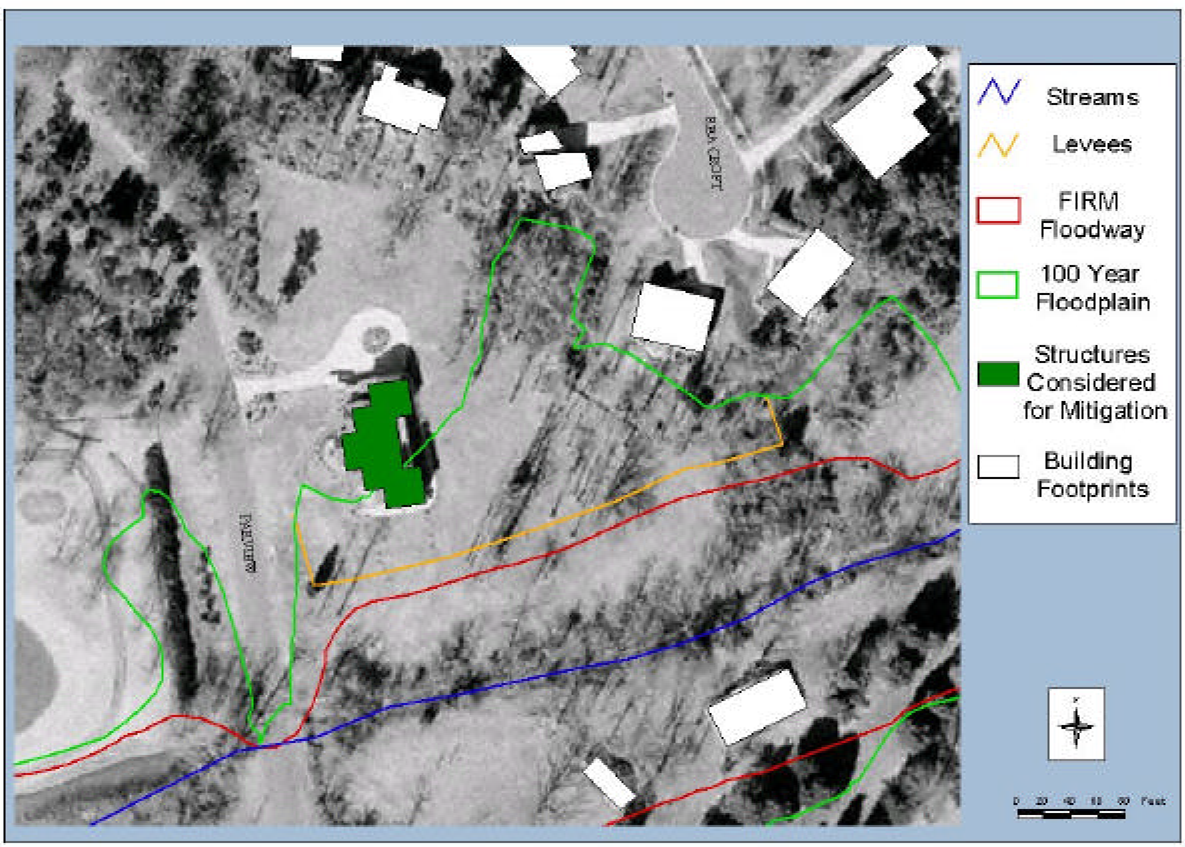


Fig. 37 Parview Area Mitigation Structure

Old Meadow/Riverton – McAlpine Trib 6

The summary of the benefit:cost analysis for this neighborhood is shown in Table 38. The highest benefit:cost ratio is 0.049 for the elevation option, which is well below the acceptable level of 1.0 to be economically feasible. There are 6 affected buildings as shown in Figure 38 (storage sheds and other structures marked on flooded lots). These buildings are situated at the limit of the detailed study. Levees cannot be used for protection of these buildings because of floodway infringement and blockage of the drainage path. None of the alternatives is cost effective, and no mitigation measures are proposed for this area.

Table 38. Mitigation Measures for Old Meadow/Riverton Neighborhood

Possible Mitigation Project								
Acquisition			Elevation			Levee		
Benefit	Cost	Ratio	Benefit	Cost	Ratio	Benefit	Cost	Ratio
$ 12,117.00	$ 699,845.00	0.017	$ 9,979.00	$ 202,858.00	0.049	$ 10,562.00	NA	NA

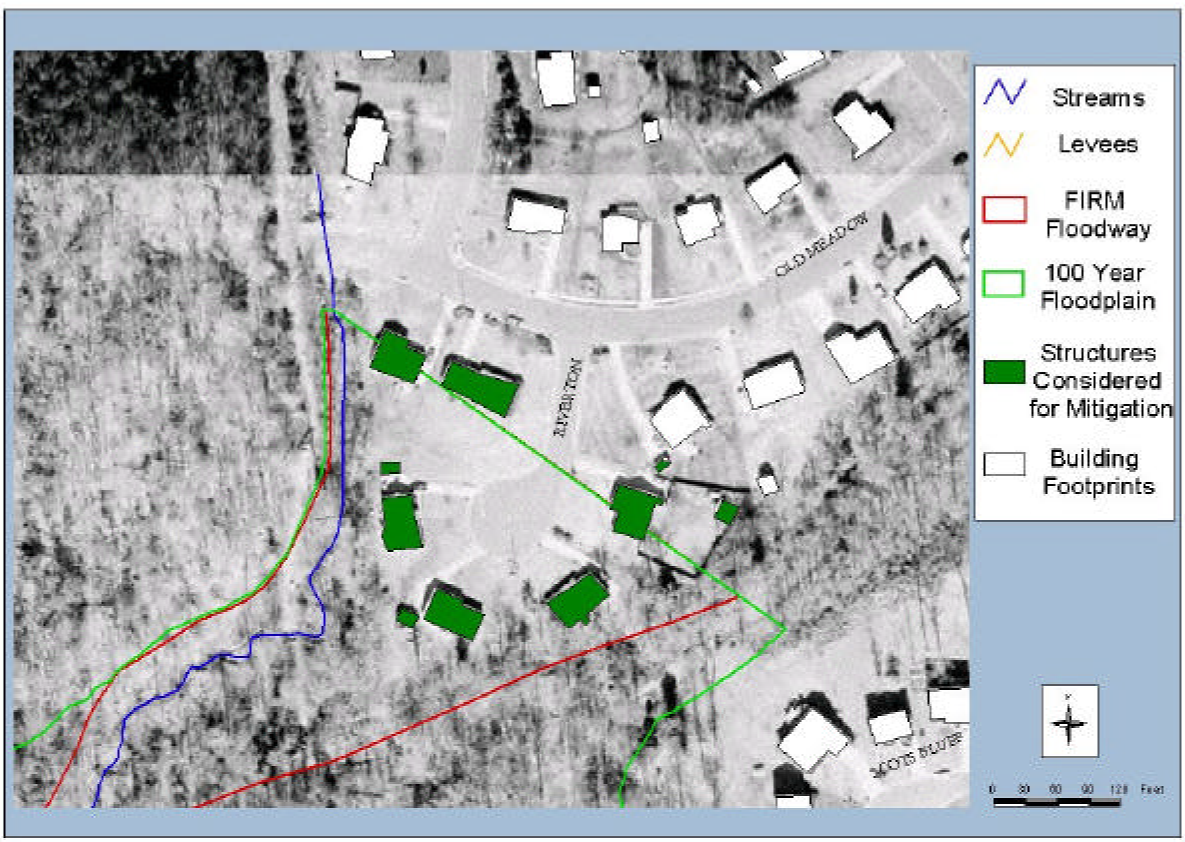


Fig. 38 Old Meadow/Riverton Neighborhood Mitigation Structures

Summary of the recommended Mitigation Alternatives

Based on the results as presented for individual neighborhoods or project areas, a summary of the mitigation measures which meet the economic criteria of a benefit:cost ratio greater than 1.0 are shown in Table 39. Also included in the table are cases where the benefit:cost ratio is high, but below the acceptance limit of any particular mitigation measure. Where there are multiple mitigation measures that meet the economic criteria for the same neighborhood, the alternative with a higher benefit:cost ratio would be economically the more feasible choice. However, values in this table are based on generalized costs of elevating a structure or construction of a levee. This table should serve as an advisory tool for further, more detailed analysis of areas where a mitigation measure may be undertaken.

Table 39. Summary of the Proposed Flood Mitigation Measures

Stream	Project Area/Neighborhood	No. of Structures	Mitigation Measure	B:C
McAlpine Creek				
	Bentway Dr/Green Rea Rd	2	Elevation	7.70
	Bentway Dr/Green Rea Rd	2	Levee	20.52
	Cedar Croft/CoolSprings/ Kirkstall/Knightswood/Providence Ln/Providence Rd/Rea/Rugby	13	Elevation	1.05
	Landing View	1	Elevation	1.24
	Landing View	1	Levee	3.29
Swan Run Branch				
	Blueberry Lane	1	Levee	1.01
Swan Run Branch				
	Blueberry Lane	1	Elevation	0.90
Rea Branch				
	Parview Drive	1	Levee	0.81

4. CONCLUSIONS AND RECOMMENDATIONS

The McAlpine Creek basin constitutes a mature section of Mecklenburg County. The basin may experience its ultimate development stage in the near future. McAlpine Creek and its main tributaries, McAlpine Trib 1, McAlpine Trib 1A, Rea Branch, McAlpine Trib 3, Swan Run Branch, Sardis Branch, Irvins Creek (including Irvins Trib 1 and 2), Campbell Creek, and McAlpine Trib 6 are all in a reasonably stable condition due to four main factors:

1. Stabilized stream banks because of a sewer main line extending along the creek

2. Heavily vegetated banks and floodplains

3. Numerous road crossings and other man-made structures, including physical stabilization measures, that form grade controls and limit bank erosion, head cutting, and stream scour

4. Past stabilization efforts along the creek

In the event of a 100-year flood, flooding hazard for the structures lining the banks of the creek may be identified in 27 general neighborhoods. A total of 109 structures are affected, of which 39 are located in the floodplain and 70 are located in flood fringe areas (within 2 ft of BFE). Of the three mitigation measures considered for the affected neighborhoods, namely elevating the structures, levee construction, and acquisition, one neighborhood meets the economic criteria for levee construction, one meets the criteria for elevation, and two neighborhoods meet the criteria for both. None of the identified flooded or potentially flooded areas meet the criteria for acquisition. The remaining 22 neighborhoods do not meet the economic criteria for any of the proposed mitigation measures. The "no action" option is recommended for those neighborhoods. Two of the neighborhoods show relatively high benefit:cost ratios for two of the recommended mitigation measures, and may be the subject of more detailed analysis at some time in the future.

There are several road crossings that are subject to overtopping in case of a 100-year flood. Flood depths over the roadway may be as high as 8 – 10 ft due to backwater, or 5.6 ft in one case for the future 100-year flood. Several mitigation measures should be considered for the road crossings of this watershed, which include warning signs for the approaching motorists, tall guardrails or indicators to guide the vehicles away from the edge of the road in case of a flash flood, raising the elevation of the road at the stream crossing, and emergency response team notification. Regular maintenance at man-made structures such as road crossings and storm water outfalls will be necessary to maintain the stream capacity and stability.

5. References

The following sources have been consulted in the preparation of this report

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