CITY OF GREENVILLE

FORK SWAMP
WATERSHED MASTER PLAN

WKD # 20140067.00.RA

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Prepared for

City of Greenville
1500 Beatty Street
Greenville, NC 27834

Prepared by
W. K. Dickson & Co., Inc.
Raleigh, NC
919/782/0495
NC License No. F-0374

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EXECUTIVE SUMMARY

The City of Greenville retained WK Dickson to complete a Master Plan for the Fork Swamp watershed. The goals of this master plan include: (1) evaluate the existing flooding, water quality and erosion problems, (2) recommend and prioritize capital improvements to control existing flooding by reducing the frequency and severity of flooding for property owners, and (3) identify stream stabilization projects to reduce the risk of property loss along streams and reduce sediment loads as a result of erosion. To assist in achieving the goals listed above, WK Dickson completed a stormwater drainage infrastructure inventory for drainage structures and features within the Fork Swamp watershed. Over 2,350 drainage structures and approximately 40 miles of drainage pipes was located and incorporated into a GIS database as part of this effort.

The project included a broad range of stakeholders to collect as much data, information, and tacit knowledge of the watershed as feasible. The general public was solicited through questionnaires mailed to all property owners in the watershed and through an open house public meeting where residents and business owners were encouraged to provide feedback on stormwater issues in the watershed. Information collected from the questionnaires and public meeting can be found in Section 2.1 and Appendix D. City staff served as a critical stakeholder by providing valuable information regarding historical flooding and erosion problems in the watershed as well as providing feedback on potential capital improvements and their prioritization.

The project watershed is approximately ten (10) square miles and is located in the south central portion of Greenville. Approximately 60% of the watershed is contained in the City limits, and it is 75% developed as predominantly residential land use. WK Dickson conducted an Existing Conditions Analysis in order to evaluate the existing hydrologic and hydraulic characteristics of the Fork Swamp watershed. Noted in this report as the Primary System are the following:

- Fork Swamp Main Branch;
- Unnamed Tributary 1 to Fork Swamp (referred to as FSUT1);
- Unnamed Tributary 2 to Fork Swamp Reach 1(referred to as FSUT2R1);
- Unnamed Tributary 2 to Fork Swamp Reach 2(referred to as FSUT2R2); and
- Unnamed Tributary 3 to Fork Swamp (referred to as FSUT3).

These Primary Systems were hydraulically studied in detail and were selected based on historical flooding of residential areas and roadways. Furthermore, high storm flows have eroded channel banks over time causing impacts to private yards, fences, and other property enhancements. In addition to the Primary Systems, select conveyance systems (referred to as secondary systems) in the Fork Swamp watershed were analyzed to determine if they meet the desired City design requirements outlined in Section 1.2. These secondary systems were identified based on feedback from City residents and staff.

As a result of the Existing Conditions Analysis, multiple capital improvement and maintenance projects were identified to reduce the severity and frequency of flooding, stabilize stream banks, and improve water quality through stormwater treatment practices. Additionally, the identified projects meet the City's design requirements outlined in Section 1.2 for future conditions.

The proposed capital projects are as follows with the locations of each project shown on Figure ES-1.

Flood Control Projects

Fork Swamp Main Branch Primary System

East Baywood Lane – The existing twin 72" corrugated metal pipes (CMPs) at this crossing are currently providing a 2-year level of service. The water surface elevations (WSELs) at East Baywood Lane are controlled by the backwater from the downstream railroad crossing. With the proposed downstream improvements, the resultant 25-year WSEL is reduced by over 2 feet. However, East Baywood Lane still does not meet the required 25-year level of service and will operate just below a 10-year level of service. Increasing the capacity at the crossing does not impact the WSEL since the culvert is in outlet control. Furthermore, there is no room available to incorporate floodplain benching immediately downstream of the crossing to try to lower the tailwater. Therefore, no capital improvements are proposed at this location. Reductions in flooding in the vicinity of East Baywood Lane will occur as a result of the railroad crossing and Evans Street projects described below.

Railroad Crossing – The existing twin 84" CMPs at this crossing are currently operating at a 25-year level of service. In order to aid in lowering the tailwater at East Baywood Lane, floodplain benches downstream of the railroad crossing in the left overbank are proposed for approximately 770 linear feet. The floodplain benching will improve the performance of the existing CMPs at the railroad crossing and bring it up to the desired 100-year level of service while also reducing water surface elevations in the Westhaven neighborhood upstream by increasing the cross-sectional area of flow. The proposed improvements would result in up to a 2.3-foot decrease in WSEL for the 25-year event. Lowering the tailwater at the railroad by installing floodplain benching is the only feasible alternative for reducing the water surface elevations in the upstream Westhaven neighborhood. Based on the model results 121 properties are at risk for lowest adjacent grade (LAG) flooding during the 25-year storm upstream of the railroad crossing. The combination of the Evans Street project and the railroad project will remove 15 of these properties from the 25-year floodplain. Approximately 25% of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. Additionally, the floodplain benching could be

coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Evans Street – The existing twin 84" CMPs at this crossing are currently providing a 25-year level of service. Since Evans Street is classified as a major thoroughfare, the desired level of service is the 50-year storm. This alternative entails replacing the existing CMPs with twin 7′ x 7′ RCBCs coupled with floodplain benching downstream of the crossing to lower the tailwater. The floodplain benching is proposed in the left overbank for approximately 1,200 linear feet. The improvements proposed will bring Evans Street up to the desired 50-year level of service. It should be noted that NCDOT has an upcoming widening project planned for Evans Street. In order to implement the culvert improvements with this planned roadway widening project, coordination with NCDOT will be required. Depending upon the timing, another option would be to complete this project in phases. Phase 1 would be the installation of the proposed floodplain benching followed by Phase 2, the culvert upgrades. The proposed improvements would result in up to a 2.9-foot decrease in WSEL for the 25-year event. As noted above, 15 out of the 121 properties are expected to be removed from the 25-year floodplain as a result of implementing the railroad and Evans Street improvements. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. Additionally, the floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

East Fire Tower Road – The existing bridge at this crossing is in good condition and currently performs at a 25-year level or service. Since East Fire Tower Road is a major thoroughfare, the desired level of service is the 50-year storm. In order to provide a 50-year level of service at this crossing, the recommended alternative is to reduce the tailwater by grading floodplain benches downstream of East Fire Tower Road. This alternative entails proposed floodplain benching in the right overbank for approximately 2,000 linear feet. The proposed improvements will bring East Fire Tower Road up to the desired 50-year level of service and provide a reduction in the severity, frequency, and duration of flooding for several properties along Treetops Circle. The proposed improvements would result in up to a 2.3-foot reduction in WSEL for the 25-year event. Additionally, four (4) out of six (6) properties may expect to be removed from the 25-year floodplain and twelve (12) properties from the 100-year floodplain. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Fork Swamp Main Branch Floodplain Benching – In addition to the improvements proposed at and near the individual road crossings, there is a proposed floodplain bench and stream stabilization project located along the main branch of Fork Swamp downstream of FSUT1 and

FSUT2. Approximately 2,670 linear feet of floodplain benching is proposed in the left and right overbank. The proposed project will reduce tailwater for FSUT1 and FSUT2, provide additional floodplain storage and remove four (4) and one (1) properties from the 25-year and 100-year floodplains, respectively. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

The total length of the proposed Fork Swamp Greenway is 3.3 miles. Approximately 1.25 miles of the proposed greenway overlaps with the floodplain benching limits. If possible construction of the benching and greenway should be coordinated.

Fork Swamp UT1 (FSUT1) Primary System

Trafalgar Drive – South – The twin 60" CMPs at this crossing are currently providing a 2-year level of service. In order to meet a 25-year level of service, the twin 60" CMPs will remain in place and an additional 60" floodplain culvert will be required along with a new headwall. The proposed improvements will WSEL for the 25-year storm by up to 0.67 feet upstream of Trafalgar Drive- South and remove one property from the 25-year floodplain.

Trafalgar Drive – North – The 60" and 66" CMPs at this crossing are operating at a 2-year level of service. To meet the desired 25-year level of service, it is proposed that the existing CMPs be removed and replaced with twin 8' x 5' RCBCs. The resulting upstream WSEL will be reduced by as much as 0.95 feet in the 25-year if improvements are completed in conjunction with those proposed at Corey Road as described below. This will bring two (2) properties out of the 25-year floodplain and two (2) additional properties out of the 100-year floodplain.

Corey Road – The existing twin 13' x 4.5' corrugated metal arch pipes at this crossing are relatively new and meet the desired 25-year level of service. However, the WSEL at the upstream Trafalgar Drive – North is impacted by the tailwater from Corey Road. In order to lower the tailwater, it is proposed that twin 48" floodplain culverts be installed along with approximately 2,300 linear feet of floodplain benching in the left and right overbanks downstream of Corey Road. The Corey Road improvements should be constructed prior to culvert upgrades at Trafalgar Drive to provide the desired level of service noted above. The proposed improvements would result in up to 2-foot reduction in WSEL for the 25-year event. This will bring one property out of the 25-year floodplain and an additional property out of the 100-year floodplain.

Fork Swamp UT2 Reach 1 (FSUT2R1) Primary System

Old Tar Road – The existing 72" CMP at this crossing is currently operating at a 2-year level of service. In order to meet the desired 50-year level of service, the existing CMP will need to be replaced with twin 7' x 8' RCBCs with 230 linear feet of floodplain benching in the left and right overbanks proposed downstream of Old Tar Road. The NCDOT maintained Old Tar Road is located immediately west of the existing City limits and the City's ETJ. A portion of the proposed floodplain benching along the left bank would be inside the City limits. Based on the location of the road crossing outside the City limits, the Old Tar Road project is not included as a capital project for the City of Greenville.

Fork Swamp UT2 Reach 2 (FSUT2R2) Primary System

West Fire Tower Road – The existing 10' x 8' reinforced concrete box culvert (RCBC) at this crossing is in good condition and is currently exceeding a 100-year level of service. Therefore, no capital improvements are proposed for West Fire Tower Road.

Fork Swamp UT3 (FSUT3) Primary System

Coleman Drive – The existing triple 10' x 4' RCBCs at this crossing are in good condition and currently meet the desired 25-year level of service. With the downstream improvements recommended along FSUT3, the RCBCs will continue to pass the 25-year storm. Therefore, no capital improvements are proposed at this location.

County Home Road – The twin 48" reinforced concrete pipes (RCPs) at this crossing currently pass a 10-year storm event. Based on its classification as a major thoroughfare, it is required to meet a 50-year level of service. It is proposed that the twin 48" RCPs remain in place and an additional 42" floodplain culvert be installed with approximately 240 linear feet of floodplain benching in the left overbank downstream of Country Home Road. The proposed improvements will bring the crossing up to a 50-year level of service and result in up to a 1.3-foot reduction in WSEL for the 25-year event. This will bring two (2) properties out of the 25-year floodplain and two (2) additional properties out of the 100-year floodplain.

East Fire Tower Road – U/S – The existing twin 54" RCPs at this crossing are currently providing a 2-year level of service. In order to meet the desired 50-year level of service, the twin 54" RCPs under East Fire Tower Road will be replaced with twin 6'x 6' RCBCs. The proposed improvements would result in up to a 1.5-foot reduction in WSEL for the 25-year event and one (1) property being removed from the 25-year floodplain.

Wimbledon Drive – The twin 60" CMPs at this crossing are currently providing a 2-year level of service. In order to meet a 25-year level of service, the twin 60" CMPs will be replaced with twin 10' x 5' RCBCs. Additionally, 245 linear feet of floodplain benching is proposed in the right overbank downstream of Wimbledon Drive. Final limits of the proposed benching may

change to minimize impacts to private property owners. The proposed improvements would result in up to a 1.2-foot reduction in WSEL for the 25-year event and removal of one property from the 25-year floodplain.

Tower Place – The twin 66" CMPs at this crossing are currently operating at a 2-year level of service. In order to meet a 25-year level of service, the twin 66" CMPs will be replaced with twin 10' x 5' RCBCs. The proposed improvements would result in up to a 1.0-foot reduction in WSEL for the 25-year event. This will bring two (2) properties out of the 25-year floodplain and one additional property out of the 100-year floodplain.

Summerhaven Drive – Currently, the twin 66" CMPs at this crossing provides a 2-year level of service. To meet a 25-year level of service, the twin 66" CMPs will be replaced with quad 6' x 6' RCBCs. It is proposed that 115 linear feet of floodplain benching be graded downstream of Summerhaven Drive to help lower the tailwater. The proposed improvements would result in up to a 1.2-foot reduction in WSEL for the 25-year event and seven (7) properties being removed from the 25-year floodplain.

East Fire Tower Road – D/S – The existing twin 10' x 7' corrugated metal ellipse pipes only pass the 2-year storm. To meet a 50-year level of service, it is proposed that the existing culverts be removed and replaced with quad 6' x 7' RCBCs. In addition to the culvert upgrade, a total of 3,240 linear feet of floodplain benching is proposed (990 linear feet upstream of the crossing in the left overbank and 2,250 linear feet downstream of the crossing in the left and right overbanks). The proposed improvements would result in up to 1.9 feet reduction in WSEL for the 25-year event. Additionally, forty-two (42) properties will be removed from the 25- and 100-year floodplain.

The floodplain benching could be coordinated with the proposed Fire Tower to Hub - Connector Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Secondary Systems

Corey Road Closed System – The majority of the system is operating at or above the required 10-year level or service. Therefore, the proposed improvements consist of minimal upgrades including upsizing the downstream discharge pipes along Southlea Drive. The proposed pipe improvements range in size from 24" to 48" RCP. The proposed improvements are expected to decrease WSELs by up to 1.7 feet for the 25-year event.

Trafalgar Drive Closed System – All segments of this system located in the Farrington subdivision are operating above the required 10-year level of service. Therefore, no capital improvements are proposed at this location.

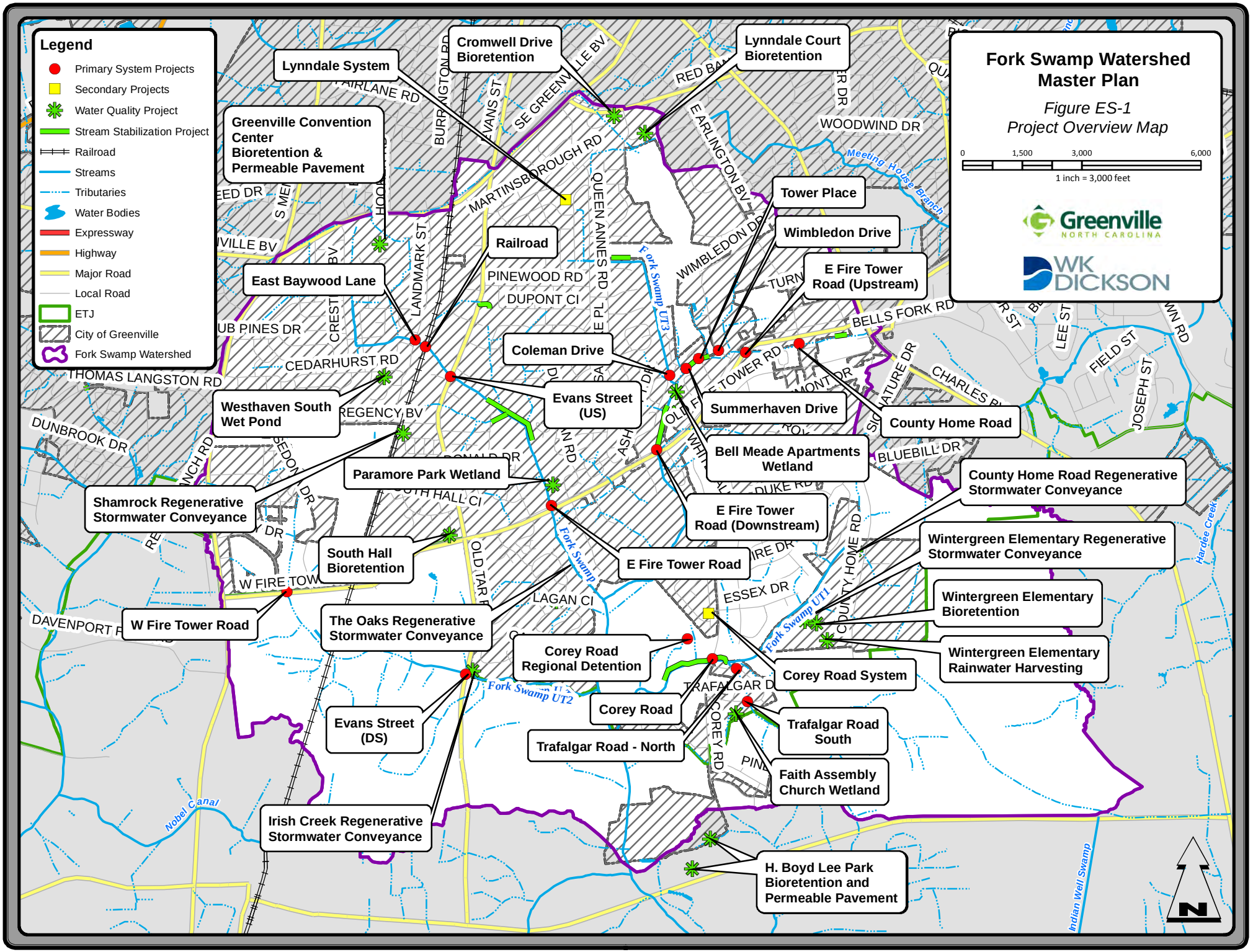
Lynndale System – Seven (7) questionnaires were received from the residents in the Lynndale subdivision reporting yard and street flooding. A study for this area has been completed with

proposed recommendations by River & Associates. The proposed design is included as part of this report. Due to the size of the project, it is recommended that the Lynndale system be completed in three (3) separate phases.

Evans Street Channels – Two (2) channel sections east of Evans Street and south of Pinewood Drive were reported by City staff as being eroded. The channel velocities calculated by the model range between 0.2 and 3.3 feet per second in the 10-year storm event. These channel sections were walked and evaluated by WK Dickson personnel. Based on this evaluation, a stream stabilization project (Project #7) is proposed along the upstream segment.

Regional Detention

A Corey Road facility is proposed in the southern part of the Fork Swamp watershed along FSUT1 adjacent to Corey Road. It is recommended to help offset peak flow increases that will be created as a result of the proposed upstream culvert upgrades. Based on the development of a cursory model, the proposed 20-acre detention pond would lower the flows in the 2-, 10-, 25-, 50-, and 100-year storms by 20 to 25 percent at the confluence of FSUT1 with Fork Swamp. These flow reductions continue through the downstream modeling limits of the Fork Swamp watershed. The regional detention facility will not impact the size of culverts along FSUT1 but will reduce the downstream flows (and therefore the water surface elevations) along the main branch of Fork Swamp. The location of this facility is close to the border of Winterville and outside of the existing City limits, although City residents upstream and downstream of this facility would benefit from the project. The proposed detention facility would be an opportunity to partner with this Winterville and potentially Pitt County. If 25-year detention is required in the areas shown in Section 4.3, then the size of the regional detention area can be substantially reduced to maintain no net increase in the 25-year storm at the study area limits for the future conditions.


Legend
Primary System Projects
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ETJ
City of Greenville
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Fork Swamp Watershed Master Plan
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Project Overview Map
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Lynndale System
Cromwell Drive Bioretention
Lynndale Court Bioretention
Greenville Convention Center Bioretention & Permeable Pavement
Tower Place
Wimbledon Drive
Railroad
East Baywood Lane
E Fire Tower Road (Upstream)
Coleman Drive
Evans Street (US)
Summerhaven Drive
County Home Road
Westhaven South Wet Pond
Bell Meade Apartments Wetland
Paramore Park Wetland
County Home Road Regenerative Stormwater Conveyance
Shamrock Regenerative Stormwater Conveyance
E Fire Tower Road (Downstream)
Wintergreen Elementary Regenerative Stormwater Conveyance
South Hall Bioretention
E Fire Tower Road
W Fire Tower Road
The Oaks Regenerative Stormwater Conveyance
Wintergreen Elementary Bioretention
Wintergreen Elementary Rainwater Harvesting
Corey Road Regional Detention
Corey Road System
Evans Street (DS)
Corey Road
Trafalgar Road South
Trafalgar Road - North
Faith Assembly Church Wetland
Irish Creek Regenerative Stormwater Conveyance
H. Boyd Lee Park Bioretention and Permeable Pavement
Fork Swamp UT3
Fork Swamp UT2
Fork Swamp UT1
Fork Swamp
Meeting House Branch
Hardee Creek
Indian Well Swamp
Nobel Canal
MARTINSBOROUGH RD
QUEEN ANNES RD
PINEWOOD RD
DUPONT CI
WOODWIND DR
EARLINGTON BV
WIMBLEDON DR
BELLS FORK RD
E FIRE TOWER RD
CEDARHURST RD
THOMAS LANGSTON RD
DUNBROOK DR
REGENCY BV
BLUEBILL DR
SOUTH HALL CI
LAGAN CI
ESSEX DR
TRAFALGAR D
COREY RD
COUNTY HOME RD
OLD TAR R
LANDMARK ST
EVANS ST
FIELD ST
JOSEPH ST
LEE ST
CHARLES P
DAVENPORT F
N

Flood Control Prioritization

To appropriately allocate City resources, the flood control projects listed above were prioritized based on the following categories as described in Appendix L:

- Public health and safety
- Severity of street flooding
- Cost effectiveness
- Effect of improvements
- Water quality – BMP
- Open channel – erosion control
- Implementation constraints
- Grant funding
- Constructability

Scores were assigned to each project for the factors listed above to determine the priority list. In some instances, project prioritization will be impacted by the required sequencing of projects to provide the highest possible flood reduction benefits and to reduce or negate any downstream impacts from the proposed projects. Tables ES-1 and ES-2 show the proposed prioritizations and conceptual cost estimates for the Flood Control Improvements. The City should re-visit the prioritization lists annually to determine if priorities should shift. The prioritization scoring for each project and a description of the aforementioned categories is included in Appendix L. The total cost for all of the recommended primary and secondary system improvements in the Fork Swamp watershed is approximately $31,730,000.

Table ES-1: Flood Control Project Prioritization – Primary Systems

Prioritization	Project	Cost
1	Railroad Crossing (Fork Swamp)	$1,000,000
2	Summerhaven Drive (FSUT3)	$650,000
3	Evans Street (Fork Swamp)	$1,920,000
4	Trafalgar Drive - South (FSUT1)	$180,000
5	County Home Road (FSUT3)	$210,000
6	Tower Place (FSUT3)	$640,000
7	East Fire Tower Road (Fork Swamp)	$1,740,000
8	Trafalgar Drive - North (FSUT1)	$440,000
9	Corey Road (FSUT1)	$6,870,000
10	Wimbledon Drive (FSUT3)	$610,000
11	Fork Swamp Main Branch Floodplain Benching	$5,240,000
12	East Fire Tower Road - Downstream (FSUT3)	$4,000,000
13	East Fire Tower Road - Upstream (FSUT3)	$680,000
	Total	$24,180,000

See Appendix L for prioritization details.

Table ES-2: Flood Control Project Prioritization – Secondary Systems

Prioritization	Project	Cost
1	Lynndale Closed System Phase I	$1,010,000
2	Lynndale Closed System Phase II	$3,420,000
3	Lynndale Closed System Phase III	$2,750,000
4	Corey Road Closed System	$370,000
	Total	$7,550,000

See Appendix L for prioritization details.

The additional cost to construct the Corey Road Regional Detention Facility would be $9,500,000 which would include anticipated land acquisition costs.

Stream Stabilization and Water Quality Projects

During the Existing Conditions Analysis, the majority of the streams were quantitatively assessed for stability. Based on this assessment, seven (7) stream stabilization projects were identified as shown on Figure ES-1. Potential components of the stabilization project include, flattening the slope of the channel banks, installing erosion control matting and plantings, rock grade control structures, retaining walls, and rip-rap. The stabilization project will protect residential yards, fences, and structures from further erosion, and substantially decrease the in-stream sediment loads to downstream receiving waters.

In additions to the stream stability projects, eighteen (18) water quality BMP retrofit projects were recommended. Potential project locations were initially identified using available GIS data by focusing on locations with contributing drainage areas that are highly impervious and preferably on publically-owned land. Impervious areas typically generate the highest concentration of pollutants, so treating the runoff from these areas would provide more pollutant material than treating water that carried fewer pollutants. Publically-owned land is ideal for BMP retrofits to reduce or eliminate potential land acquisition costs. See Section 5.2 for additional evaluation criteria for BMP retrofit sites. Potential locations that were identified using GIS were then presented to the City. Following concurrence with the City, the final list of BMPs were field inspected to determine any project constraints present that may not be discernible from GIS data, such as utility conflicts, limited access to the site, or private property conflicts.

The stream stabilization and water quality projects were prioritized using categories similar to those used to prioritize the flood control projects described above (See Appendix L). Cost effectiveness for the stream stabilization project was calculated based on a cost per linear foot of stabilized stream while for water quality projects, it was calculated based on a cost per impervious acre treated. Tables ES-3 and ES-4 show the prioritization of the stream stabilization and water quality projects along with estimates of their preliminary cost.

Table ES-3: Stream Stabilization Prioritization

Prioritization	Project	Cost
1	Evans Street	$130,000
2	Live Oak Lane	$280,000
3	Tower Place	$140,000
4	Charles Boulevard	$90,000
5	East Fire Tower Road	$230,000
6	Queen Annes Road	$220,000
N/A*	Corey Road*	$590,000
	Total	$1,090,000*

*The Corey Road Stream Project is located outside City Limits and therefore was not ranked or included in the total cost. However, improvements will benefit residents in the City limits. See Appendix L for prioritization details.

Table ES-4: Water Quality Project Prioritization

Prioritization	Project	Cost
1	WGP Properties Regenerative Stormwater Conveyance	$60,000
2	H. Boyd Lee Park Bioretention	$340,000
3	Wintergreen Elementary Rainwater Harvesting	$20,000
4	Wintergreen Elementary Bioretention	$310,000
5	South Hall Bioretention	$240,000
6	Lynndale Court Bioretention	$150,000
7	Shamrock Regenerative Stormwater Conveyance	$130,000
8	Paramore Park Wetland	$210,000
9	H. Boyd Lee Park Permeable Pavement	$970,000
10	County Home Road Regenerative Stormwater Conveyance	$490,000
11	The Oaks Regenerative Stormwater Conveyance	$200,000
12	Wintergreen Elementary Regenerative Stormwater Conveyance	$180,000
13	Cromwell Drive Bioretention	$350,000
14	Belle Meade Apartments Wetland	$570,000
15	Faith Assembly Church Pond Retrofit	$270,000
16	Westhaven South Wetland	$820,000
17	Irish Creek Regenerative Stormwater Conveyance	$250,000
18	Greenville Convention Center Permeable Pavement	$2,870,000
	Total	$8,430,000

See Appendix L for prioritization details.

25-Year Detention Analysis

As part of the Fork Swamp Master Plan, an analysis was completed to determine if there are areas within the watershed that should be considered "well documented water quantity problems" requiring detention for the 25-year, 24-hour storm event. As noted in Section 3.1, documented flooding issues are located along Fork Swamp Main Branch, Unnamed Tributary 3, and Unnamed Tributary 1 including the area between Baywood Lane and Treetops Circle along Fork Swamp Main Branch, the area between Corey Road and Trafalgar Drive along Unnamed Tributary 1, and the area between East Fire Tower Road and County Home Road along Unnamed Tributary 3. Large portions of the Fork Swamp watershed are already fully developed, however there are some areas of the watershed where the future conditions 25-year flows could be greater than 10% higher than the current existing flows. These areas are outlined in Section 4.3.

If 25-year detention is required in the proposed areas, the need for culvert improvements will not be eliminated but the recommended culvert sizes could be decreased. Although the cost savings to the City would not be substantial, the severity, frequency, and duration of flooding would be reduced, which would in return provide savings to the property owners.

The Corey Road Regional Detention area is the largest portion of the overall cost for flood control projects in the Fork Swamp watershed ($9,500,000). As previously noted, this project is proposed to address increases in the 25-year flows as a result of increasing upstream capacity and proposed future development. If the City requires 25-year detention for portions of the watershed as shown in Section 4.3, the size of the Corey Road regional detention area can be reduced, which would substantially lower the cost of the proposed detention area by approximately $5 million.

INTRODUCTION

1.1 PROJECT DESCRIPTION

The City of Greenville retained WK Dickson to complete a Watershed Master Plan for the Fork Swamp watershed. As shown in Figure 1-1, the Fork Swamp watershed is located in the south central portion of Greenville and generally drains north to south ultimately discharging to the Neuse River. As noted in the Executive Summary, the goals of the Master Plan include: (1) evaluate the existing flooding, water quality and erosion problems, (2) recommend and prioritize capital improvements to control existing flooding by reducing the frequency and severity of flooding for property owners, and (3) identify stream stabilization projects to reduce the risk of property loss along streams and reduce sediment loads as a result of erosion. To assist in achieving the goals listed above, WK Dickson completed a stormwater drainage infrastructure inventory for drainage structures and features within the Fork Swamp watershed.

The Master Plan includes an evaluation of the segment of Fork Swamp from East Baywood Lane at the upstream end to approximately 900 feet upstream of the Worthington Road crossing at the existing City limits. The following tributaries were evaluated as part of this Master Plan:

- Fork Swamp UT1 from approximately 250 feet upstream of the Trafalgar Drive – South crossing at the upstream end to its confluence with Fork Swamp at the downstream end;
- Fork Swamp UT2R1 from the Old Tar Toad crossing at the upstream end to its confluence with Fork Swamp at the downstream end;
- Fork Swamp UT2R2 from approximately 300 feet downstream of the Regency Boulevard crossing at the upstream end to the West Fire Tower Road crossing at the downstream end; and
- Fork Swamp UT3 from the Queen Annes Road crossing and Charles Boulevard at the upstream end to its confluence with Fork Swamp at the downstream end.

Additionally, four (4) conveyance systems that drain to the primary systems were evaluated. For the purposes of this report, Fork Swamp and its tributaries (FSUT1, FSUT2R1, FSUT2R2, and FSUT3) will be noted as primary systems and the conveyance systems will be noted as secondary systems. A project area map showing the Fork Swamp watershed and the conveyance systems evaluated as part of this Master Plan is included as Figure 1-2. Detailed hydraulic analysis included the following:

- Primary System – Fork Swamp
    - East Baywood Lane Culvert
    - Railroad Crossing Culvert
    - Evans Street Culvert
    - East Fire Tower Road Bridge

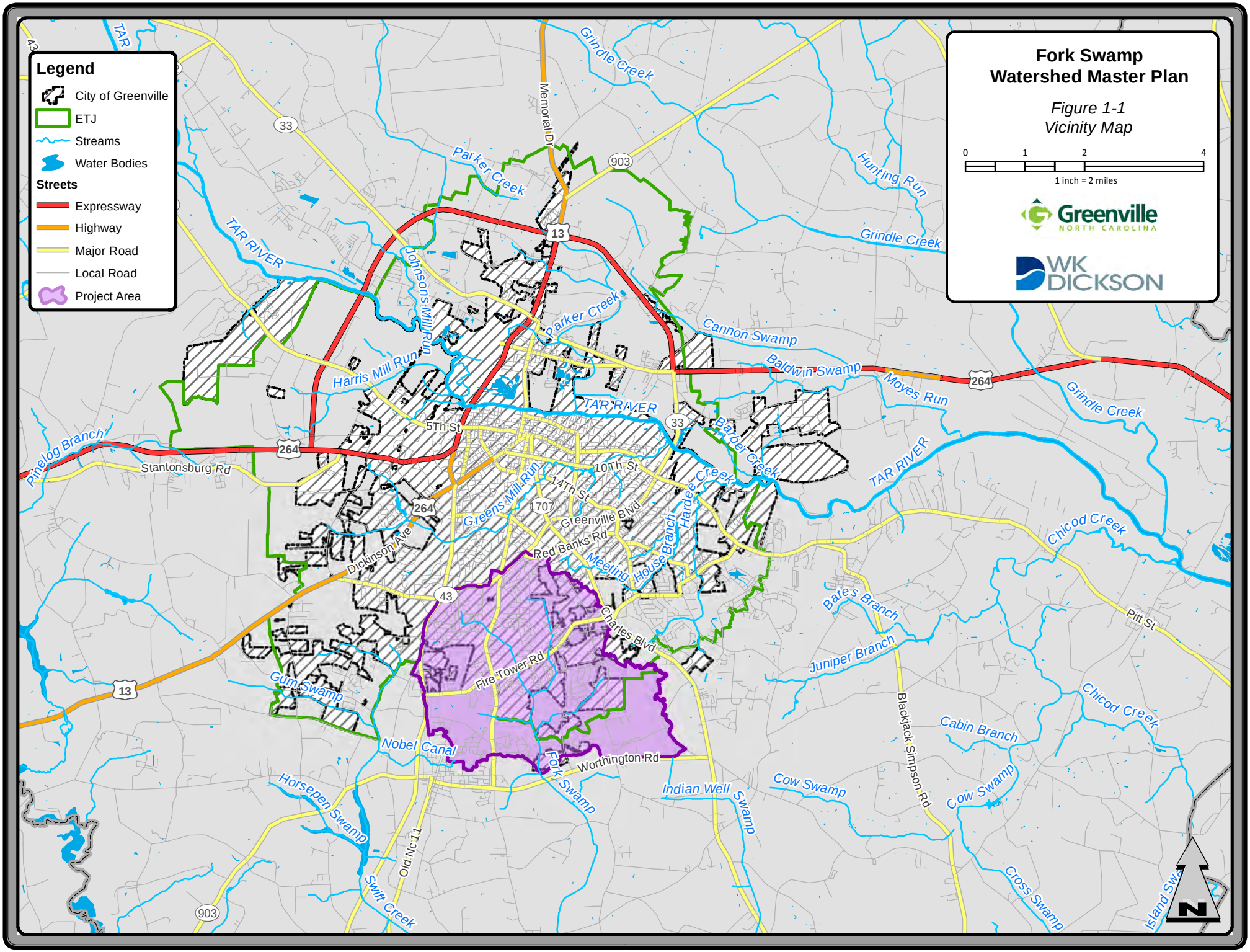
- Primary System – FSUT1
  - Trafalgar Drive – South Culvert
  - Trafalgar Drive – North Culvert
  - Corey Road Culvert

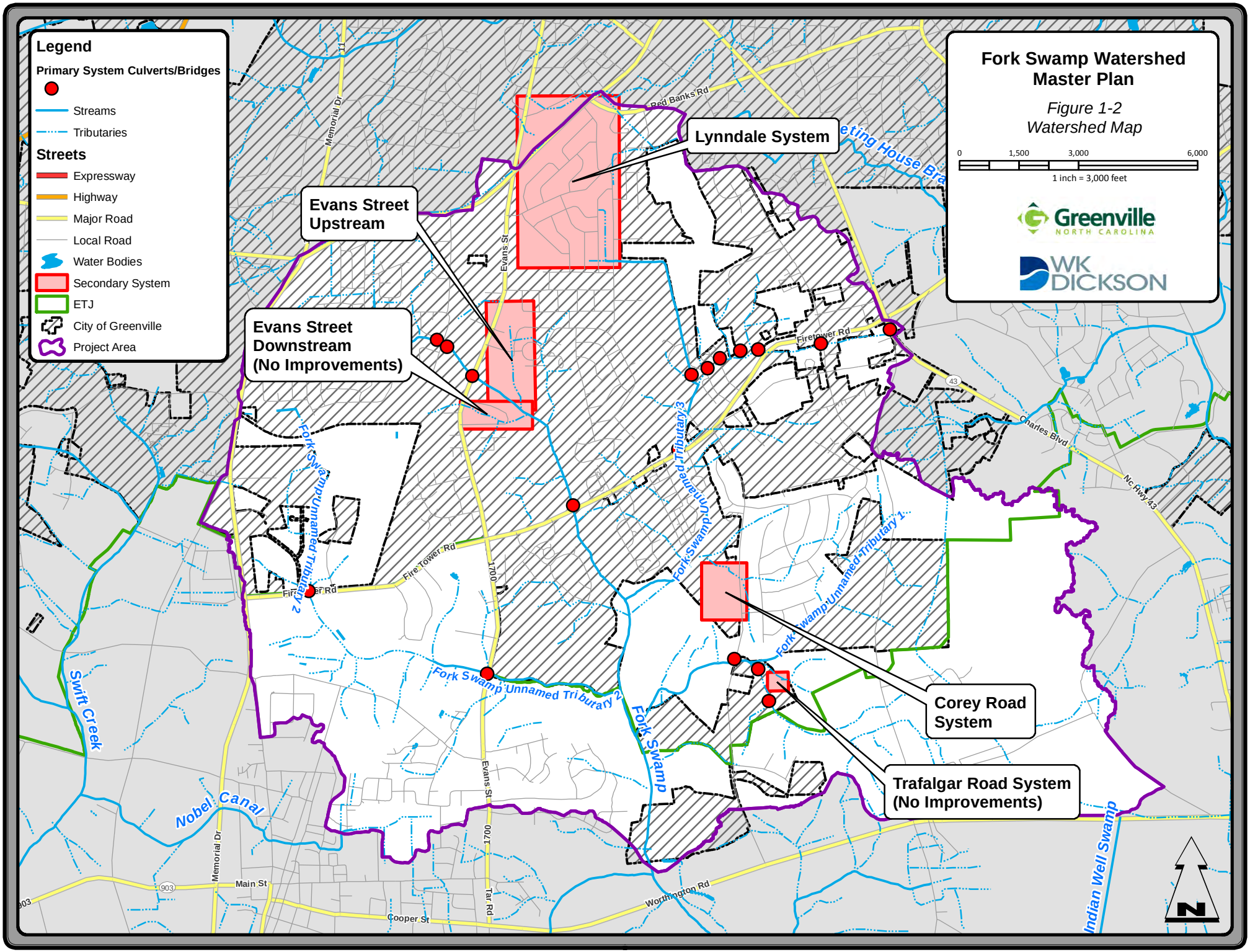
- Primary System – FSUT2R1
  - Old Tar Road Culvert

- Primary System – FSUT2R2
  - West Fire Tower Road Culvert

- Primary System – FSUT3
  - Coleman Drive Culvert
  - County Home Culvert
  - East Fire Tower Road – Upstream Culvert
  - Wimbledon Drive Culvert
  - Tower Place Culvert
  - Summerhaven Drive Culvert
  - East Fire Tower Road – Downstream Culvert

- Secondary Systems
  - Corey Road System
  - Trafalgar System
  - Lynndale System
  - Evans Street Channel System


Legend
City of Greenville
ETJ
Streams
Water Bodies
Streets
Expressway
Highway
Major Road
Local Road
Project Area
Fork Swamp
Watershed Master Plan
Figure 1-1
Vicinity Map
0
1
2
4
1 inch = 2 miles
Greenville
NORTH CAROLINA
WK DICKSON
Grindle Creek
Memorial Dr
Parker Creek
Hunting Run
TAR RIVER
Johnsons Mill Run
Harris Mill Run
Cannon Swamp
Baldwin Swamp
Moyes Run
Pinelog Branch
Stantonsburg Rd
5Th St
10Th St
14Th St
Greens Mill Run
Barber Creek
Hardee Creek
Greenville Blvd
Red Banks Rd
Meeting House Branch
Dickinson Ave
Chicod Creek
Bates Branch
Pitt St
Charles Blvd
Fire Tower Rd
Juniper Branch
Gum Swamp
Nobel Canal
Worthington Rd
Blackjack Simpson Rd
Cabin Branch
Horsepen Swamp
Old Nc 11
Swift Creek
Indian Well Swamp
Cow Swamp
Cross Swamp
33
903
13
264
43
1707
N


Legend
Primary System Culverts/Bridges
Streams
Tributaries
Streets
Expressway
Highway
Major Road
Local Road
Water Bodies
Secondary System
ETJ
City of Greenville
Project Area
Fork Swamp Watershed Master Plan
Figure 1-2
Watershed Map
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Lynndale System
Evans Street Upstream
Evans Street Downstream (No Improvements)
Corey Road System
Trafalgar Road System (No Improvements)
Red Banks Rd
Memorial Dr
Evans St
Fire Tower Rd
Firetower Rd
Charles Blvd
NC Hwy 43
Fork Swamp Unnamed Tributary 2
Fork Swamp Unnamed Tributary 3
Fork Swamp Unnamed Tributary 1
Fork Swamp
Swift Creek
Nobel Canal
Main St
Cooper St
Worthington Rd
Tar Rd
Indian Well Swamp
1700
903
43
N

1.2 DESIGN STANDARDS AND CRITERIA

The following design storms were used to evaluate the performance of the primary and secondary systems in this Master Plan:

- 10-year storm event – piped collection systems;
- 25-year storm event – minor thoroughfare roadway bridges and culverts;
- 50-year storm event – major thoroughfare roadway bridges and culverts;
- 100-year storm event – structural flooding of homes; and
- 100-year storm event – overtopping of railroad.

Table 1-1 shows the applicable storm for the project areas evaluated as part of this Master Plan. The corresponding rainfall depths for the design storms are included in Appendix A.

Table 1-1: Project Area Design Standards and Criteria

Drainage Type	Design Storm (years)	Project Area
Piped Collection Systems	10	• Corey Road System • Trafalgar System • Lynndale System
Minor Thoroughfare Roadway Crossings	25	• East Baywood Lane Culvert (Fork Swamp) • East Fire Tower Road Bridge (Fork Swamp) • Trafalgar Drive – South Culvert (FSUT1) • Trafalgar Drive – North Culvert (FSUT1) • Corey Road Culvert (FSUT1) • Old Tar Road Culvert (FSUT2R1) • Coleman Drive Culvert (FSUT3) • Wimbledon Drive Culvert (FSUT3) • Tower Place Culvert (FSUT3) • Summerhaven Drive Culvert (FSUT3)
Major Thoroughfare Roadway Crossings	50	• Evans Street Culvert (Fork Swamp) • West Fire Tower Road Culvert(FSUT2R2) • County Home Road Culvert (FSUT3) • East Fire Tower Road – U/S Culvert (FSUT3) • East Fire Tower Road – D/S Culvert (FSUT3)
Railroad Crossing	100	• Fork Swamp – Culvert

EXISTING WATERSHED CONDITIONS

2.1 CITIZEN INPUT

The Master Plan included a citizen input component to solicit feedback and information regarding stormwater impacts and future stormwater management in the City. In August of 2014, the City began distribution of questionnaires related to stormwater management property owners in the Fork Swamp watershed. Thirty-six (36) questionnaires were completed and returned to the City for consideration from Fork Swamp watershed property owners. The questionnaire results were georeferenced according to the address of the questionnaire respondent (See Figure 2-1). There was one response that was located outside of the City limits. Seven (7) of the respondents indicated some level of property flooding, with one (1) property owners experiencing living space flooding, (4) four crawl space flooding, and 2 (two) AC/storage at least once per year. Twenty-four (24) respondents identified locations where street flooding occurs while another ten (10) residents reported yard flooding. A total of five (5) residents reported erosion threatening streets, yards, garages, or fences. See Figure 2-2 for locations of reported erosion. A sample questionnaire and the tabulated results are provided in Appendix D.

On November 4, 2014, the City provided another avenue for obtaining citizen input by holding a public meeting. An open house format allowed property owners to attend at their convenience and speak to City staff or representatives from WK Dickson. Nine (9) residents from the watershed provided feedback at the meeting. All of these residents were located within the City limits. Minutes from this meeting are included in Appendix D. The results and comments from the citizen's input contributed significantly to the identification and prioritization of problem areas, and validation of model results.

2.2 WATERSHED CHARACTERISTICS

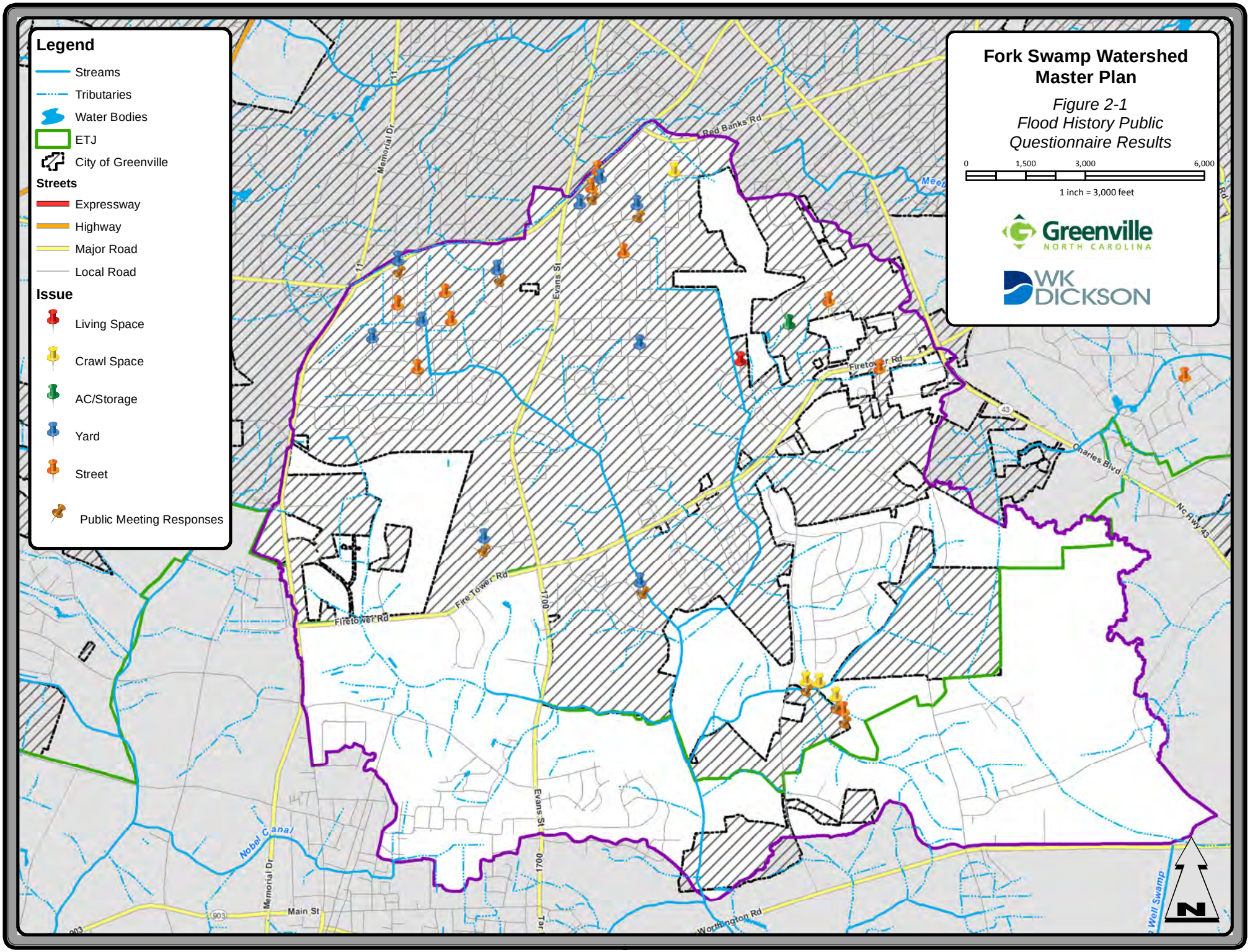
The Fork Swamp watershed is approximately 6,800 acres (10.6 square miles) between its downstream boundary in the vicinity of Worthington Road and its upstream boundary along SE Greenville Boulevard. Approximately 60% of this total watershed area is located within the City limits. Land use in the watershed is approximately 75 percent built out as shown on the Existing Conditions Land Use Map included in Appendix C. The existing land use in the watershed is mostly residential and smaller percentages of commercial, office, and institutional (See Table 2-1a). The soils within the watershed are predominately NRCS hydrologic groups B/D and C as shown on the Soils Map included in Appendix C. More detailed information about the land use and soils in the Fork Swamp watershed is provided in Appendix A.

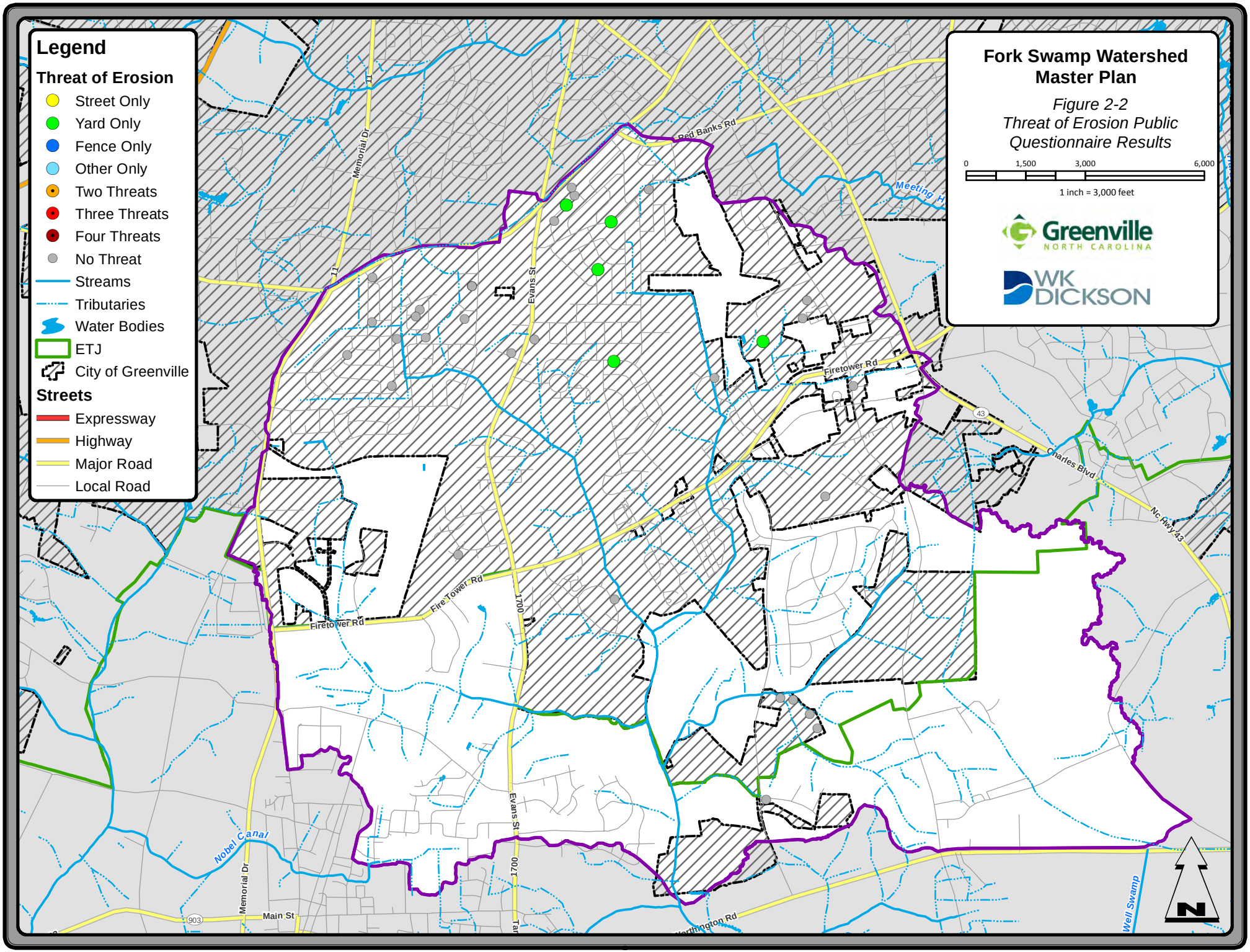
Table 2-1a: Fork Swamp Watershed Existing Land Use

Land Use Category	Area (acres)
Commercial	452
Mixed Use/Office/Institutional	29
Office/Institutional/Multi-Family	293
Office/Institutional/Medical	67
High Density Residential	508
Medium Density Residential	1,149
Low Density Residential	572
Very Low Density Residential	905
Conservation/Open Space	2,067
Right-of-Way	733
Industrial	32

Table 2-1b: Fork Swamp Watershed Future Land Use

Land Use Category	Area (acres)
Commercial	617
Mixed Use/Office/Institutional	33
Office/Institutional/Multi-Family	381
Office/Institutional/Medical	67
High Density Residential	623
Medium Density Residential	2,074
Low Density Residential	576
Very Low Density Residential	1,146
Conservation/Open Space	628
Right-of-Way	733
Industrial	32


Legend
Streams
Tributaries
Water Bodies
ETJ
City of Greenville
Streets
Expressway
Highway
Major Road
Local Road
Issue
Living Space
Crawl Space
AC/Storage
Yard
Street
Public Meeting Responses
Fork Swamp Watershed Master Plan
Figure 2-1
Flood History Public Questionnaire Results
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Red Banks Rd
Memorial Dr
Evans St
Fire Tower Rd
Firetower Rd
Charles Blvd
NC Hwy 43
Main St
Worthington Rd
Nobel Canal
Well Swamp
N


Legend
Threat of Erosion
Street Only
Yard Only
Fence Only
Other Only
Two Threats
Three Threats
Four Threats
No Threat
Streams
Tributaries
Water Bodies
ETJ
City of Greenville
Streets
Expressway
Highway
Major Road
Local Road
Fork Swamp Watershed Master Plan
Figure 2-2
Threat of Erosion Public Questionnaire Results
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Red Banks Rd
Memorial Dr
Evans St
Firetower Rd
Fire Tower Rd
Charles Blvd
NC Hwy 43
Nobel Canal
Main St
Worthington Rd
Well Swamp
N

2.3 EXISTING CONDITIONS SURVEY AND FIELD DATA COLLECTION

For the Fork Swamp Watershed Master Plan, stormwater utility infrastructure throughout the watershed was collected by WK Dickson and River & Associates personnel to compile a Geographic Information System (GIS) stormwater inventory database for the City. This was accomplished by using Global Positioning Systems (GPS) at the primary means of data capture. Survey grade employed GPS to locate the x, y, and z coordinates of each visible stormwater system structure and conventional surveying techniques to obtain attributes including but not limited to size, material, slope, and length. The data was collected using horizontal datum NAD 1983 and vertical datum NAVD 1988. A total of 2,379 closed system structures and 208,261 linear feet of pipe were collected as part of the inventory. Tables 2-2 and 2-3 summarize the inventory collected in the Fork Swamp watershed.

Table 2-2: Inventory Summary – Closed System Structures

Structure Type	Number Surveyed
Yard Inlet	220
Drop Inlet	65
Junction Box	103
Pipe End	533
Pond Structure	8
Slab Top Inlet	8
Catch Basin	1,416
Underground Pipe Junction	26

Table 2-3: Inventory Summary – Pipes

Size	Length (Linear Feet)
12″ Diameter	152
15″ Diameter	35,292
18″ Diameter	40,753
24″ Diameter	47,174
30″ Diameter	27,939
36″ Diameter	23,640
42″ Diameter	10,895
48″ Diameter	9,458
54″ Diameter	2,647
60″ Diameter	2,036
66″ Diameter	799
72″ Diameter	525
84″ Diameter	382

Data was obtained for those open channels required to complete connectivity for modeling purposed. Attributes such as shape, lining type, bed type, flow, bottom width, top width, and bank heights were collected for 160 open channel sections totaling over 24 miles in length. For those sections of open channel where more detailed information was required for model input, cross sections were surveyed. Data including elevations for the top of the back, bottom of bank, and channel centerline was obtained for eighty-nine (89) cross sections to supplement the existing FEMA Cross section data. One (1) bridge was also included in the inventory. Refer to the City of Greenville's Storm Water System Inventory Standard Operating Procedures for additional information about the processes and details of the inventory database.

EXISTING WATERSHED ANALYSIS

3.1 PRIMARY SYSTEM HYDROLOGIC AND HYDRAULIC ANALYSES

3.1.1 HYDROLOGY

The purpose of the hydrologic analysis is to estimate the magnitude of selected frequency floods for the Fork Swamp Watershed. The United States Army Corps of Engineers (USACE) HEC-HMS was selected to model the primary systems. HEC-HMS simulates the surface runoff response to precipitation for an interconnected system of surfaces, channels, and ponds. Input data for the HEC-HMS model was developed using topographic, land use, and soils maps in GIS to delineate and calculate the basin areas and Natural Resources Conservation Service (NRCS) hydrologic parameters. Detailed descriptions of the model parameters can be found in Appendices A and B.

The HEC-HMS model offers a variety of methods for simulating the rainfall-runoff response, hydrograph development, channel and pond routing. The selection of methods for the analyses is based on the study objectives, data availability, and watershed characteristics. The precipitation data for the 24-hour duration, Type III storm was used to represent the synthetic rainfall event. The Type III storm was selected based on the location of the City of Greenville. The geographic boundaries for the different NRCS rainfall distributions are shown on Figure B-2 of NRCS document Urban Hydrology for Small Watersheds, dated June 1986 and commonly referred to as TR-55 (See Appendix A). As shown in TR-55 for the coastal regions of North Carolina including Greenville, a Type III storm is more characteristic. The NRCS curve number approach was selected to calculate runoff volumes from the precipitation data, and the sub-basin unit hydrographs for these flood volumes were developed using the NRCS lag times.

Peak flows for the primary systems were developed for the 2-, 10- , 25- , 50- and 100-year storm events. The existing conditions flows were developed assuming attenuation occurs at the following locations:

- East Baywood Lane (Fork Swamp)
- Railroad Crossing (Fork Swamp)
- Evans Street (Fork Swamp)
- Corey Road (FSUT1)
- Trafalgar Drive - North (FSUT1)
- Trafalgar Drive - South (FSUT1)
- West Fire Tower Road (FSUT2R2)
- County Home Road (FSUT3)
- East Fire Tower Road – Upstream (FSUT3)
- Wimbledon Drive (FSUT3)
- Tower Place (FSUT3)
- Coleman Drive (FSUT3)

Storage routing was modeled just upstream of the culverts listed above because of the large storage volume available behind the pipe's entrance. The culverts that have not been included provide little to no accessible storage volume in the area upstream of its respective crossing. The results of the hydrologic model used as input for HEC-RAS are summarized in Table 3-1. A hard copy of the HEC-HMS output is included as Appendix H. The CD found in Appendix J contains this digital information.

Table 3-1: Existing Conditions Flows from HEC-HMS for Fork Swamp Watershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
FORK SWAMP							
East Baywood Lane	East Baywood Lane	55891	188	352	468	569	681
Railroad	Railroad	55592	251	475	629	765	916
Evans Street	Evans Street	54609	256	486	642	784	937
E Fire Tower Road (Bridge)	East Fire Tower Road	50168	438	844	1,138	1,395	1,681
ADD FSUT3 to FS	Confluence of FSUT3 and Fork Swamp	46863	538	1,055	1,414	1,756	2,122
ADD FSUT2	Confluence of FSUT2 and Fork Swamp	44420	757	1,477	2,003	2,486	3,052
ADD FSUT1	Confluence of FSUT1 and Fork Swamp	43230	963	1,937	2,637	3,288	4,025
FORK SWAMP UT1							
U/S Limit FSUT1	Upstream Limit of FSUT1/Trafalgar Drive – South	5103	107	223	309	387	474
Trafalgar Drive	Trafalgar Drive – North	4235	111	231	319	399	490
Corey Road – FSUT1	Corey Road	3380	195	410	577	719	897
FORK SWAMP UT2R1							
ADD FSUT2-7B	Old Tar Road	3499	215	439	604	752	914
FORK SWAMP UT2R2							
U/S Limit FSUT2	Upstream Limit of FSUT2	4262	49	90	118	143	171
West Fire Tower	West Fire Tower Road	303	99	201	276	343	419
FORK SWAMP UT3							
U/S Limit FSUT3	Upstream Limit of FSUT3	4360	108	213	290	358	434

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
Coleman Drive	Coleman Drive	289	141	290	401	500	612
County Home	County Home Road	10420	62	113	148	178	211
East Fire Tower Road – North	East Fire Tower Road – U/S	8790	89	163	202	250	295
Wimbledon Drive	Wimbledon Drive	8238	142	260	331	409	486
Tower Pl_ Summerhaven Dr	Tower Place/ Summerhaven Drive	7694/ 7287	159	302	392	487	583
East Fire Tower Road - South	East Fire Tower Road – D/S	5065	308	610	810	1,012	1,220

3.1.2 HYDRAULICS

The purpose of the hydraulic analysis is to determine an existing level of flooding for the storm drainage network and to develop proposed solutions to mitigate flooding. The USACE HEC-RAS was selected to model the primary systems to remain consistent the existing FEMA modeling. HEC-RAS calculates water surface profiles for steady, gradually varied flow in channels and floodplains. The standard backwater analysis for sub-critical flow was modeled for the Fork Swamp Watershed. The model calculates the effect of obstructions, such as culverts, and building structures in the channel and floodplain on the water surface profile. The hydraulic computations are based on the solution of a one-dimensional energy equation with energy loss due to friction evaluated by Manning's equation. Input data for HEC-RAS include the following:

- Cross-section geometry of the channel and floodplain;
- Roughness coefficients to describe characteristics of the channel and floodplain;
- Size, shape, and characteristics of culverts and roadways along the stream reach; and
- Energy loss coefficients for flow in the channel and at roadway crossings.

Channel cross sections utilized in the HEC-RAS model were based on the existing FEMA cross sections and WK Dickson surveyed cross sections. The channel cross sections were merged with State LiDAR data to develop cross sections spanning the entire floodplain area.

There were five (5) separate HEC-RAS models developed to analyze the stream reaches located in the Fork Swamp watershed. The starting water surface elevations for the HEC-RAS models were calculated using the slope-area method for three (3) of the models. The calculated normal depths are as follows:

- 0.0037 feet/feet for Fork Swamp Main Branch

- 0.0043 feet/feet for Fork Swamp UT2-R2
- 0.0035 feet/feet for Fork Swamp UT3

For the Fork Swamp UT1 (FSUT1) and Fork Swamp UT2-R1 (FSUT2R1) HEC-RAS models, the starting water surfaces elevations were set based on values calculated in the Fork Swamp Main Branch HEC-RAS model.

Hydraulic Performance

Sixteen (16) roadway crossings were analyzed for flooding potential for the primary system. Descriptions of the existing primary system crossings analyzed are summarized in Table 3-2. Pictures 3-1 through 3-14 of this report provide a visual image of the primary system crossings.

Table 3-2: Existing Condition of Primary System Crossings

Location	Size/Material	Condition
East Baywood Lane (Main Branch)	Twin 72″ CMPs	Good
Railroad (Main Branch)	Twin 84″ CMPs	Fair
Evans Street (Main Branch)	Twin 84″ CMPs	Fair
East Fire Tower Road(Main Branch)	Bridge	Good
Trafalgar Drive – South (FSUT1)	Twin 60″ CMPs	Good
Trafalgar Drive – North (FSUT1)	60″ CMP and 66″ CMP	Good
Corey Road (FSUT1)	Twin 13′ x 4.5′ CMP Arches	Good
Old Tar Toad (FSUT2-R1)	72″ CMP	Poor – Rusted Bottom
West Fire Tower Road (FSUT2 – R2)	10′ x 8′ RCBC	Good
Coleman Drive (FSUT3)	Triple 10′ x 4′ RCBCs	Good
County Home Road (FSUT3)	Twin 48″ RCPs	Good
East Fire Tower Road – U/S (FSUT3)	Twin 54″ RCPs	Good
Wimbledon Drive (FSUT3)	Twin 60″ CMPs	Fair
Tower Place (FSUT3)	Twin 66″ CMPs	Fair
Summerhaven Drive (FSUT3)	Twin 66″ CMPs	Fair
East Fire Tower Road – U/S (FSUT3)	Twin 10′ x 7′ CMP Ellipses	Good

Picture 3-1. East Baywood Lane Culvert – Upstream Face

Picture 3-2. Railroad Crossing Culvert – Upstream Face

Picture 3-3. Evans Street Culvert – Downstream Face

Picture 3-4. Trafalgar Drive – South Culvert – Downstream Face

Picture 3-5. Trafalgar Drive – North Culvert – Downstream Face

Picture 3-6. Corey Road Culvert – Upstream Face

Picture 3-7. West Fire Tower Road Culvert – Downstream Face

Picture 3-8. Coleman Drive Culvert – Downstream Face

Picture 3-9. County Home Road Culvert – Upstream Face

Picture 3-10. East Tower Road –U/S Culvert – Upstream Face

Picture 3-11. Wimbledon Drive Culvert – Upstream Face

Picture 3-12. Tower Place Culvert – Downstream Face

Picture 3-13. Summerhaven Drive Culvert – Upstream Face

Picture 3-14. East Tower Road –D/S Culvert – Upstream Face

The 2-, 10-, 25-, 50- and 100-year existing conditions flood elevations for the primary system crossings are identified in Table 3-3. The minimum elevations at the top of the road for each crossing are also listed in Table 3-3. Along Fork Swamp, none of the four crossings are meeting its desired level of service. East Baywood Lane is operating at a 2-year level of service while the railroad crossing, Evans Street, East Fire Tower Road have a 25-year level of service. The desired level of service for East Baywood Lane and the railroad crossing are the 25-year and 100-year storms, respectively. Evans Street and East Fire Tower Road are major thoroughfares with a desired 50-year level of service.

Along FSUT1, one out of the three crossings is meeting its desired level of service. The desired level of service for Trafalgar Drive – South, Trafalgar Drive – North, and Corey Road is the 25-year storm. As shown in Table 3-3, Trafalgar Drive – South is providing a 2-year level of service while Trafalgar Drive – North is providing a 10-year level of service. The new culvert at the Corey Road crossing is performing at the desired 25-year level of service.

There is only one roadway crossing along FSUT2R1, Old Tar Road. It is located on the edge of the City's limit and operating at a 2-year level of service. This is below the 25-year desired level of service. Along FSUT2R2 there is one roadway crossing, West Fire Tower Road. The desired level of service at this location is 50-year. Currently, West Fire Tower Road exceeds a 100-year storm with over 18 inches of freeboard.

Along FSUT3, one out of the seven crossings is meeting its desired level of service. As shown in Table 3-3, only Coleman Drive is providing the desired 25-year level of service while the remaining Wimbledon Drive, Tower Place, and Summerhaven Drive are performing at a 2-year level of service. The desired level of service for Coleman Drive, Wimbledon Drive, Tower Place, and Summerhaven Drive is the 25-year storm. County Home Road, East Fire Tower Road – U/S, and East Fire Tower Road – D/S are desired to meet a 50-year level of service. Currently, County Home Road provides a 10-year level of service while East Fire Tower Road – U/S and East Fire Tower Road – D/S only operate at a 2-year level or service.

Table 3-3: Hydraulic Performance for Existing Conditions Roadway Flooding

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
FORK SWAMP							
East Baywood Lane (Culvert)	66.01	25-year	63.88	**66.27**	**68.77**	**70.98**	**71.36**
Railroad (Culvert)	70.89	100-year	63.05	65.99	68.74	**70.97**	**71.35**
Evans Street (Culvert)	66.51	50-year	61.42	63.97	65.78	**66.88**	**67.20**
East Fire Tower Road (Bridge)	58.23	50-year	55.49	57.02	57.39	**58.33**	**58.68**
FORK SWAMP UT1							
Trafalgar Drive – South (Culvert)	55.81	25-year	53.69	**55.95**	**56.29**	**56.48**	**56.63**
Trafalgar Drive – North (Culvert)	54.35	25-year	53.05	**54.67**	**55.14**	**55.43**	**55.78**
Corey Road (Culvert)	54.81	25-year	52.31	53.39	54.26	**55.05**	**55.43**
FORK SWAMP UT2R1							
Old Tar Road (Culvert)	55.64	25-year	55.44	**56.26**	**56.59**	**56.71**	**56.86**
FORK SWAMP UT2R2							
West Fire Tower Road (Culvert)	65.70	50-year	60.61	61.90	62.67	63.30	63.96
FORK SWAMP UT3							
Coleman Drive (Culvert)	61.97	25-year	59.18	61.26	61.96	**62.44**	**62.81**
County Home Road (Culvert)	65.81	50-year	63.09	65.51	**66.13**	**66.45**	**66.72**
East Fire Tower Road – U/S (Culvert)	64.51	50-year	61.96	**64.72**	**64.96**	**65.16**	**65.32**
Wimbledon Drive (Culvert)	63.61	50-year	61.69	**64.09**	**64.25**	**64.35**	**64.44**
Tower Place (Culvert)	63.01	25-year	60.62	**63.02**	**63.29**	**63.45**	**63.58**
Summerhaven Drive (Culvert)	61.51	25-year	59.81	**62.13**	**62.49**	**62.75**	**62.93**
East Fire Tower Road – U/S (Culvert)	59.51	25-year	57.48	**59.74**	**60.20**	**60.49**	**60.72**

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.

** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

In addition to evaluating the roadway crossings, an evaluation was performed to determine the residences along the primary system streams that are at risk of flooding during the 25- and 100-year storm event. The existing 25- and 100- year floodplains for these streams are shown in Figures 3-1 through 3-8. The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance

purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Tables 3-4 through 3-8 lists the lowest adjacent grade elevations along with the existing 25- and 100-year water surface elevation for those properties at risk of flooding. The lowest adjacent grade (LAG) elevations shown in the table are not surveyed and are estimated based on the State of North Carolina's LiDAR data. LAG flooding shown in the tables may not result in actual LAG or finished floor flooding, but it is indicative of structures being at risk of flooding.

Table 3-4: Existing Conditions At-Risk Properties/Structures – Fork Swamp

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
4004 ALBION DR	58.70	57.68	**58.77**
102 AMBER LN	70.00	68.80	**71.36**
103 AMBER LN	70.00	68.80	**71.36**
104 AMBER LN	70.00	68.80	**71.36**
102 ANTLER RD	70.00	68.80	**71.36**
103 ANTLER RD	70.53	68.80	**71.36**
104 ANTLER RD	70.00	68.80	**71.36**
105 ANTLER RD	70.16	68.80	**71.36**
106 ANTLER RD	70.00	68.80	**71.36**
107 ANTLER RD	70.16	68.80	**71.36**
108 ANTLER RD	70.00	68.80	**71.36**
109 ANTLER RD	70.62	68.80	**71.36**
110 ANTLER RD	70.00	68.80	**71.36**
111 ANTLER RD	70.62	68.80	**71.36**
112 ANTLER RD	70.05	68.80	**71.36**
114 ANTLER RD	71.02	68.80	**71.36**
126 ANTLER RD	70.37	68.80	**71.36**
129 ANTLER RD	71.10	68.80	**71.36**
131 ANTLER RD	70.00	68.80	**71.36**
133 ANTLER RD	70.00	68.80	**71.36**
100 E BAYWOOD LN	69.33	68.80	**71.36**
101 E BAYWOOD LN	69.16	68.80	**71.36**
102 E BAYWOOD LN	69.57	68.80	**71.36**
103 E BAYWOOD LN	69.16	68.80	**71.36**
104 E BAYWOOD LN	69.57	68.80	**71.36**
105 E BAYWOOD LN	69.03	68.80	**71.36**
106 E BAYWOOD LN	68.29	**68.80**	**71.36**
107 E BAYWOOD LN	69.03	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
201 E BAYWOOD LN	68.00	**68.80**	**71.36**
203 E BAYWOOD LN	68.00	**68.80**	**71.36**
205 E BAYWOOD LN	68.00	**68.80**	**71.36**
3101 E BAYWOOD LN	69.06	68.80	**71.36**
3200 E BAYWOOD LN	68.01	**68.80**	**71.36**
3202 E BAYWOOD LN	69.79	68.80	**71.36**
3203 E BAYWOOD LN	70.00	68.80	**71.36**
3205 E BAYWOOD LN	70.00	68.80	**71.36**
3301 E BAYWOOD LN	70.00	68.79	**71.36**
3303 E BAYWOOD LN	70.00	68.78	**71.36**
3400 E BAYWOOD LN	68.59	**68.78**	**71.36**
3402 E BAYWOOD LN	68.00	**68.78**	**71.36**
3403 E BAYWOOD LN	68.00	**68.77**	**71.35**
3404 E BAYWOOD LN	66.00	**68.77**	**71.36**
3405 E BAYWOOD LN	66.02	**68.77**	**71.35**
3406 E BAYWOOD LN	66.00	**68.77**	**71.36**
3407 E BAYWOOD LN	66.02	**68.77**	**71.35**
3409 E BAYWOOD LN	66.02	**68.77**	**71.35**
3411 E BAYWOOD LN	66.00	**68.77**	**71.35**
3501 E BAYWOOD LN	66.00	**68.77**	**71.35**
3503 E BAYWOOD LN	66.00	**68.77**	**71.35**
3505 E BAYWOOD LN	65.34	**68.77**	**71.35**
3601 E BAYWOOD LN	65.34	**68.77**	**71.35**
3603 E BAYWOOD LN	69.62	68.77	**71.35**
100 S BAYWOOD LN	66.31	**68.80**	**71.36**
102 S BAYWOOD LN	68.03	**68.80**	**71.36**
103 S BAYWOOD LN	69.33	68.80	**71.36**
104 S BAYWOOD LN	67.72	**68.80**	**71.36**
105 S BAYWOOD LN	70.00	68.80	**71.36**
106 S BAYWOOD LN	70.00	68.80	**71.36**
107 S BAYWOOD LN	70.00	68.80	**71.36**
108 S BAYWOOD LN	70.00	68.80	**71.36**
109 S BAYWOOD LN	70.00	68.80	**71.36**
110 S BAYWOOD LN	69.19	68.80	**71.36**
111 S BAYWOOD LN	70.00	68.80	**71.36**
112 S BAYWOOD LN	69.19	68.80	**71.36**
114 S BAYWOOD LN	68.86	68.80	**71.36**
116 S BAYWOOD LN	68.86	68.80	**71.36**
202 S BAYWOOD LN	68.00	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
203 S BAYWOOD LN	70.00	68.80	**71.36**
204 S BAYWOOD LN	70.00	68.80	**71.36**
205 S BAYWOOD LN	70.00	68.80	**71.36**
206 S BAYWOOD LN	70.00	68.80	**71.36**
207 S BAYWOOD LN	70.00	68.80	**71.36**
208 S BAYWOOD LN	70.00	68.80	**71.36**
209 S BAYWOOD LN	70.00	68.80	**71.36**
210 S BAYWOOD LN	70.00	68.80	**71.36**
211 S BAYWOOD LN	70.00	68.80	**71.36**
207 BELVEDERE DR	71.17	68.80	**71.36**
209 BELVEDERE DR	70.00	68.80	**71.36**
210 BELVEDERE DR	70.00	68.80	**71.36**
211 BELVEDERE DR	70.00	68.80	**71.36**
212 BELVEDERE DR	70.00	68.80	**71.36**
213 BELVEDERE DR	70.00	68.80	**71.36**
214 BELVEDERE DR	70.00	68.80	**71.36**
215 BELVEDERE DR	70.00	68.80	**71.36**
217 BELVEDERE DR	70.00	68.80	**71.36**
218 BELVEDERE DR	70.00	68.80	**71.36**
219 BELVEDERE DR	70.00	68.80	**71.36**
220 BELVEDERE DR	70.00	68.80	**71.36**
222 BELVEDERE DR	70.00	68.80	**71.36**
302 BELVEDERE DR	70.60	68.80	**71.36**
204 BENT CREEK DR	67.15	**68.79**	**71.36**
206 BENT CREEK DR	69.89	68.80	**71.36**
208 BENT CREEK DR	65.64	**68.80**	**71.36**
210 BENT CREEK DR	70.31	68.80	**71.36**
3800 BOXWOOD LN	70.00	68.80	**71.36**
3802 BOXWOOD LN	70.00	68.80	**71.36**
3804 BOXWOOD LN	70.00	68.80	**71.36**
3806 BOXWOOD LN	70.00	68.80	**71.36**
102 BRIARWOOD DR	70.00	68.80	**71.36**
103 BRIARWOOD DR	70.00	68.80	**71.36**
104 BRIARWOOD DR	70.00	68.80	**71.36**
105 BRIARWOOD DR	70.00	68.80	**71.36**
106 BRIARWOOD DR	70.00	68.80	**71.36**
107 BRIARWOOD DR	70.00	68.80	**71.36**
200 BRISTOL CT	67.74	**68.80**	**71.36**
201 BRISTOL CT	67.49	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
202 BRISTOL CT	68.90	68.80	**71.36**
203 BRISTOL CT	69.90	68.80	**71.36**
204 BRISTOL CT	68.90	68.80	**71.36**
205 BRISTOL CT	70.86	68.80	**71.36**
206 BRISTOL CT	69.78	68.80	**71.36**
207 BRISTOL CT	70.86	68.80	**71.36**
208 BRISTOL CT	70.00	68.80	**71.36**
209 BRISTOL CT	71.28	68.80	**71.36**
210 BRISTOL CT	70.00	68.80	**71.36**
211 BRISTOL CT	71.28	68.80	**71.36**
212 BRISTOL CT	70.00	68.80	**71.36**
731 CEDAR RIDGE DR	53.17	52.29	**53.31**
737 CEDAR RIDGE DR	53.17	52.28	**53.30**
743 CEDAR RIDGE DR	51.77	**52.26**	**53.28**
749 CEDAR RIDGE DR	51.77	**52.25**	**53.27**
751 CEDAR RIDGE DR	53.20	52.23	**53.25**
329 CEDARHURST RD	70.38	68.80	**71.36**
330 CEDARHURST RD	70.00	68.80	**71.36**
332 CEDARHURST RD	70.00	68.80	**71.36**
400 CEDARHURST RD	70.00	68.80	**71.36**
401 CEDARHURST RD	70.00	68.80	**71.36**
402 CEDARHURST RD	70.00	68.80	**71.36**
403 CEDARHURST RD	70.00	68.80	**71.36**
404 CEDARHURST RD	70.00	68.80	**71.36**
405 CEDARHURST RD	70.00	68.80	**71.36**
407 CEDARHURST RD	70.00	68.80	**71.36**
500 CEDARHURST RD	70.00	68.80	**71.36**
502 CEDARHURST RD	70.00	68.80	**71.36**
503 CEDARHURST RD	70.00	68.80	**71.36**
504 CEDARHURST RD	70.00	68.80	**71.36**
505 CEDARHURST RD	70.00	68.80	**71.36**
506 CEDARHURST RD	70.00	68.80	**71.36**
507 CEDARHURST RD	70.00	68.80	**71.36**
508 CEDARHURST RD	70.00	68.80	**71.36**
509 CEDARHURST RD	70.00	68.80	**71.36**
510 CEDARHURST RD	69.74	68.80	**71.36**
511 CEDARHURST RD	70.00	68.80	**71.36**
512 CEDARHURST RD	69.74	68.80	**71.36**
513 CEDARHURST RD	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
514 CEDARHURST RD	70.00	68.80	**71.36**
515 CEDARHURST RD	70.62	68.80	**71.36**
516 CEDARHURST RD	70.25	68.80	**71.36**
601 CEDARHURST RD	70.62	68.80	**71.36**
603 CEDARHURST RD	70.07	68.80	**71.36**
604 CEDARHURST RD	70.00	68.80	**71.36**
605 CEDARHURST RD	70.00	68.80	**71.36**
606 CEDARHURST RD	70.00	68.80	**71.36**
607 CEDARHURST RD	70.00	68.80	**71.36**
608 CEDARHURST RD	70.00	68.80	**71.36**
609 CEDARHURST RD	70.00	68.80	**71.36**
700 CEDARHURST RD	70.00	68.80	**71.36**
701 CEDARHURST RD	70.00	68.80	**71.36**
702 CEDARHURST RD	70.00	68.80	**71.36**
703 CEDARHURST RD	70.00	68.80	**71.36**
600 CHELTENHAM DR	70.58	68.80	**71.36**
608 CHELTENHAM DR	70.00	68.80	**71.36**
612 CHELTENHAM DR	70.00	68.80	**71.36**
628 CHELTENHAM DR	70.65	68.80	**71.36**
102 CLAYBOURNE CT	69.14	68.80	**71.36**
104 CLAYBOURNE CT	69.14	68.80	**71.36**
106 CLAYBOURNE CT	69.14	68.80	**71.36**
108 CLAYBOURNE CT	70.00	68.80	**71.36**
201 CLAYBOURNE CT	68.00	**68.80**	**71.36**
103 CLUB PINES DR	70.32	68.80	**71.36**
200 CLUB PINES DR	70.94	68.80	**71.36**
205 CLUB PINES DR	70.38	68.80	**71.36**
206 CLUB PINES DR	72.00	68.80	**71.36**
300 CLUB PINES DR	70.62	68.80	**71.36**
301 CLUB PINES DR	70.21	68.80	**71.36**
302 CLUB PINES DR	70.19	68.80	**71.36**
303 CLUB PINES DR	70.21	68.80	**71.36**
304 CLUB PINES DR	70.19	68.80	**71.36**
305 CLUB PINES DR	70.53	68.80	**71.36**
400 CLUB PINES DR	70.00	68.80	**71.36**
401 CLUB PINES DR	70.00	68.80	**71.36**
402 CLUB PINES DR	70.00	68.80	**71.36**
403 CLUB PINES DR	70.00	68.80	**71.36**
500 CLUB PINES DR	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
503 CLUB PINES DR	70.00	68.80	**71.36**
507 CLUB PINES DR	70.00	68.80	**71.36**
601 CLUB PINES DR	70.00	68.80	**71.36**
603 CLUB PINES DR	70.91	68.80	**71.36**
3296 COLONY CT	70.00	68.80	**71.36**
898 CORBETT ST	52.90	51.99	**52.98**
4698 COREY RD	48.00	**52.13**	**53.13**
102 CRESTLINE PL	69.07	68.80	**71.36**
104 CRESTLINE PL	70.00	68.80	**71.36**
200 CRESTLINE BV	70.64	68.80	**71.36**
202 CRESTLINE BV	70.00	68.80	**71.36**
203 CRESTLINE BV	72.00	68.80	**71.36**
204 CRESTLINE BV	70.00	68.80	**71.36**
205 CRESTLINE BV	70.00	68.80	**71.36**
206 CRESTLINE BV	70.00	68.80	**71.36**
207 CRESTLINE BV	70.00	68.80	**71.36**
208 CRESTLINE BV	70.00	68.80	**71.36**
209 CRESTLINE BV	70.00	68.80	**71.36**
210 CRESTLINE BV	70.00	68.80	**71.36**
211 CRESTLINE BV	70.00	68.80	**71.36**
212 CRESTLINE BV	70.00	68.80	**71.36**
213 CRESTLINE BV	70.00	68.80	**71.36**
214 CRESTLINE BV	70.00	68.80	**71.36**
215 CRESTLINE BV	70.00	68.80	**71.36**
216 CRESTLINE BV	70.00	68.80	**71.36**
217 CRESTLINE BV	69.26	68.80	**71.36**
300 CRESTLINE BV	70.00	68.80	**71.36**
301 CRESTLINE BV	70.00	68.80	**71.36**
302 CRESTLINE BV	70.00	68.80	**71.36**
303 CRESTLINE BV	68.85	68.80	**71.36**
304 CRESTLINE BV	70.00	68.80	**71.36**
305 CRESTLINE BV	68.85	68.80	**71.36**
307 CRESTLINE BV	68.43	**68.80**	**71.36**
309 CRESTLINE BV	66.12	**68.80**	**71.36**
311 CRESTLINE BV	66.12	**68.80**	**71.36**
313 CRESTLINE BV	70.00	68.80	**71.36**
400 CRESTLINE BV	70.00	68.80	**71.36**
401 CRESTLINE BV	69.20	68.80	**71.36**
402 CRESTLINE BV	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
403 CRESTLINE BV	69.20	68.80	**71.36**
404 CRESTLINE BV	70.00	68.80	**71.36**
405 CRESTLINE BV	70.00	68.80	**71.36**
406 CRESTLINE BV	70.16	68.80	**71.36**
407 CRESTLINE BV	70.00	68.80	**71.36**
408 CRESTLINE BV	70.16	68.80	**71.36**
409 CRESTLINE BV	70.00	68.80	**71.36**
410 CRESTLINE BV	70.78	68.80	**71.36**
411 CRESTLINE BV	70.00	68.80	**71.36**
412 CRESTLINE BV	70.00	68.80	**71.36**
413 CRESTLINE BV	70.00	68.80	**71.36**
415 CRESTLINE BV	71.36	68.80	**71.36**
501 CRESTLINE BV	66.00	**68.80**	**71.36**
502 CRESTLINE BV	71.88	68.80	**71.36**
503 CRESTLINE BV	66.00	**68.80**	**71.36**
504 CRESTLINE BV	71.14	68.80	**71.36**
505 CRESTLINE BV	67.93	**68.80**	**71.36**
506 CRESTLINE BV	70.00	68.80	**71.36**
507 CRESTLINE BV	67.93	**68.80**	**71.36**
508 CRESTLINE BV	70.00	68.80	**71.36**
509 CRESTLINE BV	70.00	68.80	**71.36**
511 CRESTLINE BV	70.00	68.80	**71.36**
512 CRESTLINE BV	70.00	68.80	**71.36**
513 CRESTLINE BV	70.00	68.80	**71.36**
514 CRESTLINE BV	70.40	68.80	**71.36**
515 CRESTLINE BV	70.00	68.80	**71.36**
517 CRESTLINE BV	70.00	68.80	**71.36**
519 CRESTLINE BV	70.49	68.80	**71.36**
522 CRESTLINE BV	70.17	68.80	**71.36**
524 CRESTLINE BV	70.17	68.80	**71.36**
526 CRESTLINE BV	70.00	68.80	**71.36**
528 CRESTLINE BV	70.00	68.80	**71.36**
530 CRESTLINE BV	70.00	68.80	**71.36**
531 CRESTLINE BV	70.95	68.80	**71.36**
532 CRESTLINE BV	70.00	68.80	**71.36**
533 CRESTLINE BV	70.00	68.80	**71.36**
534 CRESTLINE BV	70.00	68.80	**71.36**
535 CRESTLINE BV	70.00	68.80	**71.36**
536 CRESTLINE BV	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
537 CRESTLINE BV	70.00	68.80	**71.36**
538 CRESTLINE BV	70.00	68.80	**71.36**
539 CRESTLINE BV	70.00	68.80	**71.36**
540 CRESTLINE BV	70.00	68.80	**71.36**
543 CRESTLINE BV	70.00	68.80	**71.36**
545 CRESTLINE BV	70.00	68.80	**71.36**
547 CRESTLINE BV	70.00	68.80	**71.36**
3401 CUTLER CT	69.09	68.78	**71.36**
3402 CUTLER CT	68.00	**68.80**	**71.36**
3403 CUTLER CT	68.00	**68.79**	**71.36**
102 DARWIN CT	70.47	68.80	**71.36**
104 DARWIN CT	70.47	68.80	**71.36**
106 DARWIN CT	70.00	68.80	**71.36**
108 DARWIN CT	70.00	68.80	**71.36**
4246 DUDLEYS GRANT DR 1	54.00	**54.20**	**54.96**
4246 DUDLEYS GRANT DR 2	54.00	**54.20**	**54.96**
4246 DUDLEYS GRANT DR 3	54.00	**54.20**	**54.96**
4267 DUDLEYS GRANT DR H	54.00	53.38	**54.23**
4267 DUDLEYS GRANT DR I	54.00	53.46	**54.29**
4271 DUDLEYS GRANT DR A	54.10	53.30	**54.16**
4271 DUDLEYS GRANT DR B	54.10	53.27	**54.14**
4271 DUDLEYS GRANT DR C	54.10	53.25	**54.12**
4271 DUDLEYS GRANT DR D	51.68	**53.08**	**53.98**
4272 DUDLEYS GRANT DR A	54.10	53.26	**54.14**
4275 DUDLEYS GRANT DR F	51.68	**53.08**	**53.98**
4275 DUDLEYS GRANT DR E	51.68	**53.13**	**54.03**
4275 DUDLEYS GRANT DR D	51.68	**53.05**	**53.97**
4275 DUDLEYS GRANT DR C	51.68	**53.05**	**53.97**
4275 DUDLEYS GRANT DR B	51.68	**53.08**	**53.98**
4202 DUNHAGAN RD	58.47	**58.87**	**59.69**
4204 DUNHAGAN RD	58.00	**58.62**	**59.49**
4206 DUNHAGAN RD	58.64	58.53	**59.41**
4208 DUNHAGAN RD	58.00	**58.42**	**59.33**
3400 DUNHAVEN DR	68.00	**68.80**	**71.36**
3402 DUNHAVEN DR	68.00	**68.80**	**71.36**
3403 DUNHAVEN DR	68.00	**68.80**	**71.36**
3404 DUNHAVEN DR	68.73	**68.80**	**71.36**
3405 DUNHAVEN DR	68.00	**68.80**	**71.36**
3406 DUNHAVEN DR	68.72	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3407 DUNHAVEN DR	68.00	**68.80**	**71.36**
3408 DUNHAVEN DR	67.11	**68.80**	**71.36**
3409 DUNHAVEN DR	68.00	**68.79**	**71.36**
3410 DUNHAVEN DR	68.00	**68.80**	**71.36**
3411 DUNHAVEN DR	67.25	**68.79**	**71.36**
3412 DUNHAVEN DR	68.00	**68.80**	**71.36**
3414 DUNHAVEN DR	68.00	**68.79**	**71.36**
3416 DUNHAVEN DR	68.00	**68.78**	**71.36**
430 E FIRE TOWER RD	53.31	**56.09**	**58.86**
413 FORREST PK	58.54	**59.30**	**60.06**
416 FORREST PK	60.00	59.35	**60.10**
417 FORREST PK	58.54	**59.33**	**60.08**
420 FORREST PK	58.00	**59.43**	**60.17**
424 FORREST PK	58.00	**59.45**	**60.19**
428 FORREST PK	58.00	**59.44**	**60.18**
432 FORREST PK	58.00	**59.32**	**60.07**
436 FORREST PK	58.00	**59.25**	**60.01**
440 FORREST PK	58.00	**59.17**	**59.95**
441 FORREST PK	58.54	**59.28**	**60.04**
448 FORREST PK	59.07	**59.12**	**59.90**
449 FORREST PK	60.00	59.24	**60.01**
2187 FRANKLIN DR	49.13	**52.19**	**53.20**
2197 FRANKLIN DR	49.79	**52.15**	**53.15**
100 GREENWOOD DR	70.00	68.80	**71.36**
102 GREENWOOD DR	70.97	68.80	**71.36**
103 GREENWOOD DR	70.00	68.80	**71.36**
104 GREENWOOD DR	70.00	68.80	**71.36**
105 GREENWOOD DR	70.55	68.80	**71.36**
106 GREENWOOD DR	70.20	68.80	**71.36**
108 GREENWOOD DR	70.20	68.80	**71.36**
111 GREENWOOD DR	71.22	68.80	**71.36**
113 GREENWOOD DR	70.00	68.80	**71.36**
115 GREENWOOD DR	70.52	68.80	**71.36**
116 GREENWOOD DR	71.10	68.80	**71.36**
118 GREENWOOD DR	70.38	68.80	**71.36**
120 GREENWOOD DR	70.20	68.80	**71.36**
121 GREENWOOD DR	71.32	68.80	**71.36**
123 GREENWOOD DR	71.32	68.80	**71.36**
200 GREENWOOD DR	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
202 GREENWOOD DR	70.00	68.80	**71.36**
204 GREENWOOD DR	70.00	68.80	**71.36**
205 GREENWOOD DR	70.00	68.80	**71.36**
206 GREENWOOD DR	70.00	68.80	**71.36**
208 GREENWOOD DR	70.00	68.80	**71.36**
212 GREENWOOD DR	70.00	68.80	**71.36**
301 GREENWOOD DR	70.00	68.80	**71.36**
303 GREENWOOD DR	70.00	68.80	**71.36**
401 GREENWOOD DR	68.23	**68.80**	**71.36**
403 GREENWOOD DR	68.48	**68.80**	**71.36**
405 GREENWOOD DR	68.48	**68.80**	**71.36**
200 HARMONY ST	70.88	68.80	**71.36**
201 HARMONY ST	70.00	68.80	**71.36**
203 HARMONY ST	70.00	68.80	**71.36**
204 HARMONY ST	70.95	68.80	**71.36**
205 HARMONY ST	70.00	68.80	**71.36**
206 HARMONY ST	70.00	68.80	**71.36**
207 HARMONY ST	70.00	68.80	**71.36**
208 HARMONY ST	70.00	68.80	**71.36**
209 HARMONY ST	70.00	68.80	**71.36**
210 HARMONY ST	70.00	68.80	**71.36**
211 HARMONY ST	70.00	68.80	**71.36**
212 HARMONY ST	70.00	68.80	**71.36**
213 HARMONY ST	70.00	68.80	**71.36**
214 HARMONY ST	70.00	68.80	**71.36**
215 HARMONY ST	70.00	68.80	**71.36**
216 HARMONY ST	70.00	68.80	**71.36**
217 HARMONY ST	68.05	**68.80**	**71.36**
219 HARMONY ST	68.05	**68.80**	**71.36**
219 HARTFORD ST	70.62	68.80	**71.36**
318 HAVEN DR	68.31	**68.80**	**71.36**
320 HAVEN DR P1	70.00	68.78	**71.36**
320 HAVEN DR P5	70.00	68.78	**71.36**
320 HAVEN DR P-6	70.00	68.78	**71.36**
322 HAVEN DR 2	70.00	68.78	**71.36**
322 HAVEN DR 4	70.00	68.78	**71.36**
322 HAVEN DR 7	70.00	68.78	**71.36**
322 HAVEN DR N1	70.00	68.78	**71.36**
322 HAVEN DR N-5	70.00	68.78	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
322 HAVEN DR N8	70.00	68.78	**71.36**
324 HAVEN DR 3	70.00	68.79	**71.36**
324 HAVEN DR 4	70.00	68.79	**71.36**
324 HAVEN DR L6	70.00	68.79	**71.36**
324 HAVEN DR L1	70.00	68.79	**71.36**
324 HAVEN DR L5	70.00	68.79	**71.36**
324 HAVEN DR L2	70.00	68.79	**71.36**
326 HAVEN DR O6	70.00	68.80	**71.36**
326 HAVEN DR O3	70.00	68.80	**71.36**
326 HAVEN DR O-2	70.00	68.80	**71.36**
326 HAVEN DR O5	70.00	68.80	**71.36**
328 HAVEN DR 8	70.00	68.80	**71.36**
328 HAVEN DR M1	70.00	68.80	**71.36**
328 HAVEN DR M2	70.00	68.80	**71.36**
328 HAVEN DR M3	70.00	68.80	**71.36**
328 HAVEN DR M4	70.00	68.80	**71.36**
328 HAVEN DR M5	70.00	68.80	**71.36**
328 HAVEN DR M6	70.00	68.80	**71.36**
328 HAVEN DR M7	70.00	68.80	**71.36**
330 HAVEN DR 4K	70.00	68.80	**71.36**
330 HAVEN DR 5K	66.00	**68.80**	**71.36**
330 HAVEN DR 6K	70.00	68.80	**71.36**
330 HAVEN DR 1K	70.00	68.80	**71.36**
330 HAVEN DR 3K	70.00	68.80	**71.36**
330 HAVEN DR 2K	70.00	68.80	**71.36**
332 HAVEN DR R1	70.00	68.80	**71.36**
332 HAVEN DR R2	70.00	68.80	**71.36**
332 HAVEN DR R3	70.00	68.80	**71.36**
332 HAVEN DR R4	70.00	68.80	**71.36**
332 HAVEN DR R5	70.00	68.80	**71.36**
332 HAVEN DR R6	70.00	68.80	**71.36**
332 HAVEN DR R7	70.00	68.80	**71.36**
332 HAVEN DR R8	70.00	68.80	**71.36**
334 HAVEN DR Q-1	70.00	68.80	**71.36**
334 HAVEN DR Q-2	70.00	68.80	**71.36**
334 HAVEN DR Q-3	70.00	68.80	**71.36**
334 HAVEN DR Q-4	70.00	68.80	**71.36**
334 HAVEN DR Q-5	70.00	68.80	**71.36**
334 HAVEN DR Q-6	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
334 HAVEN DR Q-7	70.00	68.80	**71.36**
334 HAVEN DR Q-8	70.00	68.80	**71.36**
334 HAVEN DR Q-9	66.00	**68.80**	**71.36**
336 HAVEN DR T1	69.06	68.80	**71.36**
336 HAVEN DR T2	69.06	68.80	**71.36**
336 HAVEN DR T3	69.06	68.80	**71.36**
336 HAVEN DR T4	69.06	68.80	**71.36**
336 HAVEN DR T5	69.06	68.80	**71.36**
336 HAVEN DR T6	69.06	68.80	**71.36**
338 HAVEN DR S1	69.22	68.80	**71.36**
338 HAVEN DR S2	69.22	68.80	**71.36**
338 HAVEN DR S3	69.22	68.80	**71.36**
338 HAVEN DR S4	66.47	**68.80**	**71.36**
338 HAVEN DR S5	69.22	68.80	**71.36**
338 HAVEN DR S6	69.22	68.80	**71.36**
338 HAVEN DR S7	69.22	68.80	**71.36**
340 HAVEN DR U-1	68.31	**68.80**	**71.36**
340 HAVEN DR U2	68.31	**68.80**	**71.36**
340 HAVEN DR U3	69.18	68.80	**71.36**
340 HAVEN DR U-4	69.18	68.80	**71.36**
340 HAVEN DR U5	69.18	68.80	**71.36**
340 HAVEN DR U6	69.18	68.80	**71.36**
342 HAVEN DR V-1	68.00	**68.80**	**71.36**
342 HAVEN DR V-2	68.31	**68.80**	**71.36**
342 HAVEN DR V-3	68.31	**68.80**	**71.36**
342 HAVEN DR V-4	68.31	**68.80**	**71.36**
342 HAVEN DR V5	68.31	**68.80**	**71.36**
342 HAVEN DR V6	68.31	**68.80**	**71.36**
344 HAVEN DR W1	68.00	**68.80**	**71.36**
344 HAVEN DR W2	68.00	**68.80**	**71.36**
344 HAVEN DR W3	68.00	**68.80**	**71.36**
344 HAVEN DR W4	68.00	**68.80**	**71.36**
344 HAVEN DR W5	68.00	**68.80**	**71.36**
344 HAVEN DR W6	68.00	**68.80**	**71.36**
344 HAVEN DR W7	68.00	**68.80**	**71.36**
344 HAVEN DR W-8	68.00	**68.80**	**71.36**
344 HAVEN DR W-9	68.00	**68.80**	**71.36**
346 HAVEN DR 2	66.00	**68.80**	**71.36**
346 HAVEN DR 3	66.00	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
346 HAVEN DR 6	68.00	**68.80**	**71.36**
346 HAVEN DR 8	68.00	**68.80**	**71.36**
346 HAVEN DR X 1	66.00	**68.80**	**71.36**
346 HAVEN DR X-4	68.00	**68.80**	**71.36**
346 HAVEN DR X-5	68.00	**68.80**	**71.36**
346 HAVEN DR X7	68.00	**68.80**	**71.36**
346 HAVEN DR X-9	68.00	**68.80**	**71.36**
348 HAVEN DR 1	66.47	**68.80**	**71.36**
348 HAVEN DR 2	66.47	**68.80**	**71.36**
348 HAVEN DR 3	66.00	**68.80**	**71.36**
348 HAVEN DR AA-4	66.00	**68.80**	**71.36**
348 HAVEN DR AA-5	66.00	**68.80**	**71.36**
348 HAVEN DR AA-6	66.00	**68.80**	**71.36**
350 HAVEN DR Z1	68.00	**68.80**	**71.36**
350 HAVEN DR Z-2	68.00	**68.80**	**71.36**
350 HAVEN DR Z3	68.00	**68.80**	**71.36**
350 HAVEN DR Z-4	68.00	**68.80**	**71.36**
350 HAVEN DR Z-5	69.22	68.80	**71.36**
350 HAVEN DR Z-6	69.22	68.80	**71.36**
352 HAVEN DR Y 4	68.00	**68.80**	**71.36**
352 HAVEN DR Y-1	69.06	68.80	**71.36**
352 HAVEN DR Y-2	69.06	68.80	**71.36**
352 HAVEN DR Y-3	68.00	**68.80**	**71.36**
352 HAVEN DR Y-5	68.00	**68.80**	**71.36**
352 HAVEN DR Y-6	68.00	**68.80**	**71.36**
102 HEARTHSIDE DR	70.08	68.80	**71.36**
103 HEARTHSIDE DR	70.00	68.80	**71.36**
104 HEARTHSIDE DR	70.08	68.80	**71.36**
105 HEARTHSIDE DR	70.00	68.80	**71.36**
106 HEARTHSIDE DR	70.30	68.80	**71.36**
107 HEARTHSIDE DR	70.00	68.80	**71.36**
108 HEARTHSIDE DR	70.00	68.80	**71.36**
109 HEARTHSIDE DR	70.00	68.80	**71.36**
110 HEARTHSIDE DR	70.00	68.80	**71.36**
112 HEARTHSIDE DR	70.00	68.80	**71.36**
114 HEARTHSIDE DR	70.00	68.80	**71.36**
116 HEARTHSIDE DR	70.00	68.80	**71.36**
103 IRONWOOD DR	70.00	68.80	**71.36**
104 IRONWOOD DR	70.57	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
105 IRONWOOD DR	70.00	68.80	**71.36**
106 IRONWOOD DR	70.57	68.80	**71.36**
107 IRONWOOD DR	70.00	68.80	**71.36**
108 IRONWOOD DR	70.75	68.80	**71.36**
109 IRONWOOD DR	70.00	68.80	**71.36**
110 IRONWOOD DR	70.85	68.80	**71.36**
111 IRONWOOD DR	70.00	68.80	**71.36**
112 IRONWOOD DR	70.85	68.80	**71.36**
400 KEMPTON DR	70.00	68.80	**71.36**
402 KEMPTON DR	70.00	68.80	**71.36**
403 KEMPTON DR	71.30	68.80	**71.36**
404 KEMPTON DR	70.00	68.80	**71.36**
405 KEMPTON DR	70.00	68.80	**71.36**
406 KEMPTON DR	70.40	68.80	**71.36**
407 KEMPTON DR	71.17	68.80	**71.36**
408 KEMPTON DR	70.00	68.80	**71.36**
410 KEMPTON DR	70.00	68.80	**71.36**
412 KEMPTON DR	70.00	68.80	**71.36**
506 KEMPTON DR	70.00	68.80	**71.36**
507 KEMPTON DR	70.57	68.80	**71.36**
508 KEMPTON DR	70.00	68.80	**71.36**
510 KEMPTON DR	70.87	68.80	**71.36**
604 KEMPTON DR	70.00	68.80	**71.36**
606 KEMPTON DR	70.00	68.80	**71.36**
607 KEMPTON DR	71.55	68.80	**71.36**
700 KEMPTON DR	70.00	68.80	**71.36**
702 KEMPTON DR	70.00	68.80	**71.36**
0 LANDMARK ST	70.00	68.77	**71.35**
326 LANDMARK ST O1	70.00	68.80	**71.36**
326 LANDMARK ST O4	70.00	68.80	**71.36**
338 LANDMARK ST	69.22	68.80	**71.36**
3229 LANDMARK ST	70.61	68.75	**71.36**
3243 LANDMARK ST	70.00	68.77	**71.36**
3256 LANDMARK ST A1	70.00	68.78	**71.36**
3256 LANDMARK ST A2	70.00	68.77	**71.36**
3256 LANDMARK ST A3	70.00	68.77	**71.36**
3256 LANDMARK ST A4	70.00	68.77	**71.36**
3256 LANDMARK ST A5	70.00	68.77	**71.36**
3256 LANDMARK ST A6	70.00	68.78	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3258 LANDMARK ST B1	70.00	68.78	**71.36**
3258 LANDMARK ST B2	70.00	68.78	**71.36**
3258 LANDMARK ST B3	70.00	68.78	**71.36**
3258 LANDMARK ST B4	70.00	68.78	**71.36**
3258 LANDMARK ST B5	70.00	68.78	**71.36**
3258 LANDMARK ST B6	70.00	68.78	**71.36**
3258 LANDMARK ST B7	70.00	68.78	**71.36**
3260 LANDMARK ST C1	70.00	68.78	**71.36**
3260 LANDMARK ST C2	70.00	68.77	**71.36**
3260 LANDMARK ST C3	70.00	68.77	**71.36**
3260 LANDMARK ST C4	70.00	68.77	**71.36**
3260 LANDMARK ST C5	70.00	68.78	**71.36**
3260 LANDMARK ST C6	70.00	68.77	**71.36**
3262 LANDMARK ST D1	70.00	68.78	**71.36**
3262 LANDMARK ST D2	70.00	68.78	**71.36**
3262 LANDMARK ST D3	70.00	68.78	**71.36**
3262 LANDMARK ST D4	70.00	68.77	**71.36**
3262 LANDMARK ST D5	70.00	68.77	**71.36**
3262 LANDMARK ST D6	70.00	68.78	**71.36**
3262 LANDMARK ST E1	70.00	68.78	**71.36**
3262 LANDMARK ST E2	70.00	68.77	**71.36**
3262 LANDMARK ST E3	70.00	68.78	**71.36**
3262 LANDMARK ST E4	70.00	68.78	**71.36**
3262 LANDMARK ST E5	70.00	68.78	**71.36**
3262 LANDMARK ST E6	70.00	68.78	**71.36**
3262 LANDMARK ST E7	70.00	68.78	**71.36**
3264 LANDMARK ST F1	70.00	68.77	**71.36**
3264 LANDMARK ST F2	70.00	68.78	**71.36**
3264 LANDMARK ST F3	70.00	68.78	**71.36**
3264 LANDMARK ST F4	70.00	68.78	**71.36**
3264 LANDMARK ST F5	70.00	68.78	**71.36**
3264 LANDMARK ST F6	70.00	68.78	**71.36**
3264 LANDMARK ST G1	70.00	68.77	**71.36**
3264 LANDMARK ST G2	70.00	68.78	**71.36**
3264 LANDMARK ST G3	70.00	68.77	**71.36**
3264 LANDMARK ST G4	70.00	68.77	**71.36**
3264 LANDMARK ST G5	70.00	68.77	**71.36**
3264 LANDMARK ST G6	70.00	68.78	**71.36**
3264 LANDMARK ST G7	70.00	68.78	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3264 LANDMARK ST G8	70.00	68.78	**71.36**
3264 LANDMARK ST G9	70.00	68.77	**71.36**
3275 LANDMARK ST	70.00	68.77	**71.35**
3300 LANDMARK ST	70.00	68.78	**71.36**
3300 LANDMARK ST A-1	70.00	68.78	**71.36**
3300 LANDMARK ST A-2	70.00	68.78	**71.36**
3300 LANDMARK ST A-3	70.00	68.78	**71.36**
3300 LANDMARK ST A-4	70.00	68.78	**71.36**
3300 LANDMARK ST A-4	70.00	68.78	**71.36**
3300 LANDMARK ST A-5	70.00	68.78	**71.36**
3300 LANDMARK ST A-6	70.00	68.78	**71.36**
3308 LANDMARK ST B1	70.00	68.78	**71.36**
3308 LANDMARK ST B2	70.00	68.78	**71.36**
3308 LANDMARK ST B3	70.00	68.77	**71.36**
3308 LANDMARK ST B4	70.00	68.78	**71.36**
3308 LANDMARK ST B5	70.00	68.77	**71.36**
3320 LANDMARK ST C-1	69.37	68.76	**71.35**
3320 LANDMARK ST C-2	70.00	68.78	**71.36**
3320 LANDMARK ST C-3	70.00	68.78	**71.36**
3320 LANDMARK ST C-4	70.00	68.78	**71.36**
3320 LANDMARK ST C-5	70.00	68.77	**71.36**
3320 LANDMARK ST C-6	70.00	68.78	**71.36**
3320 LANDMARK ST C-7	70.00	68.78	**71.36**
3320 LANDMARK ST C-8	70.00	68.78	**71.36**
3320 LANDMARK ST C-9	70.00	68.78	**71.36**
3326 LANDMARK ST D1	70.00	68.77	**71.36**
3326 LANDMARK ST D2	70.00	68.78	**71.36**
3326 LANDMARK ST D3	70.00	68.78	**71.36**
3326 LANDMARK ST D4	70.00	68.77	**71.36**
3326 LANDMARK ST D5	70.00	68.77	**71.36**
3326 LANDMARK ST D6	70.00	68.77	**71.36**
3326 LANDMARK ST D7	70.00	68.77	**71.36**
3326 LANDMARK ST D8	70.00	68.78	**71.36**
3336 LANDMARK ST H1	70.00	68.77	**71.36**
3336 LANDMARK ST H2	70.00	68.77	**71.36**
3336 LANDMARK ST H3	70.00	68.78	**71.36**
3336 LANDMARK ST H4	70.00	68.78	**71.36**
3336 LANDMARK ST H5	70.00	68.77	**71.36**
3336 LANDMARK ST H6	70.00	68.77	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3336 LANDMARK ST H7	70.00	68.78	**71.36**
3336 LANDMARK ST H8	70.00	68.78	**71.36**
3344 LANDMARK ST I1	70.00	68.78	**71.36**
3344 LANDMARK ST I2	70.00	68.77	**71.36**
3344 LANDMARK ST I3	70.00	68.77	**71.36**
3344 LANDMARK ST I4	70.00	68.78	**71.36**
3344 LANDMARK ST I5	70.00	68.78	**71.36**
3344 LANDMARK ST I6	70.00	68.77	**71.36**
3344 LANDMARK ST I7	70.00	68.77	**71.36**
3344 LANDMARK ST I8	70.00	68.78	**71.36**
3348 LANDMARK ST J1	66.08	**68.79**	**71.36**
3348 LANDMARK ST J2	66.08	**68.79**	**71.36**
3348 LANDMARK ST J3	66.08	**68.80**	**71.36**
3348 LANDMARK ST J4	66.08	**68.79**	**71.36**
3348 LANDMARK ST J5	66.08	**68.79**	**71.36**
3348 LANDMARK ST J6	66.08	**68.79**	**71.36**
3348 LANDMARK ST J7	66.08	**68.79**	**71.36**
3385 LANDMARK ST	67.79	**68.77**	**71.35**
3395 LANDMARK ST	70.00	68.77	**71.35**
3398 LANDMARK ST	70.00	68.77	**71.36**
3401 LANDMARK ST	69.13	68.77	**71.35**
100 LINDENWOOD DR	70.00	68.80	**71.36**
102 LINDENWOOD DR	68.47	**68.80**	**71.36**
104 LINDENWOOD DR	68.47	**68.80**	**71.36**
106 LINDENWOOD DR	69.76	68.80	**71.36**
108 LINDENWOOD DR	69.76	68.80	**71.36**
202 LINDENWOOD DR	70.00	68.80	**71.36**
204 LINDENWOOD DR	70.00	68.80	**71.36**
513 MARY LEE CT	56.96	**58.18**	**59.14**
517 MARY LEE CT	56.96	**58.17**	**59.13**
3525 S MEMORIAL DR	70.00	68.80	**71.36**
3535 S MEMORIAL DR	70.00	68.80	**71.36**
401 MIDDLEBURY DR	70.00	68.80	**71.36**
403 MIDDLEBURY DR	70.00	68.80	**71.36**
405 MIDDLEBURY DR	70.00	68.80	**71.36**
4101 PARMER PL	59.07	**59.14**	**59.92**
4105 PARMER PL	59.19	59.06	**59.85**
4113 PARMER PL	58.04	**58.93**	**59.75**
132 PINE BRANCHES CL	57.00	56.59	**57.37**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
133 PINE BRANCHES CL	57.00	56.59	**57.37**
140 PINE BRANCHES CL	54.00	**56.39**	**57.16**
141 PINE BRANCHES CL	54.00	**56.35**	**57.12**
142 PINE BRANCHES CL	57.00	56.39	**57.16**
143 PINE BRANCHES CL	57.00	56.45	**57.23**
170 PINE BRANCHES CL	56.00	**56.21**	**56.98**
172 PINE BRANCHES CL	54.84	**56.26**	**57.03**
173 PINE BRANCHES CL	54.84	**56.17**	**56.94**
180 PINE BRANCHES CL	55.58	**56.07**	**56.84**
181 PINE BRANCHES CL	55.58	**55.98**	**56.75**
103 PLACID WY	70.88	68.80	**71.36**
201 PLACID WY	70.84	68.80	**71.36**
202 PLACID WY	70.00	68.80	**71.36**
203 PLACID WY	70.84	68.80	**71.36**
103 RAVENWOOD DR	70.00	68.80	**71.36**
105 RAVENWOOD DR	70.00	68.80	**71.36**
107 RAVENWOOD DR	70.00	68.80	**71.36**
109 RAVENWOOD DR	70.00	68.80	**71.36**
111 RAVENWOOD DR	70.00	68.80	**71.36**
112 RAVENWOOD DR	70.00	68.80	**71.36**
114 RAVENWOOD DR	70.00	68.80	**71.36**
116 RAVENWOOD DR	70.00	68.80	**71.36**
200 RAVENWOOD DR	70.00	68.80	**71.36**
201 RAVENWOOD DR	70.00	68.80	**71.36**
202 RAVENWOOD DR	70.00	68.80	**71.36**
203 RAVENWOOD DR	70.00	68.80	**71.36**
204 RAVENWOOD DR	70.00	68.80	**71.36**
206 RAVENWOOD DR	70.00	68.80	**71.36**
300 RAVENWOOD DR	70.00	68.80	**71.36**
301 RAVENWOOD DR	70.00	68.80	**71.36**
302 RAVENWOOD DR	70.00	68.80	**71.36**
303 RAVENWOOD DR	70.00	68.80	**71.36**
304 RAVENWOOD DR	70.00	68.80	**71.36**
878 RAY CRAWFORD DR	49.97	**50.54**	**51.50**
886 RAY CRAWFORD DR	49.97	**50.53**	**51.49**
894 RAY CRAWFORD DR	49.25	**50.51**	**51.47**
895 RAY CRAWFORD DR	50.00	**50.73**	**51.69**
899 RAY CRAWFORD DR	50.00	**50.70**	**51.66**
901 RAY CRAWFORD DR	49.34	**50.62**	**51.58**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
902 RAY CRAWFORD DR	48.00	**50.45**	**51.41**
903 RAY CRAWFORD DR	48.09	**50.54**	**51.50**
117 RIPLEY DR	70.00	68.80	**71.36**
120 RIPLEY DR	70.31	68.80	**71.36**
122 RIPLEY DR	70.31	68.80	**71.36**
124 RIPLEY DR	71.32	68.80	**71.36**
102 SHAMROCK CI	70.00	68.80	**71.36**
104 SHAMROCK CI	70.00	68.80	**71.36**
106 SHAMROCK CI	70.00	68.80	**71.36**
108 SHAMROCK CI	70.00	68.80	**71.36**
807 SPRING RUN RD	54.00	51.37	**52.33**
813 SPRING RUN RD	50.71	**51.25**	**52.20**
825 SPRING RUN RD	50.71	**51.09**	**52.05**
835 SPRING RUN RD	50.00	**50.93**	**51.89**
0 STAFFORDSHIRE RD	69.56	68.80	**71.36**
103 STAFFORDSHIRE RD	69.67	68.80	**71.36**
200 STAFFORDSHIRE RD	68.82	68.80	**71.36**
201 STAFFORDSHIRE RD	69.56	68.80	**71.36**
202 STAFFORDSHIRE RD	70.00	68.80	**71.36**
203 STAFFORDSHIRE RD	70.00	68.80	**71.36**
204 STAFFORDSHIRE RD	70.00	68.80	**71.36**
205 STAFFORDSHIRE RD	70.00	68.80	**71.36**
207 STAFFORDSHIRE RD	70.00	68.80	**71.36**
209 STAFFORDSHIRE RD	70.00	68.80	**71.36**
211 STAFFORDSHIRE RD	70.00	68.80	**71.36**
213 STAFFORDSHIRE RD	70.00	68.80	**71.36**
302 SYCAMORE BRANCHES CL	53.60	**55.15**	**55.91**
303 SYCAMORE BRANCHES CL	56.96	55.48	**56.25**
304 SYCAMORE BRANCHES CL	54.00	**55.56**	**56.33**
3608 THORNBROOK DR	70.00	68.80	**71.36**
3612 THORNBROOK DR	70.00	68.80	**71.36**
3616 THORNBROOK DR	68.16	**68.80**	**71.36**
3625 THORNBROOK DR	70.00	68.80	**71.36**
3635 THORNBROOK DR	70.34	68.80	**71.36**
3644 THORNBROOK DR	70.00	68.80	**71.36**
3648 THORNBROOK DR	70.55	68.80	**71.36**
3652 THORNBROOK DR	70.55	68.80	**71.36**
3656 THORNBROOK DR	70.39	68.80	**71.36**
4104 TREETOPS CI	53.15	**53.86**	**54.64**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
4108 TREETOPS CI	54.50	54.07	**54.84**
4112 TREETOPS CI	53.67	**54.41**	**55.16**
4114 TREETOPS CI	53.67	**54.50**	**55.25**
4116 TREETOPS CI	55.19	54.70	**55.45**
4118 TREETOPS CI	55.19	54.70	**55.45**
908 VAN GERT DR	49.74	**52.24**	**53.26**
912 VAN GERT DR	49.48	**52.22**	**53.24**
916 VAN GERT DR	50.69	**52.18**	**53.20**
944 VAN GERT DR	48.99	**51.99**	**52.98**
3700 WALNUT DR	70.00	68.80	**71.36**
3702 WALNUT DR	70.00	68.80	**71.36**
3703 WALNUT DR	70.00	68.80	**71.36**
3704 WALNUT DR	70.00	68.80	**71.36**
3705 WALNUT DR	70.00	68.80	**71.36**
3707 WALNUT DR	70.00	68.80	**71.36**
3709 WALNUT DR	70.00	68.80	**71.36**
3801 WALNUT DR	70.00	68.80	**71.36**
3802 WALNUT DR	70.97	68.80	**71.36**
3803 WALNUT DR	70.00	68.80	**71.36**
104 WESTHAVEN RD	70.00	68.80	**71.36**
105 WESTHAVEN RD	70.18	68.80	**71.36**
107 WESTHAVEN RD	70.00	68.80	**71.36**
109 WESTHAVEN RD	70.00	68.80	**71.36**
111 WESTHAVEN RD	68.75	**68.80**	**71.36**
113 WESTHAVEN RD	70.00	68.80	**71.36**
200 WESTHAVEN RD	70.00	68.80	**71.36**
201 WESTHAVEN RD	70.00	68.80	**71.36**
202 WESTHAVEN RD	70.00	68.80	**71.36**
203 WESTHAVEN RD	70.00	68.80	**71.36**
205 WESTHAVEN RD	70.00	68.80	**71.36**
206 WESTHAVEN RD	70.00	68.80	**71.36**
206 WESTHAVEN RD	70.00	68.80	**71.36**
207 WESTHAVEN RD	70.00	68.80	**71.36**
208 WESTHAVEN RD	70.00	68.80	**71.36**
209 WESTHAVEN RD	70.00	68.80	**71.36**
210 WESTHAVEN RD	70.00	68.80	**71.36**
211 WESTHAVEN RD	70.00	68.80	**71.36**
212 WESTHAVEN RD	70.00	68.80	**71.36**
300 WESTHAVEN RD	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
302 WESTHAVEN RD	70.00	68.80	**71.36**
400 WESTHAVEN RD	70.00	68.80	**71.36**
402 WESTHAVEN RD	70.00	68.80	**71.36**
403 WESTHAVEN RD	70.00	68.80	**71.36**
404 WESTHAVEN RD	70.00	68.80	**71.36**
405 WESTHAVEN RD	70.00	68.80	**71.36**
407 WESTHAVEN RD	70.00	68.80	**71.36**
501 WESTHAVEN RD	70.00	68.80	**71.36**
502 WESTHAVEN RD	70.00	68.80	**71.36**
500 WINSTEAD RD	70.00	68.80	**71.36**
501 WINSTEAD RD	70.46	68.80	**71.36**
502 WINSTEAD RD	70.00	68.80	**71.36**
503 WINSTEAD RD	70.69	68.80	**71.36**
504 WINSTEAD RD	70.00	68.80	**71.36**
505 WINSTEAD RD	70.69	68.80	**71.36**
506 WINSTEAD RD	70.00	68.80	**71.36**
507 WINSTEAD RD	70.00	68.80	**71.36**
508 WINSTEAD RD	70.00	68.80	**71.36**
509 WINSTEAD RD	70.00	68.80	**71.36**
510 WINSTEAD RD	70.00	68.80	**71.36**
511 WINSTEAD RD	70.34	68.80	**71.36**
600 WINSTEAD RD	70.00	68.80	**71.36**
601 WINSTEAD RD	70.05	68.80	**71.36**
602 WINSTEAD RD	70.00	68.80	**71.36**
603 WINSTEAD RD	70.05	68.80	**71.36**
604 WINSTEAD RD	70.00	68.80	**71.36**
605 WINSTEAD RD	70.01	68.80	**71.36**
606 WINSTEAD RD	70.00	68.80	**71.36**
607 WINSTEAD RD	69.66	68.80	**71.36**
608 WINSTEAD RD	70.00	68.80	**71.36**
868 WINTERFIELD DR	50.62	50.19	**51.16**
874 WINTERFIELD DR	50.62	50.25	**51.22**
882 WINTERFIELD DR	50.97	50.37	**51.34**
888 WINTERFIELD DR	50.97	50.37	**51.34**
101 WOODHAVEN RD	68.00	**68.80**	**71.36**
102 WOODHAVEN RD	69.64	68.80	**71.36**
102 WOODHAVEN CT	70.00	68.80	**71.36**
103 WOODHAVEN RD	68.00	**68.80**	**71.36**
104 WOODHAVEN CT	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
105 WOODHAVEN RD	69.49	68.80	**71.36**
106 WOODHAVEN CT	70.00	68.80	**71.36**
107 WOODHAVEN RD	70.00	68.80	**71.36**
108 WOODHAVEN CT	70.00	68.80	**71.36**
200 WOODHAVEN RD	70.00	68.80	**71.36**
201 WOODHAVEN RD	70.00	68.80	**71.36**
202 WOODHAVEN RD	70.00	68.80	**71.36**
203 WOODHAVEN RD	69.69	68.80	**71.36**
205 WOODHAVEN RD	69.69	68.80	**71.36**
206 WOODHAVEN RD	70.00	68.80	**71.36**
207 WOODHAVEN RD	69.49	68.80	**71.36**
208 WOODHAVEN RD	70.00	68.80	**71.36**
210 WOODHAVEN RD	70.00	68.80	**71.36**
211 WOODHAVEN RD	70.00	68.80	**71.36**
212 WOODHAVEN RD	70.00	68.80	**71.36**
213 WOODHAVEN RD	70.00	68.80	**71.36**
215 WOODHAVEN RD	70.00	68.80	**71.36**
217 WOODHAVEN RD	70.00	68.80	**71.36**
219 WOODHAVEN RD	70.00	68.80	**71.36**
301 WOODHAVEN RD	68.00	**68.80**	**71.36**
100 WOODSTOCK DR	68.00	**68.80**	**71.36**
102 WOODSTOCK DR	68.00	**68.80**	**71.36**
103 WOODSTOCK DR	68.82	68.80	**71.36**
104 WOODSTOCK DR	68.00	**68.80**	**71.36**
106 WOODSTOCK DR	68.00	**68.80**	**71.36**
108 WOODSTOCK DR	68.00	**68.80**	**71.36**
110 WOODSTOCK DR	68.00	**68.80**	**71.36**
112 WOODSTOCK DR	68.00	**68.80**	**71.36**
114 WOODSTOCK DR	64.00	**68.80**	**71.36**
116 WOODSTOCK DR	64.00	**68.80**	**71.36**
200 WOODSTOCK DR	66.38	**68.80**	**71.36**
202 WOODSTOCK DR	66.38	**68.80**	**71.36**
203 WOODSTOCK DR	67.31	**68.80**	**71.36**
204 WOODSTOCK DR	68.84	68.80	**71.36**
206 WOODSTOCK DR	68.00	**68.80**	**71.36**
207 WOODSTOCK DR	67.74	**68.80**	**71.36**
208 WOODSTOCK DR	68.00	**68.80**	**71.36**
209 WOODSTOCK DR	67.74	**68.80**	**71.36**
210 WOODSTOCK DR	68.00	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
211 WOODSTOCK DR	68.00	**68.80**	**71.36**
212 WOODSTOCK DR	68.00	**68.80**	**71.36**
214 WOODSTOCK DR	68.00	**68.80**	**71.36**
215 WOODSTOCK DR	68.00	**68.80**	**71.36**
216 WOODSTOCK DR	68.00	**68.80**	**71.36**
217 WOODSTOCK DR	68.11	**68.80**	**71.36**
218 WOODSTOCK DR	68.00	**68.80**	**71.36**
219 WOODSTOCK DR	68.71	**68.80**	**71.36**
220 WOODSTOCK DR	70.00	68.80	**71.36**
221 WOODSTOCK DR	68.71	**68.80**	**71.36**
222 WOODSTOCK DR	70.00	68.80	**71.36**
223 WOODSTOCK DR	70.00	68.80	**71.36**
224 WOODSTOCK DR	70.00	68.80	**71.36**

*Bold text indicates LAG flooding.

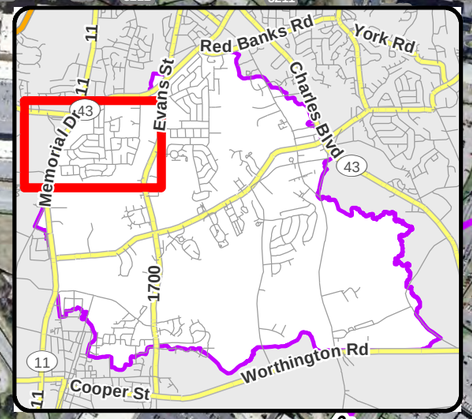
As shown in Table 3-4, 165 properties along Fork Swamp were identified for being at risk of flooding in the 25-year storm event and an additional 704 properties were identified for the 100-year event. There were several residents that provided feedback indicating that they are experiencing yard and AC/storage building flooding along Fork Swamp.

Legend

- Primary System Crossings

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Parcels
- Outside City Limits
- ETJ
- Fork Swamp Watershed



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

HARTFORD ST
LANDMARK ST
BELVEDERE DR
HARMONY ST
CRESTLINE BV
S MEMORIAL DR
MALL DR
GREENWOOD DR
RIPLEY DR
ANTLER RD
S BAYWOOD LN
BRISTOL CT
RAVENWOOD DR
REGENCY BV
EVANS ST
WELLINGHAM AV
DUNHAGAN RD
KEYS CT

EX Twin 72" CMP

EX Twin 84" CMP

EX Twin 84" CMP

Fork Swamp Watershed Master Plan

Figure 3-1
Fork Swamp Existing Conditions Floodplain Section 1

500 250 0 500 Feet

1 inch = 500 feet

Greenville NORTH CAROLINA

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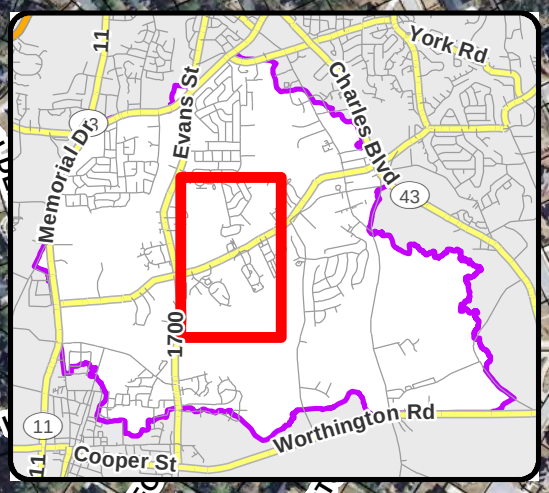
The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.



Legend

Flooding Reported

- Living Space
- Crawl Space
- AC Unit or Storage Building
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

BEDFORD CT
WYNESTON RD
DUNHAGAN RD
WALLINGFORD
BREMERTON
CHESAPEAKE PL
WICKHAM
FORREST PK
ASHBURTON DR
LIVE OAK LN
WHITE OAK DR
DONALD DR
MARY LEE CT
JACK PL
BECKY ANNE DR
ALMA LEE DR
Fork Swamp Main Branch
EX Bridge
QUARTERPATH DR
BROOKSTONE DR
LITCHFORD PL
E FIRE TOWER RD
ALBION DR
BAYWATER RD
BAYSWATER RD
DUDLEYS GRANT DR
PERSIMMON PL
GATES DR
WINDING BRANCHES DR
BIRCH PL
TREETOPS CI
OAK BRANCHES
BOYNE WY
LAGAN CI
Fork Swamp Tributary 3

Fork Swamp Watershed Master Plan

Figure 3-2
Fork Swamp Existing Conditions
Floodplain Section 2

500 250 0 500 Feet

1 inch = 500 feet

Greenville NORTH CAROLINA

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EX 72" CMP

EX Twin 54" CMP Arch

EX Twin 66" CMP

EX Twin 60" CMP

OLD TAR RD

WEST MEATH DR

LAGAN CI

SLANEY LP

GALWAY DR

TRAFALGAR DR

COREY RD

VAN-GERT DR

VICKSBURG D

PL

Fork Swamp Tributary 1

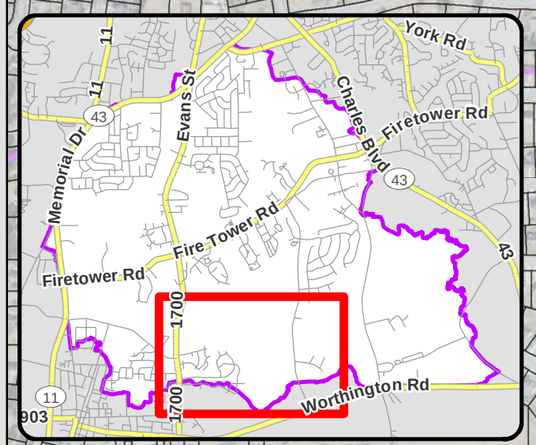
Fork Swamp Tributary 2

Fork Swamp Main Branch

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed



Fork Swamp Watershed Master Plan

Figure 3-3
Fork Swamp
Existing Conditions
Floodplain Section 3

600 300 0 600 Feet

1 inch = 600 feet

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The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Table 3-5: Existing Conditions At-Risk Properties/Structures – FSUT1

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
1203 TRAFALGAR DR	55.30	54.70	**55.78**
1205 TRAFALGAR DR	54.84	54.79	**55.86**
1209 TRAFALGAR DR	52.98	**55.10**	**55.90**
1210 TRAFALGAR DR	54.40	**55.25**	**55.96**
1214 TRAFALGAR DR	55.80	55.14	**55.99**
1215 TRAFALGAR DR	52.55	**55.14**	**55.93**
1404 TRAFALGAR DR	54.25	**55.38**	**56.16**
1405 TRAFALGAR DR	54.17	**56.36**	**56.76**
1407 TRAFALGAR DR	55.86	**56.33**	**56.71**
1409 TRAFALGAR DR	55.86	**56.29**	**56.70**
4800 TREVVETT CI	54.00	**55.30**	**56.01**
4801 TREVVETT CI	54.82	**55.36**	**56.08**
812 VAN GERT DR	51.56	**53.47**	**54.62**
816 VAN GERT DR	50.51	**53.47**	**54.62**
820 VAN GERT DR	50.51	**53.46**	**54.61**

*Bold text indicates LAG flooding.

As shown in Table 3-5, twelve (12) properties along FSUT1 were identified for being at risk of flooding in the 25-year storm event and an additional three (3) properties were identified for the 100-year event. Residents along this stream reach have provided feedback indicating that they are experiencing yard, crawl space and AC/storage building flooding.

Fork Swamp Watershed Master Plan

Figure 3-4
Fork Swamp Tributary 1
Existing Conditions Floodplain

400 200 0 400 Feet

1 inch = 400 feet

Greenville NORTH CAROLINA

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Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

BEXLEY DR
SOUTHLEA DR
WEST ESSEX DR
KNIGHT DR
BUCKINGHAM DR
ESSEX DR
LADY DI DR
COREY RD
ST JOHN DR
TREVETT CI
TRAFALGAR DR
J HICKS RD
VAN-GERT DR

EX Twin 54" CMP Arch
EX Twin 66" CMP
EX Twin 60" CMP

Fork Swamp Tributary 1
Fork Swamp Main Branch

The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

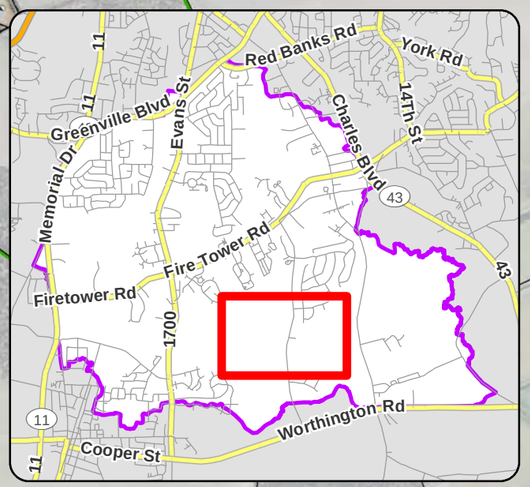


Table 3-6: Existing Conditions At-Risk Properties/Structures – FSUT2 R1

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
595 CEDAR RIDGE DR	53.45	**54.41**	**55.44**
603 CEDAR RIDGE DR	53.38	**54.43**	**55.40**
611 CEDAR RIDGE DR	52.50	**54.36**	**55.36**
619 CEDAR RIDGE DR	52.50	**54.33**	**55.35**
623 CEDAR RIDGE DR	52.05	**54.28**	**55.30**
631 CEDAR RIDGE DR	52.05	**54.23**	**55.26**
639 CEDAR RIDGE DR	51.71	**54.18**	**55.23**
647 CEDAR RIDGE DR	53.51	**54.10**	**55.17**
650 CEDAR RIDGE DR	54.00	**54.06**	**55.14**
657 CEDAR RIDGE DR	53.51	**54.05**	**55.14**
675 CEDAR RIDGE DR	53.10	**53.90**	**55.03**
681 CEDAR RIDGE DR	52.90	**53.85**	**54.99**
689 CEDAR RIDGE DR	52.80	**53.82**	**54.98**
697 CEDAR RIDGE DR	53.40	**53.78**	**54.95**
705 CEDAR RIDGE DR	53.60	**53.76**	**54.92**
711 CEDAR RIDGE DR	53.20	**53.73**	**54.90**
719 CEDAR RIDGE DR	52.25	**53.71**	**54.88**
725 CEDAR RIDGE DR	52.25	**53.69**	**54.87**
731 CEDAR RIDGE DR	53.17	**53.67**	**54.85**
4410 DONEGAL CT	54.30	**54.42**	**55.41**
4442 GALWAY DR	53.26	**53.93**	**55.05**
4448 GALWAY DR	53.68	53.67	**55.00**
4454 GALWAY DR	53.86	53.85	**54.95**
4460 GALWAY DR	54.10	53.74	**54.91**
4466 GALWAY DR	53.50	**53.70**	**54.89**
2116 HAWKS NEST LN	54.00	**54.05**	**55.13**
650 MILTON DR	56.60	56.59	**56.92**
651 MILTON DR	56.90	**56.90**	**56.97**
2121 NORTH STAR LN	54.40	54.11	**55.18**
2129 NORTH STAR LN	54.47	54.08	**55.15**
2137 NORTH STAR LN	55.00	54.05	**55.14**
CEDAR RIDGE DR PUMP STATION	52.30	**54.00**	**55.10**

*Bold text indicates LAG flooding.

As shown in Table 3-6, twenty-five (25) properties along FSUT2R1 were identified for being at risk of flooding in the 25-year storm event and an additional seven (7) properties were identified for the 100-year event. There were no reports of flooding received from residents along this stream reach.

Table 3-7: Existing Conditions At-Risk Properties/Structures – FSUT2 R2

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
505 HILLSHADE CT , UNIT B	71.33	**71.98**	**72.23**
505 HILLSHADE CT , UNIT A	71.82	**71.98**	**72.23**
509 HILLSHADE CT , UNIT B	71.33	**71.98**	**72.23**
509 HILLSHADE CT , UNIT A	71.33	**71.98**	**72.23**
3901 SEDONA DR , UNIT B	70.22	**71.98**	**72.23**
3901 SEDONA DR , UNIT A	70.22	**71.98**	**72.23**
3905 SEDONA DR , UNIT B	71.82	**71.97**	**72.22**
3905 SEDONA DR , UNIT A	70.22	**71.98**	**72.23**
3909 SEDONA DR , UNIT A	71.82	71.70	**72.16**
3909 SEDONA DR , UNIT B	71.82	71.70	**72.06**
205 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
208 SOUTH POINTE DR , UNIT B	70.22	**71.98**	**72.23**
208 SOUTH POINTE DR , UNIT A	70.22	**71.98**	**72.23**
209 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
209 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
213 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
213 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
217 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
217 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
220 SOUTH POINTE DR , UNIT B	70.39	**71.98**	**72.23**
220 SOUTH POINTE DR , UNIT A	70.39	**71.98**	**72.23**
221 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
221 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
305 SOUTH POINTE DR , UNIT A	70.00	**71.97**	**72.23**
305 SOUTH POINTE DR , UNIT B	70.00	**71.97**	**72.23**
341 SOUTH POINTE DR , UNIT B	72.00	71.88	**72.13**
341 SOUTH POINTE DR , UNIT A	72.00	71.92	**72.16**
401 SOUTH POINTE DR , UNIT B	72.00	71.79	**72.04**
401 SOUTH POINTE DR , UNIT A	72.00	71.81	**72.06**

*Bold text indicates LAG flooding.

As shown in Table 3-7, twenty-three (23) properties along FSUT2R2 were identified for being at risk of flooding in the 25-year storm event and an additional six (6) properties were identified for the 100-year event. There were no reports of flooding received from residents along this stream reach.

Fork Swamp Watershed Master Plan

Figure 3-5
Fork Swamp Tributary 2 Reach 1
Existing Conditions Floodplain

400 200 0 400 Feet

1 inch = 400 feet

Greenville NORTH CAROLINA

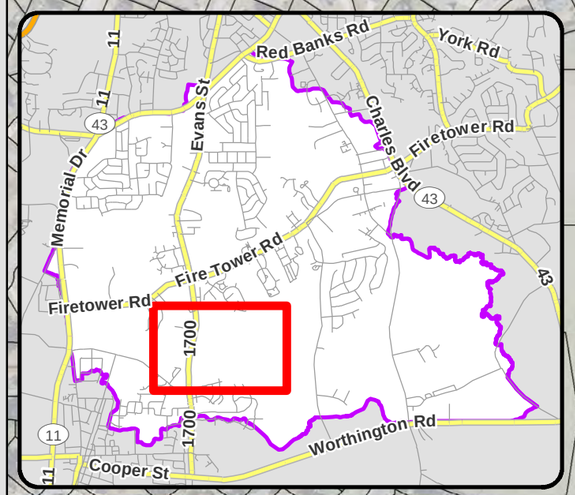
WK DICKSON

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

TREETOPS CI
BLACKWATER DR
GUINESS DR
WEST MEATH DR
BOYNE WY
LAGAN CI
OLD TAR RD
SLANEY LP
GALWAY DR
EX 72" CMP
Fork Swamp Tributary 2
Fork Swamp Main Branch
Fork Swamp Tributary 1
VAN GERT DR



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Fork Swamp Watershed Master Plan

Figure 3-6
Fork Swamp Tributary 2 Reach 2
Existing Conditions Floodplain

400 200 0 400 Feet

1 inch = 400 feet

Greenville NORTH CAROLINA

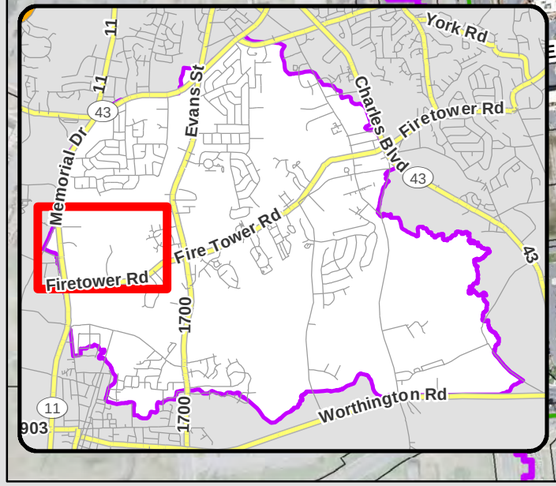
WK DICKSON

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

SOUTH SQUARE DR
GRANADA DR
SEDONA DR
LUCERNE CT
SOUTH POINTE DR
SOUTHPARK DR
SOUTH SQUARE DR
CHAPMAN RD
TICE RD
HUMBER DR
WHITLEY DR
VICTORY LN
W FIRE TOWER RD
EX 10'W X 8'H RCBC
Fork Swamp Tributary 2
HARDWICK CT SOUTHAMPTON
SOUTH HALL CI
KIPLING CT
DOBBS CT
BLARNEY ST
WY



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

N

Table 3-8: Existing Conditions At-Risk Properties/Structures – FSUT3

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
1303 ANGELS END, UNIT A	62.00	**62.61**	**63.12**
1303 ANGELS END, UNIT B	62.50	**62.59**	**63.08**
1305 ANGELS END, UNIT A	62.50	**62.54**	**63.01**
1305 ANGELS END, UNIT B	62.61	62.53	**63.01**
1402 ANGELS END, UNIT A	62.00	**63.36**	**63.69**
1402 ANGELS END, UNIT B	62.11	**63.33**	**63.64**
1404 ANGELS END, UNIT A	62.00	**63.38**	**63.73**
1404 ANGELS END, UNIT B	62.00	**63.38**	**63.73**
1406 ANGELS END, UNIT A	62.04	**63.39**	**63.74**
1409 ANGELS END, UNIT B	62.04	**63.37**	**63.79**
1409 ANGELS END, UNIT A	63.66	63.36	**63.78**
1903 ARLINGTON PARK DR	64.72	**66.29**	**66.87**
1907 ARLINGTON PARK DR	66.20	**66.31**	**66.88**
1911 ARLINGTON PARK DR	66.80	66.16	**66.88**
1915 ARLINGTON PARK DR	66.80	66.18	**66.89**
3709 ASHCROFT DR	60.00	**61.45**	**62.19**
3713 ASHCROFT DR	60.70	**61.34**	**62.07**
3717 ASHCROFT DR	59.73	**61.28**	**62.01**
3721 ASHCROFT DR	59.73	**61.17**	**61.90**
3725 ASHCROFT DR	58.29	**61.06**	**61.79**
3729 ASHCROFT DR	58.29	**60.96**	**61.68**
3733 ASHCROFT DR	60.03	**60.86**	**61.57**
3805 ASHCROFT DR	60.03	**60.82**	**61.52**
3901 ASHCROFT DR	59.22	**60.66**	**61.32**
3905 ASHCROFT DR	59.22	**60.57**	**61.22**
3909 ASHCROFT DR	58.00	**60.53**	**61.17**
3913 ASHCROFT DR	58.00	**60.47**	**61.10**
3916 ASHCROFT DR	59.79	59.70	**61.13**
3920 ASHCROFT DR	59.79	**60.43**	**61.04**
3921 ASHCROFT DR	56.51	**60.41**	**61.01**
3925 ASHCROFT DR	58.84	**60.35**	**60.94**
3928 ASHCROFT DR	58.84	**60.38**	**60.97**
3929 ASHCROFT DR	58.84	**60.33**	**60.90**
3933 ASHCROFT DR	58.48	**60.26**	**60.81**
3936 ASHCROFT DR	60.52	60.37	**60.92**
3937 ASHCROFT DR	59.70	**60.25**	**60.79**
4100 BRIDGE CT, UNIT A	58.02	**59.09**	**59.98**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
4100 BRIDGE CT, UNIT B	58.02	**59.09**	**59.98**
4107 BRIDGE CT	58.00	**58.00**	**59.38**
4109 BRIDGE CT	58.00	**58.39**	**59.30**
4110 BRIDGE CT, UNIT A	58.50	58.49	**59.44**
4110 BRIDGE CT, UNIT B	59.50	58.60	**59.51**
4112 BRIDGE CT	58.00	**58.00**	**59.38**
4114 BRIDGE CT	58.00	**58.42**	**59.33**
4116 BRIDGE CT	54.00	**58.27**	**59.21**
4118 BRIDGE CT, UNIT B	56.21	**58.14**	**59.10**
4118 BRIDGE CT, UNIT A	56.21	**58.11**	**59.07**
4120 BRIDGE CT, UNIT B	56.21	**58.14**	**59.11**
4120 BRIDGE CT, UNIT A	56.21	**58.11**	**59.07**
4122 BRIDGE CT	57.60	57.00	**59.04**
3730 CHARLES BV	69.00	**70.17**	**70.84**
3740 CHARLES BV	70.50	**70.53**	**71.06**
2001 COLEMAN DR, UNIT A	62.00	**62.00**	**62.79**
2001 COLEMAN DR, UNIT B	62.00	**62.00**	**62.79**
2003 COLEMAN DR, UNIT A	62.00	61.90	**62.73**
2003 COLEMAN DR, UNIT B	60.96	**61.90**	**62.66**
2005 COLEMAN DR, UNIT A	62.00	61.70	**62.53**
2005 COLEMAN DR, UNIT B	62.00	61.70	**62.54**
915 E FIRE TOWER RD	60.16	**60.20**	**60.72**
1011 E FIRE TOWER RD	63.80	60.30	**63.81**
1025 E FIRE TOWER RD	60.19	**60.22**	**60.76**
1209 E FIRE TOWER RD	60.75	**61.03**	**61.76**
1213 E FIRE TOWER RD	60.50	**61.20**	**61.93**
1604 E FIRE TOWER RD	64.04	**64.97**	**65.33**
1605 E FIRE TOWER RD	64.00	**64.28**	**64.48**
2050 E FIRE TOWER RD	68.00	**68.00**	**68.79**
1110 HOLDEN DR, UNIT A	62.00	**63.04**	**64.27**
1112 HOLDEN DR, UNIT B	63.90	62.95	**64.21**
1112 HOLDEN DR, UNIT A	64.10	62.95	**64.17**
1114 HOLDEN DR, UNIT B	64.00	62.90	**64.12**
1114 HOLDEN DR, UNIT A	63.73	62.80	**64.08**
1200 HOLDEN DR, UNIT B	63.73	62.80	**64.02**
1200 HOLDEN DR, UNIT A	63.73	62.70	**63.98**
1202 HOLDEN DR, UNIT A	60.00	**62.75**	**63.90**
1202 HOLDEN DR, UNIT B	63.73	62.70	**63.94**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
1204 HOLDEN DR, UNIT B	60.00	**60.00**	**63.86**
1204 HOLDEN DR, UNIT A	60.00	**60.00**	**63.82**
2000 SHADOWOOD CT, UNIT B	61.17	**62.09**	**62.82**
2000 SHADOWOOD CT, UNIT A	61.17	**62.02**	**62.78**
2002 SHADOWOOD CT, UNIT B	60.96	**61.98**	**62.75**
2002 SHADOWOOD CT, UNIT A	60.96	**61.96**	**62.74**
2004 SHADOWOOD CT, UNIT B	60.96	**61.88**	**62.66**
2004 SHADOWOOD CT, UNIT A	60.96	**61.82**	**62.59**
2006 SHADOWOOD CT, UNIT B	60.50	**61.71**	**62.47**
2006 SHADOWOOD CT, UNIT A	60.60	**61.68**	**62.43**
2007 SHADOWOOD CT, UNIT A	62.67	61.90	**62.71**
2008 SHADOWOOD CT, UNIT B	62.00	61.57	**62.35**
2008 SHADOWOOD CT, UNIT A	62.00	61.57	**62.30**
2010 SHADOWOOD CT, UNIT B	61.50	61.40	**62.25**
2010 SHADOWOOD CT, UNIT A	61.50	61.40	**62.20**
4327 SOUTHLEA DR	53.30	53.00	**54.52**
1802 SUMMERHAVEN DR, UNIT A	63.50	62.50	**63.64**
1804 SUMMERHAVEN DR, UNIT B	62.00	**62.49**	**63.56**
1804 SUMMERHAVEN DR, UNIT A	61.50	**62.45**	**63.51**
1806 SUMMERHAVEN DR, UNIT B	62.50	62.45	**63.50**
1806 SUMMERHAVEN DR, UNIT A	62.50	62.41	**63.45**
1995 SUMMERHAVEN DR, UNIT B	62.39	**62.50**	**62.94**
1995 SUMMERHAVEN DR, UNIT A	62.30	**62.50**	**62.94**
1997 SUMMERHAVEN DR, UNIT A	62.39	62.30	**62.95**
1997 SUMMERHAVEN DR, UNIT B	62.39	62.30	**62.88**
2000 SUMMERHAVEN DR, UNIT B	62.00	**62.00**	**62.76**
2000 SUMMERHAVEN DR, UNIT A	62.00	**62.00**	**62.75**
2007 SUMMERHAVEN DR, UNIT B	62.50	61.80	**62.59**
2001 TOWER PL, UNIT B	62.11	**63.22**	**63.54**
2001 TOWER PL, UNIT A	62.44	**63.11**	**63.47**
2002 TOWER PL, UNIT B	62.00	**62.68**	**63.21**
2002 TOWER PL, UNIT A	62.00	**62.68**	**63.21**
2003 TOWER PL, UNIT B	62.00	**63.28**	**63.57**
2003 TOWER PL, UNIT A	62.00	**63.14**	**63.49**
2004 TOWER PL	60.37	**62.60**	**63.10**
4006 WHITEBRIDGE DR	58.71	**59.24**	**60.12**

*Bold text indicates LAG flooding.

As shown in Table 3-8, eighty-one (81) properties along FSUT3 were identified for being at risk of flooding in the 25-year storm event and an additional thirty (30) properties were identified for the 100-year event. There were no reports of flooding received from residents along this stream reach.

Fork Swamp Watershed Master Plan

Figure 3-7
Fork Swamp Tributary 3
Existing Conditions Floodplain
Section 1

600 300 0 600 Feet

1 inch = 600 feet

Greenville NORTH CAROLINA

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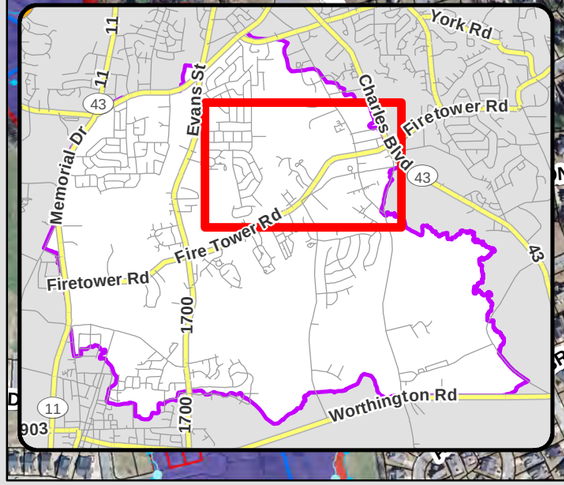
Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets Flooding
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

VASSAR RD
KENILWORTH RD
QUEEN ANNES RD
KILBY DR
KINGS RD
ONTARIO DR
ROLSTON RD
HOLDEN DR
WIMBLEDON DR
E ARLINGTON BV
TURNBURY
SMYTHE
EX Twin 54" RCP
EX Twin 54" RCP
EX 18" RCP
E FIRE TOWER RD
LONG DR
ARLINGTON PARK DR
EX 10'W X 8'H RCBC
SUMMERHAVEN DR
ANGELS END
TOWER PL
EX Twin 60" CMP
ESTHER CT
OLD FIRE TOWER RD
COUNTY HOME RD
HUNGATE DR
BELLS CHAPEL RD
GOSFORD GT
CAMPDEN WY
GUILDER LN
DAVENTRY DR
BEDFORD CT
WYNESTON RD
HUNTINGTON RD
DUNHAGAN
WALLINGFORD RD
BREMERTON DR
AMHURST LN
COLEMAN DR
Fork Swamp Tributary 3
SHADOWOOD CT
RADFORD DR
EX Twin 66" CMP
EX Twin 66" CMP
ROSEMONT DR
EX Twin 10' X 7' Oval CMP
ASHCROFT DR
MCLAREN LN
CHESAPEAKE P
QUARTERPATH DR
ROOKSTONE DR
BAYSWATER RD
COREY RD
BRIDGE CT
ADDISON CT
ROYAL DR
PICCADILLY DR
BUCCANEER WY



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Fork Swamp Watershed Master Plan

Figure 3-8
Fork Swamp Tributary 3
Existing Conditions Floodplain
Section 2

600 300 0 600 Feet

1 inch = 600 feet

Greenville NORTH CAROLINA

WK DICKSON

Legend

Flooding Reported

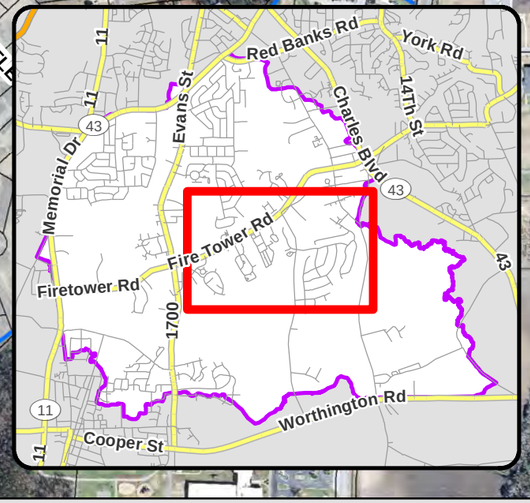
- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

EX Twin 10' X 7' Oval CMP

EX Bridge

WYNESTON RD
WALLINGFORD RD
EMERTON DR
APEAKE PL
MCLAREN LN
ASHCROFT DR
RADFORD DR
ROSEMONT DR
ASHBURTON DR
WICKHAM DR
QUARTERPATH DR
TOTTENHAM CT
BROOKSTONE DR
ALBION DR
BAYSWATER RD
BRIDGE CT
WHITEHALL RD
ADDISON CT
LEICESTER CT
HAMMERSMITH DR
PELHAM RD
COUNTY HOME RD
DUKE RD
LITCHFORD PL
BAYWATER RD
E FIRE TOWER RD
LEE DR
DUDLEYS GRANT DR
COREY RD
BUCKINGHAM DR
BISHOP DR
DUCHESS DR
SQUIRE DR
ROYAL DR
BERKSHIRE DR
CASTLE
KNIGHT DR
PERSIMMON PL
GATES DR
WINDING BRANCHES DR
BIRCH PL
TREETOPS CI
OAK BRANCHES CL
SOUTHLEA DR
BEXLEY DR
BLACKWATER DR
WEST MEATH DR
LAGAN CI
BOYNE WY
Fork Swamp Tributary 3
Fork Swamp Main Branch

The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.



3.2 SECONDARY SYSTEM HYDROLOGIC AND HYDRAULIC ANALYSES

While Fork Swamp and its tributaries are the primary source of flooding within the watershed, undersized systems can also lead to structural and roadway flooding. Based on the questionnaire responses, public meeting, and feedback from City staff, four (4) secondary systems were identified for further evaluation. The secondary systems evaluated are as follows:

- Trafalgar Drive Closed System;
- Corey Road Closed System;
- Lynndale System; and
- Evans Street Channels.

3.2.1 HYDROLOGY

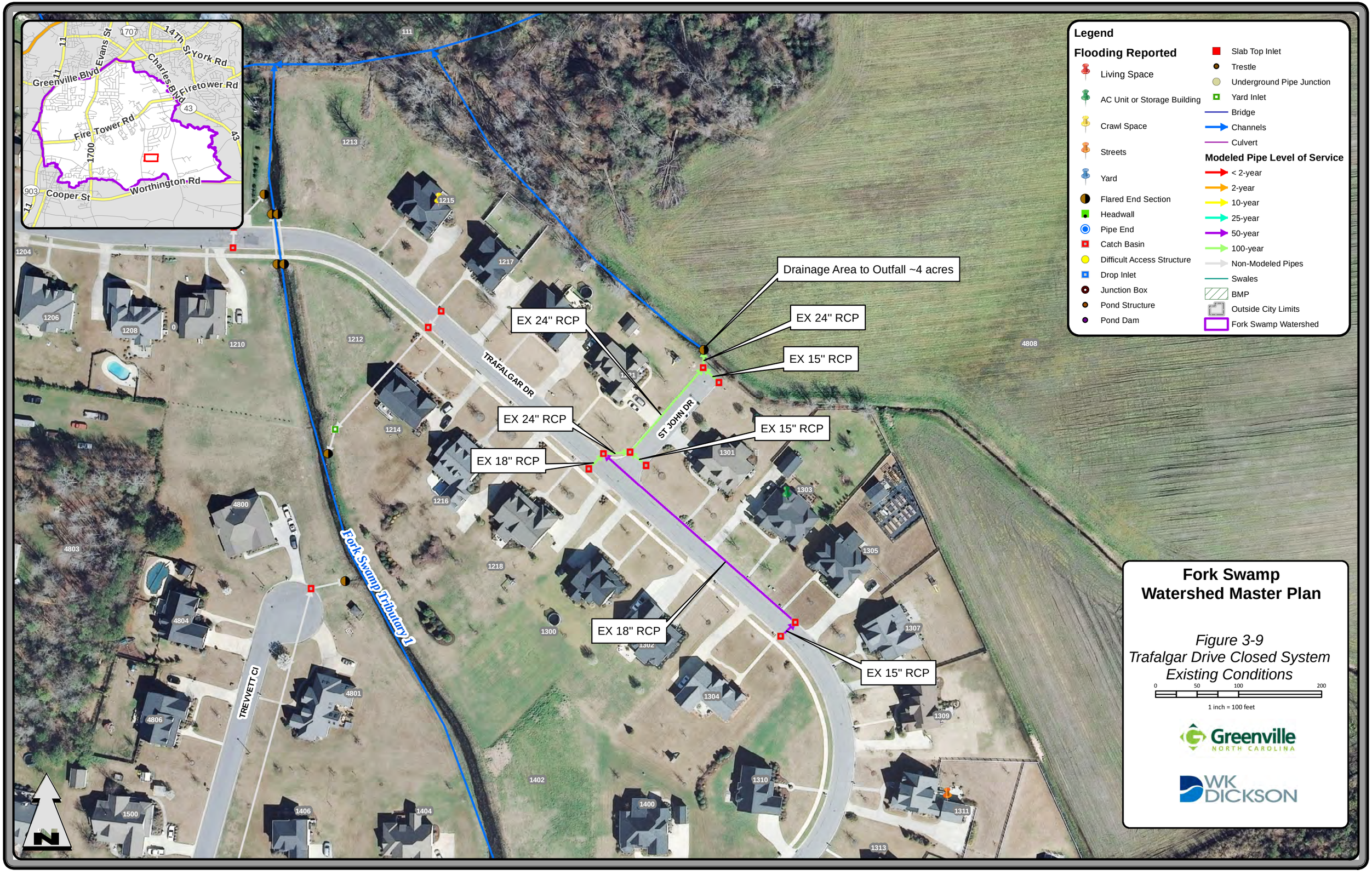
Three (3) models were used in the hydrologic evaluation of the secondary systems: HEC-HMS, EPA SWMM, and Hydraflow Storm Sewers. For the larger more complex secondary system, the Corey Road System, SWMM was selected as the hydrologic and hydraulic model. Smaller systems that were completely closed systems including Trafalgar Drive were modeled using Rational flow calculations within Hydraflow Storm Sewers. HEC-HMS was used to model the Evans Street Channels. The Lynndale System was evaluated by Rivers & Associates as a separate project, therefore modeling methodologies and parameters may not be consistent with the remaining projects within the Citywide Master Plan. A detailed description about the hydrologic modeling methodology used for they systems analyzed as part of this report is included in Appendix A.

3.2.2 HYDRAULICS

Trafalgar Drive Closed System

The Trafalgar Drive Closed System collects drainage from 4 acres in the Farrington subdivision. It discharges to a trapezoidal channel section that ultimately outlets to FSUT1. The conveyance system is comprised of RCP ranging in size from 15 to 24 inches in diameter that is in good condition based on data collected during the inventory. Flooding has historically been reported along Trafalgar Drive as noted from the City staff and public input. There is one report of flooding adjacent to this system in this area. It is a report of crawl space and AC or storage building flooding at 1303 Trafalgar Drive.

Figure 3-9 shows the level of service being provided by the existing closed system. The model results show that the existing system is operating at or above the desired 10-year level of service. Flooding appears to be related to backwater from the main stream rather than the capacity of the Trafalgar Drive conveyance system. Flooding has appeared to be less frequent and less severe since the installation of the new culverts at Corey Road.


Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Streets
Yard
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Trestle
Underground Pipe Junction
Yard Inlet
Bridge
Channels
Culvert
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
Swales
BMP
Outside City Limits
Fork Swamp Watershed
Drainage Area to Outfall ~4 acres
EX 24" RCP
EX 24" RCP
EX 15" RCP
EX 24" RCP
EX 15" RCP
EX 18" RCP
EX 18" RCP
EX 15" RCP
TRAFALGAR DR
ST JOHN DR
Fork Swamp Tributary 1
TREVETT CI
Greenville Blvd
Evans St
14Th St
York Rd
Charles Blvd
Firetower Rd
Fire Tower Rd
Cooper St
Worthington Rd
Fork Swamp Watershed
Fork Swamp
Watershed Master Plan
Figure 3-9
Trafalgar Drive Closed System
Existing Conditions
0 50 100 200
1 inch = 100 feet
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Corey Road Closed System

The Corey Road Closed System collects drainage from approximately 60 acres in the Windsor Downs subdivision and the adjacent parcels. It discharges to a channel section the outlets directly to Fork Swamp. The conveyance system is comprised mostly of RCP ranging in size from 15 to 48 inches in diameter that is in good condition based on data collected during the inventory. Flooding has historically been reported is this area as reported by City staff and the findings in the Watershed Action Plan prepared by Baker dated October 12, 2012.

Figure 3-10 shows the level of service being provided by the existing closed system. The model results show that the majority of the existing system is operating at or above the desired 10-year level of service. There are three segments of pipe that are only meeting a 2-year level of service including the twin 36" RCPs that discharges to the outlet channel.

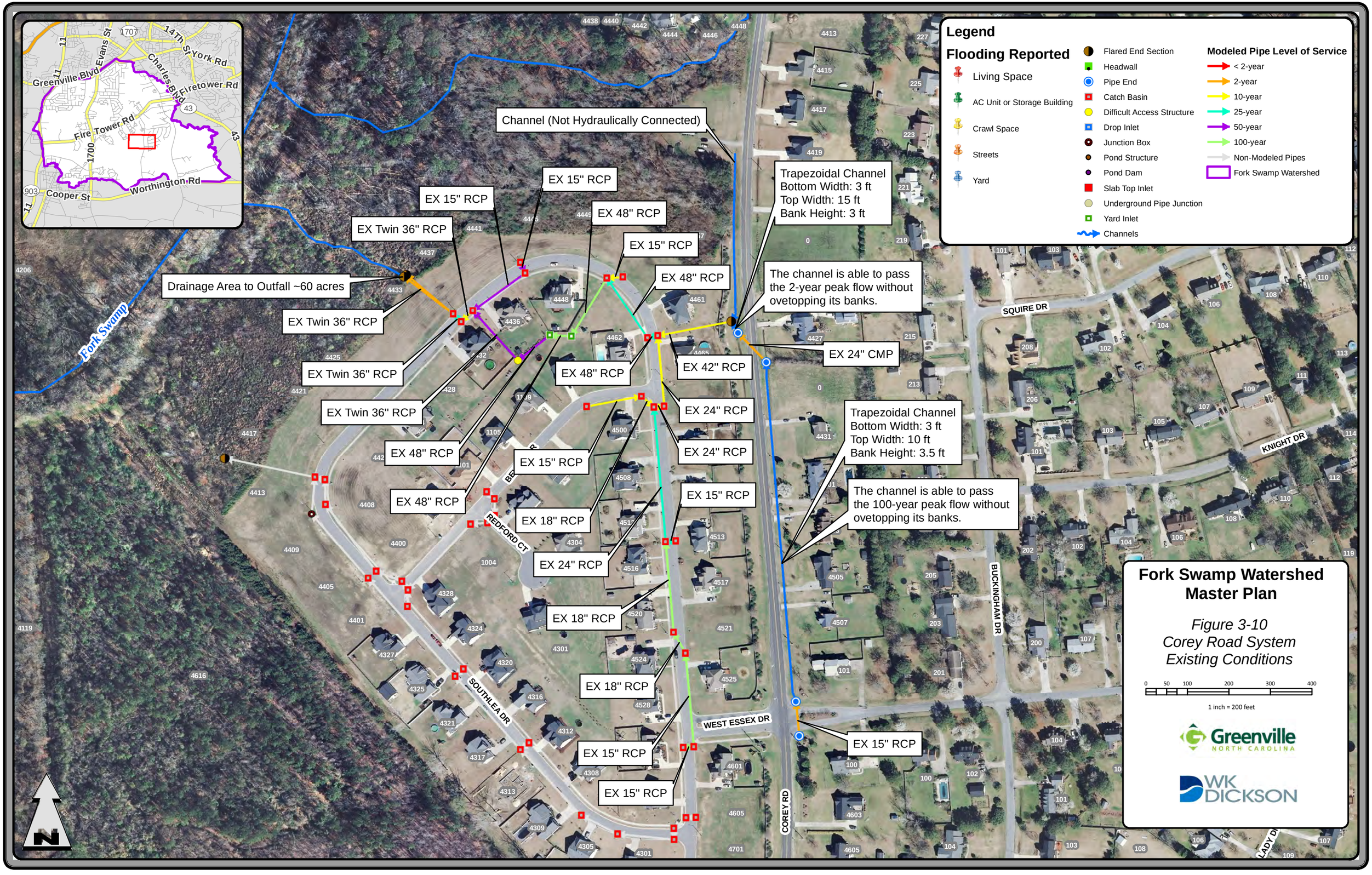
Lynndale System

Seven (7) questionnaires were received from the residents in the Lynndale subdivision reporting yard and street flooding. Based on the feedback from residents and City staff, significant roadway flooding occurs along Fort Sumter Drive, Crown Point Road, and Martinsborough Road. A study for this area has been completed with proposed recommendations by River & Associates. The Lynndale System was not reanalyzed as part of the Fork Swamp Watershed Master Plan, although improvements proposed by Rivers & Associates are included in the Master Plan prioritization.

Evans Street Channels

The Evans Street channels are located in the northern section of the Fork Swamp watershed. The upstream segment of these analyzed channels is adjacent to a highly impervious area including an office park and high-density residential area (townhouse/condominium complex). There are no reports of flooding from property owners however, the City staff has identified this area as being severely eroded. Additionally, the resident at 3307 Evans Street has reported erosion on the property that is associated with the channel.

Figure 3-11 shows the 25- and 100- year existing conditions floodplain for the Evans Street channel sections. The model shows that there is yard and parking lot flooding expected in the 25- and 100-year storm events. The channel velocities reported from the model range between 0.2 and 3.3 feet per second in the 10-year storm event. Stream bank erosion can be a concern when channel velocities exceed 4.0 feet per second for the types of soil present in the streambed, however the velocity at which erosion can occur will vary based on the site specific soil type and vegetative cover. This stream reach was walked and evaluated by WK Dickson personnel. Based on this evaluation, a stream stabilization project was developed as part of this Master Plan. The stream stabilization project (Project #7) is outlined in Section 5.1 of this report.


Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Streets
Yard
Flared End Section
Headwall
Pipe End
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Pond Structure
Pond Dam
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Channels
Modeled Pipe Level of Service
< 2-year
2-year
10-year
25-year
50-year
100-year
Non-Modeled Pipes
Fork Swamp Watershed
Channel (Not Hydraulically Connected)
Trapezoidal Channel
Bottom Width: 3 ft
Top Width: 15 ft
Bank Height: 3 ft
EX 15" RCP
EX 48" RCP
EX Twin 36" RCP
EX 15" RCP
EX 48" RCP
Drainage Area to Outfall ~60 acres
The channel is able to pass the 2-year peak flow without ovetopping its banks.
EX Twin 36" RCP
EX 24" CMP
EX 42" RCP
EX Twin 36" RCP
EX 48" RCP
EX 24" RCP
EX Twin 36" RCP
Trapezoidal Channel
Bottom Width: 3 ft
Top Width: 10 ft
Bank Height: 3.5 ft
EX 48" RCP
EX 15" RCP
EX 24" RCP
EX 48" RCP
The channel is able to pass the 100-year peak flow without ovetopping its banks.
EX 18" RCP
EX 15" RCP
EX 24" RCP
EX 18" RCP
EX 18" RCP
EX 15" RCP
EX 15" RCP
EX 15" RCP
Fork Swamp
Greenville Blvd
Evans St
14Th St York Rd
Charles Blvd
Firetower Rd
Fire Tower Rd
Cooper St
Worthington Rd
SQUIRE DR
KNIGHT DR
BUCKINGHAM DR
REDFORD CT
SOUTHLEA DR
WEST ESSEX DR
COREY RD
Fork Swamp Watershed Master Plan
Figure 3-10
Corey Road System
Existing Conditions
0 50 100 200 300 400
1 inch = 200 feet
Greenville NORTH CAROLINA
WK DICKSON

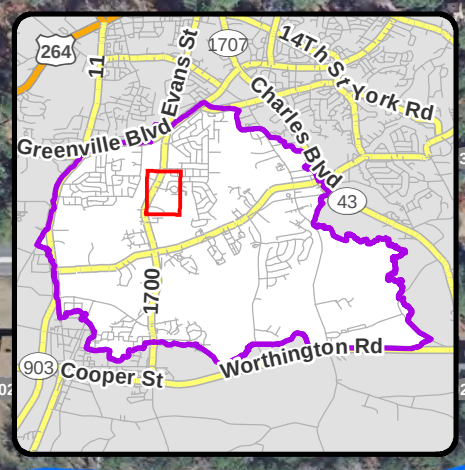
Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets Flooding
- Yard

- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

- Flared End Section
- Headwall
- Pipe End
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Pond Structure
- Pond Dam
- Slab Top Inlet
- Trestle
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Channels
- Culvert
- Non-Modeled Pipes
- Swales
- BMP



E VICTORIA CT
EVANS ST
WARWICK DR
KINETON CI
CAVERSHAM RD
WARWICK CT
GOSFORD GT
LUTHER GLEN
CAMPDEN WY
DUNHAGAN RD
BEDFORD CT
KEYS CT
LIVE OAK LN

Fork Swamp Watershed Master Plan

Figure 3-11
Evans Street Channels
Existing Conditions

0 100 200 400

1 inch = 200 feet

Greenville NORTH CAROLINA

WK DICKSON

3.3 STREAM STABILITY FIELD ASSESSMENTS

There are 13.4 miles of stream located in the Fork Swamp Watershed. Within the watershed, all 3.6 miles of Fork Swamp is classified for secondary recreation and aquatic wildlife survival and propagation (Class C) by NCDWR. Fork Swamp is also classified as nutrient sensitive waters (NSW) by NCDWR, indicating it is subject to excessive growth of microscopic or macroscopic vegetation, or it may contribute to downstream nutrient loading (NCDWR 2011). None of the streams in the watershed are listed on the NC Water Quality Assessment and Impaired Waters list (also known as the Integrated 305 (b) and 303 (d) Report).

Field assessments measuring bank stability were conducted on all of the major stream channels within the Fork Swamp Watershed. The Bank Erosion Hazard Index (BEHI) developed by Rosgen was used to evaluate the streams in the watershed. BEHI is an assessment tool that is used to quantify the erosion potential of a stream bank. Characteristics assessed as part of the BEHI rating include bank height ratio (stream bank height/maximum bankfull depth), ratio of rooting depth to bank height, root density, bank angle, and percent surface protection, and bank material composition. Each of these variables that affect the potential rate of stream bank erosion is assigned points based on specific evaluation criteria. BEHI scores range from five to fifty, with a score of fifty indicating the highest potential for erosion. A BEHI score of 5 to 19.5 indicates a very low or low potential for erosion; a score between 20 and 29.5 indicates a moderate potential for erosion; scores from 30 to 45 represent a high to very high potential for erosion; and scores between 46 and 50 indicate extreme erosion potential. The completed BEHI scores are provided in Appendix K.

In addition to BEHI ratings, a modified version of the channel stability assessment method (CSA) provided in "Assessing Stream Channel Stability at Bridges in Physiographic Regions" by Johnson (2006) was used to assess channel stability channels in the watershed. The CSA method was designed to evaluate stability indicators in the field. These parameters include: watershed characteristics, flow habit, channel pattern, entrenchment/channel confinement, bed material, bar development, presence of obstructions/debris jams, bank soil texture and coherence, average bank angle, bank vegetation/protection, bank cutting, and mass wasting/bank failure. The twelve (12) indicators were scored in the field, and a rating of excellent, good, fair, or poor was assigned to each project reach based on the total score. The completed CSA scores and a field datasheet are provided in Appendix K.

There are four (4) main drainage features within the Fork Swamp Watershed (See Figure 3-12). The largest of these is Fork Swamp. Three unnamed tributaries also drain to Fork Swamp. UT1 and UT3 originate in the eastern portion of the watershed before draining to Fork Swamp. UT2 originates in the western portion of the watershed before draining to Fork Swamp. BEHI scores for each of these drainage areas are discussed below.

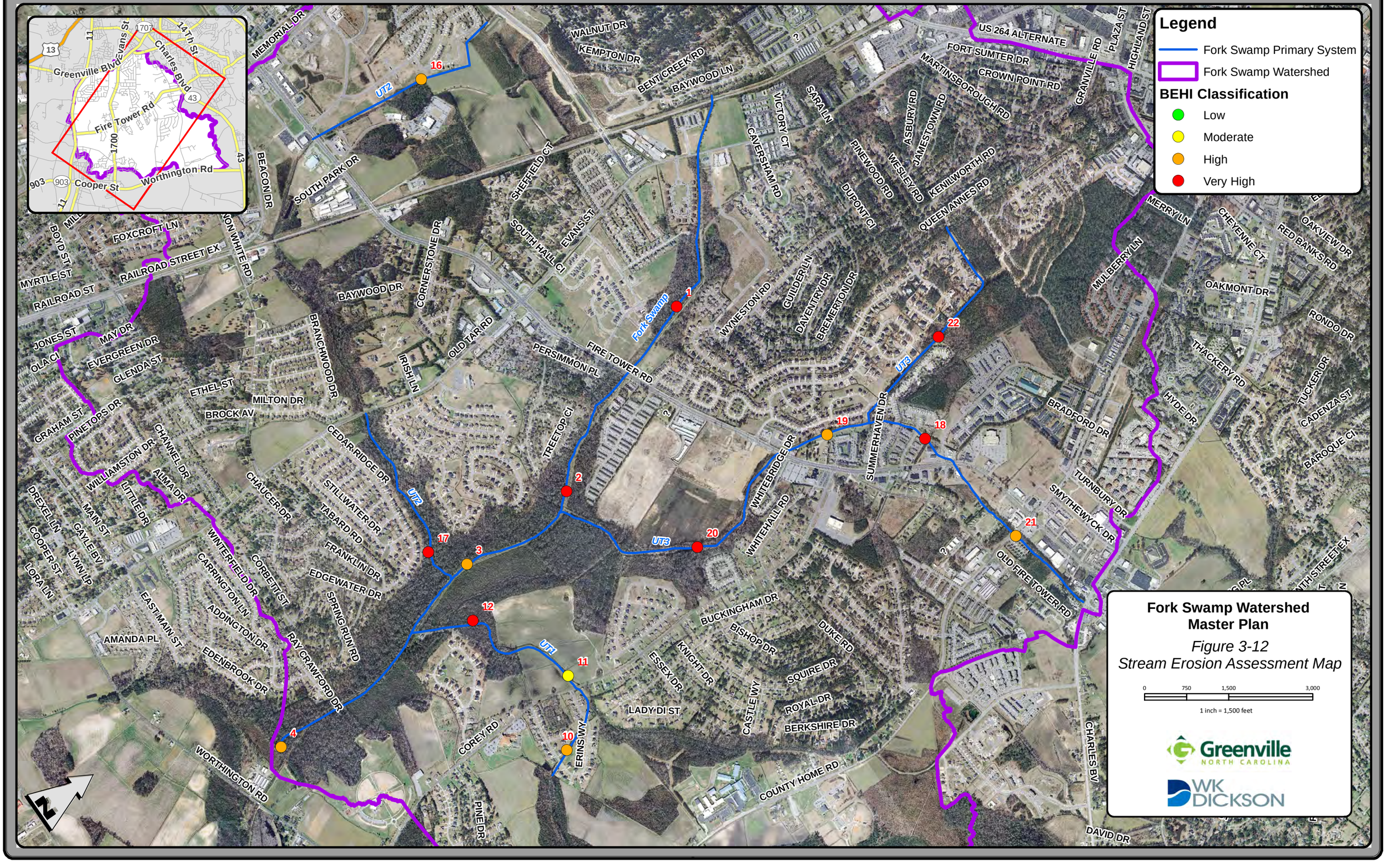
Fourteen (14) BEHI assessments were performed along the Fork Swamp drainages. Four (4) of these assessments were performed on the main branch of Fork Swamp. Sampling points 1 and 2, the samples upstream of the confluence with UT3, had ratings of Very High. Both of these

sampling points had bank height/bankfull ratios in the very high range. Additionally, these stream reaches had moderate to high surface protection and bank angles approaching 70 degrees. The downstream reaches of Fork Swamp (sampling points 3 and 4), had BEHI ratings of High. These samples had bank height/bankfull ratios in the low to moderate range, and very low root densities along the stream banks. Bank angles and surface protection scored in the very low range. These assessments illustrate that the main branch of Fork Swamp in the study area is primarily a sand bed channel with high potential for erosion.

Two (2) BEHI assessments were performed on UT2, one on the downstream reach (UT2-1) and one on the upstream reach (UT2-2). UT2-1 scored Very High and UT2-2 scored High on the BEHI assessment. UT2-1 is a sandbed channel with a fairly intact riparian buffer. UT2-1 scored moderate for bank height/bankfull ratios and bank angle, but in the high to very high range for root density and surface protection. UT2-2 is a sandbed channel with no little riparian buffer throughout most of the reach. UT2-2 scored near the extreme range for bank height/bankfull ratios, but scored in the low range for bank angle and surface protection.

Three (3) BEHI assessments were performed along UT1. The most downstream sampling point, point 12, is a sandbed channel with a fairly intact riparian buffer. This point scored moderate for bank height/bankfull ratios and bank angle, but in the high to very high range for root density and surface protection. The most upstream assessment, sampling point 10, scored High on the assessment. This reach is a sandbed channel that runs through a residential neighborhood and has areas of noticeable erosion encroaching on multiple landowner fences. Bank height/bankfull ratios in this neighborhood are very high, but bank angles and root density are in the low to moderate range. Sampling point 11, runs through a large tract of agricultural land and scored in the moderate range to high range. This reach had little to no riparian buffer and areas of obvious erosion. This section of UT1 is a good candidate for bank stabilization and buffer restoration, as highlighted in Section 5.1 for Stream Stabilization Project #2.

Five (5) BEHI assessments were performed along UT3, all ranging in the High to Very High range. All of these sampling points scored in the Extreme range for bank height/bankfull ratios and High for root density. All samples scored in the low to moderate range for bank angle and surface protection. UT3 is a sand bad channel that, as highlighted in Section 5-1, has many opportunities for bank stabilization, floodplain benching, and buffer enhancement/restoration. Upstream of Sample location 22, the City has recently completed a bank stabilization project with a hardened approach at a 90 degree turn in the stream. Stream Stabilization Project #6 detailed in Section 5-1 addresses additional stabilization issues just upstream of the completed City project.


Legend
Fork Swamp Primary System
Fork Swamp Watershed
BEHI Classification
Low
Moderate
High
Very High
Fork Swamp Watershed Master Plan
Figure 3-12
Stream Erosion Assessment Map
0
750
1,500
3,000
1 inch = 1,500 feet
Greenville
NORTH CAROLINA
WK DICKSON
Fork Swamp
UT1
UT2
UT3
Greenville Blvd
Charles Blvd
Fire Tower Rd
Worthington Rd
Cooper St
14Th St
Evans St
MEMORIAL DR
WALNUT DR
KEMPTON DR
BENT CREEK RD
BAYWOOD LN
US 264 ALTERNATE
FORT SUMTER DR
MARTINSBOROUGH RD
CROWN POINT RD
GRANVILLE RD
PLAZA ST
HIGHLAND ST
BEACON DR
SOUTH PARK DR
SHEFFIELD CT
SOUTH HALL CT
EVANS ST
CAVERSHAM RD
VICTORY CT
SARA LN
PINEWOOD RD
DUPONT CI
ASBURY RD
JAMESTOWN RD
WESLEY RD
KENILWORTH RD
QUEEN ANNES RD
MERRY LN
CHEYENNE CT
OAKVIEW DR
RED BANKS RD
MULBERRY LN
OAKMONT DR
RONDO DR
THACKERY RD
TUCKER DR
CADENZA ST
BAROQUE CI
HYDE DR
BRADFORD DR
TURNBURY DR
SMYTHEWYCK DR
OLD FIRE TOWER RD
CHARLES BV
DAVID DR
FOXCROFT LN
BOYD ST
MYRTLE ST
RAILROAD ST
RAILROAD STREET EX
CORNERSTONE DR
BAYWOOD DR
OLD TAR RD
IRISH LN
PERSIMMON PL
FIRE TOWER RD
WYNESTON RD
GUILDER LN
DAVENTRY DR
BREMERTON DR
WHITEHALL RD
WHITEBRIDGE DR
SUMMERHAVEN DR
TREETOP CI
JONES ST
MAY DR
OLA CI
EVERGREEN DR
GLENDA ST
ETHEL ST
MILTON DR
BROCK AV
BRANCHWOOD DR
CEDAR RIDGE DR
GRAHAM ST
PINETOPS DR
WILLIAMSTON DR
CHANNEL DR
ALMA DR
LITTLE DR
MAIN ST
GAYLE BV
LYNN LP
COOPER ST
DREXEL LN
LORA LN
CHAUCER DR
STILLWATER DR
TABARD RD
FRANKLIN DR
EDGEWATER DR
SPRING RUN RD
CORBETT ST
WINTERFIELD DR
CARRINGTON LN
ADDINGTON DR
EDENBROOK DR
RAY CRAWFORD DR
EAST MAIN ST
AMANDA PL
WORTHINGTON RD
COREY RD
PINE DR
ERINS WY
LADY DI ST
ESSEX DR
KNIGHT DR
BUCKINGHAM DR
BISHOP DR
DUKE RD
SQUIRE DR
ROYAL DR
BERKSHIRE DR
CASTLE WY
COUNTY HOME RD
1
2
3
4
10
11
12
16
17
18
19
20
21
22
N

FLOOD MITIGATION ALTERNATIVES

4.1 PRIMARY SYSTEMS

Developing flood control alternatives in an urban environment is a complex process based on limitations imposed by the constraints within the environment such as floodplain encroachments, increased peak flows due to impervious areas, public and private utilities, and private property. Improvements in this portion of the study were identified through an iterative process of infrastructure improvements, increasing floodplain storage, and evaluating detention options. Alternatives were finalized based on discussions with City staff. The top alternatives that achieve the goals of the project while minimizing impacts to residents and traffic are presented.

4.1.1 FORK SWAMP

East Baywood Lane – As determined by the existing conditions analysis, the existing twin 72" CMPs at this crossing do not meet the desired 25-year level of service without overtopping. Currently, it provides a 2-year level of service and is in good condition as shown in Picture 4-1.

Picture 4-1. East Baywood Lane Culvert – Upstream Face

The hydraulic performance at East Baywood Lane is affected by the backwater from the downstream railroad crossing. With the improvements proposed downstream, the resultant 25-year water surface elevation (WSEL) is reduced by over 2 feet. However, East Baywood Lane still does not meet the required 25-year level of service and will operate at a 10-year level of service. Increasing the capacity at the crossing does not impact the WSEL since the culvert is in outlet control. Additionally, there is no room available to incorporate floodplain benching immediately downstream of the crossing to lower the tailwater. It should be noted that no reports of flooding have been collected in the vicinity of East Baywood Lane. Therefore, no capital improvements are proposed at this location.

Railroad Crossing – The existing twin 84" CMPs at this crossing are currently operating at a 25-year level of service. In order to aid in lowering the tailwater at East Baywood Lane, floodplain benches are proposed downstream of the railroad crossing in the left overbank for approximately 770 linear feet.

Figure 4-1 shows the locations of the proposed floodplain benching. The benching will range in width between 140 and 150 feet. The proposed floodplain benching will improve the performance of the existing twin 84" CMPs and bring it up to the desired 100-year level of

service. The resulting upstream water surface elevation will be reduced by 2.07 to 2.35 feet in the 25-year storm event.

There are 121 properties located in the existing conditions 25-year floodplain upstream of the railroad crossing in the Westhaven subdivision and an additional 671 in the 100-year floodplain. If this alternative is implemented, 15 properties will be removed from the 25-year floodplain and an additional 18 properties from the 100-year floodplain. The majority of the residents will remain in the floodplain however, the severity, duration, and frequency of flooding will be reduced. Lowering the tailwater at the railroad by installing the floodplain benching is the only feasible alternative for reducing the water surface elevations in the Westhaven subdivision.

During a field inspection, there were several potential site restrictions and utility conflicts that were identified including overhead power lines that are located above Evans Street which may possibly be used as a construction entrance. These overhead power lines may need to be temporarily relocated based on where the contractor accesses the site. There also appears to be sanitary sewer lines that may need to be replaced or relocated. Impacts to traffic flow during construction were considered. The proposed project is not located in the roadway therefore anticipated impacts to traffic are minimal. In order to gain access and to install the proposed floodplain benching, minimal tree removal will be required. The installation of construction staging areas and entrances will require additional tree removal and temporary construction easements. It should be noted that the majority of the proposed improvements are located on private property therefore an easement would be required to complete this project and maintain the bench in the future. Approximately 25% of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

The total estimated cost for floodplain benching downstream of the Railroad crossing is $1,000,000.

Evans Street – As determined by the existing conditions analysis, the twin 84" CMPs at this crossing are currently providing a 25-year level of service. Since Evans Street is classified as a major NCDOT thoroughfare, the desired level of service is the 50-year storm.

This alternative entails replacing the existing CMPs with twin 7′ x 7′ RCBCs coupled with floodplain benching downstream of the crossing to lower the tailwater. The floodplain benching is proposed in the left overbank for approximately 1,200 linear feet. The improvements proposed will bring Evans Street up to the desired 50-year level of service. It should be noted that NCDOT has an upcoming widening project planned for Evans Street. In order to implement the culvert improvements with this planned roadway widening project, coordination with NCDOT will be required. Depending upon the timing, another option would

be to complete this project in phases. Phase 1 would be the installation of the proposed floodplain benching followed by Phase 2, the culvert upgrades. With regards to sequencing of proposed improvements along Fork Swamp, the Evans Street floodplain benching should be completed before the Railroad Crossing improvements. This will help to further reduce the tailwater between Evans Street and the railroad. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

The reductions in water surface elevation will range from 2.76 to 2.95 feet in the 25-year storm event between the railroad crossing and Evans Street. There are no structures located in the existing conditions 25- and 100-year floodplain. Figure 4-1 summarizes the improvements proposed for this location. The total estimated cost for completing the culvert improvements and floodplain benching at Evans Street is $1,920,000.

During a field inspection, there were several potential site restrictions and utility conflicts that were identified including overhead power lines that are located above the Evans Street culvert. There also appears to be sanitary sewer lines that may need to be replaced or relocated. Impacts to traffic flow during construction were considered. Evans Street is a major thoroughfare and it is anticipated that a road closure or flagged two-way one-lane operation will be required. The proposed floodplain benching is located on private property therefore an easement would be required to complete this project and maintain the bench in the future. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project.

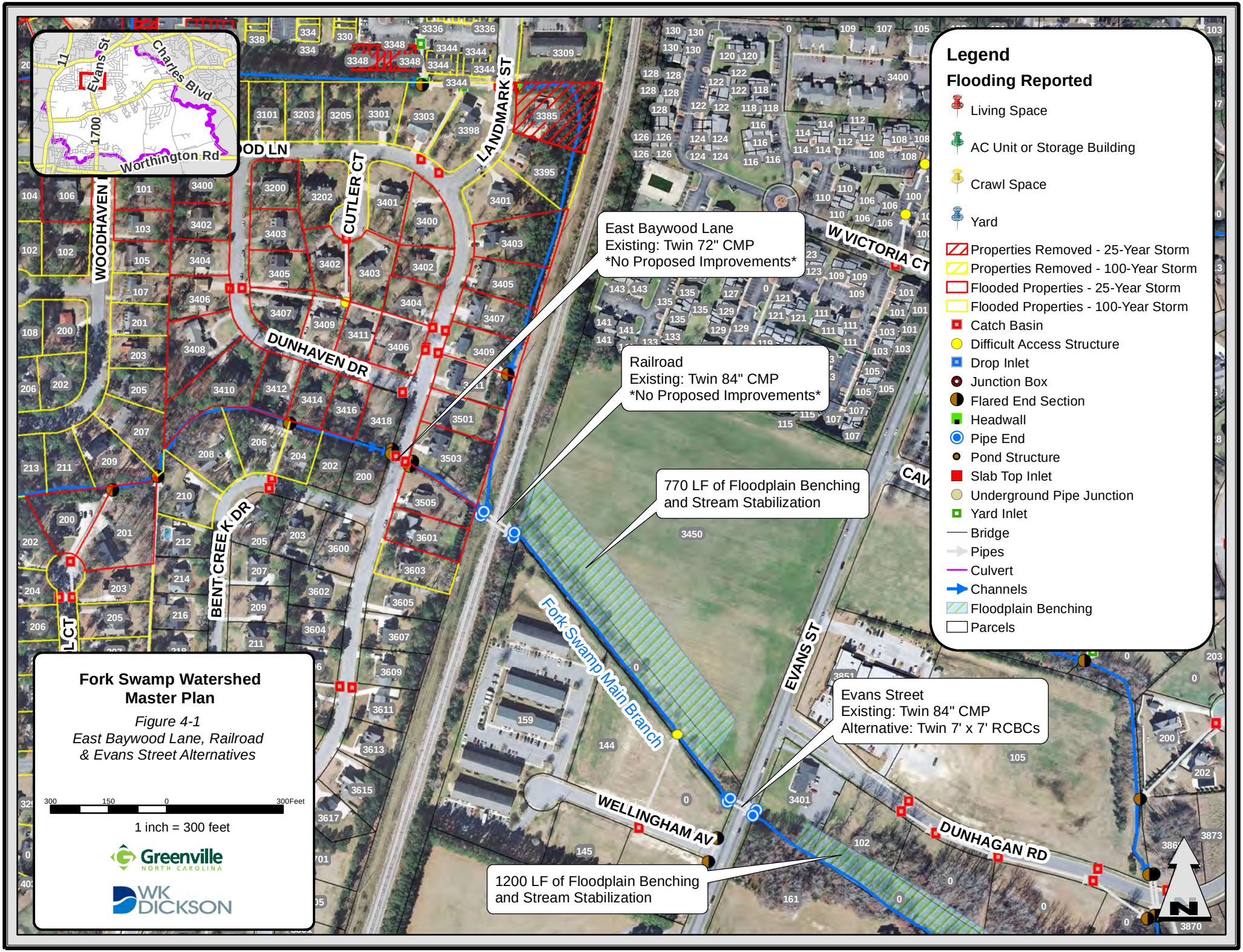
East Fire Tower Road – The existing bridge at this crossing is in good condition and currently performs at a 25-year level or service. Since East Fire Tower Road is a major thoroughfare, the desired level of service is the 50-year storm. In order to provide a 50-year level of service at this crossing, the recommended alternative is to reduce the tailwater by grading floodplain benches downstream of East Fire Tower Road.

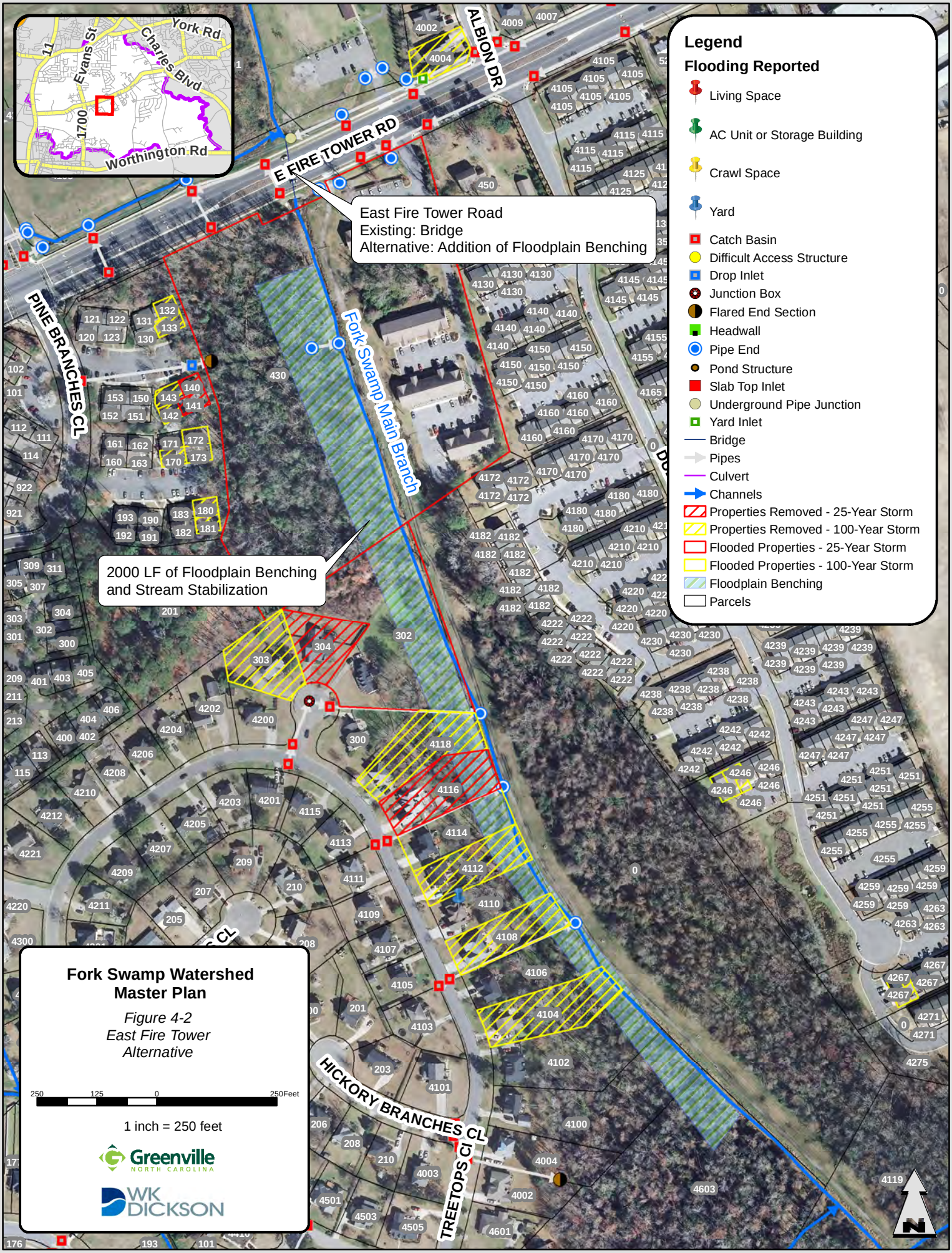
As shown in Figure 4-2, this alternative entails proposed floodplain benching in the right overbank for approximately 2,000 linear feet. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

The improvements proposed will bring East Fire Tower Road up to the desired 50-year level of service. The reductions in water surface elevation will range from 0.28 to 2.31 feet in the 25-year storm event downstream of East Fire Tower Road. This will provide potential flood relief to the Treetops Circle residents. There are six (6) properties in the existing conditions 25-year floodplain and sixteen (16) additional properties in the 100-year floodplain, that have potential to experience LAG or structural flooding. The water surface elevation will be reduced for all of these properties. Four (4) will be removed from the 25-year floodplain and twelve (12) from

the 100-year floodplain with the implementation of this project. The remaining properties will continue to be exposed to LAG or structural flooding, although depth will be reduced.

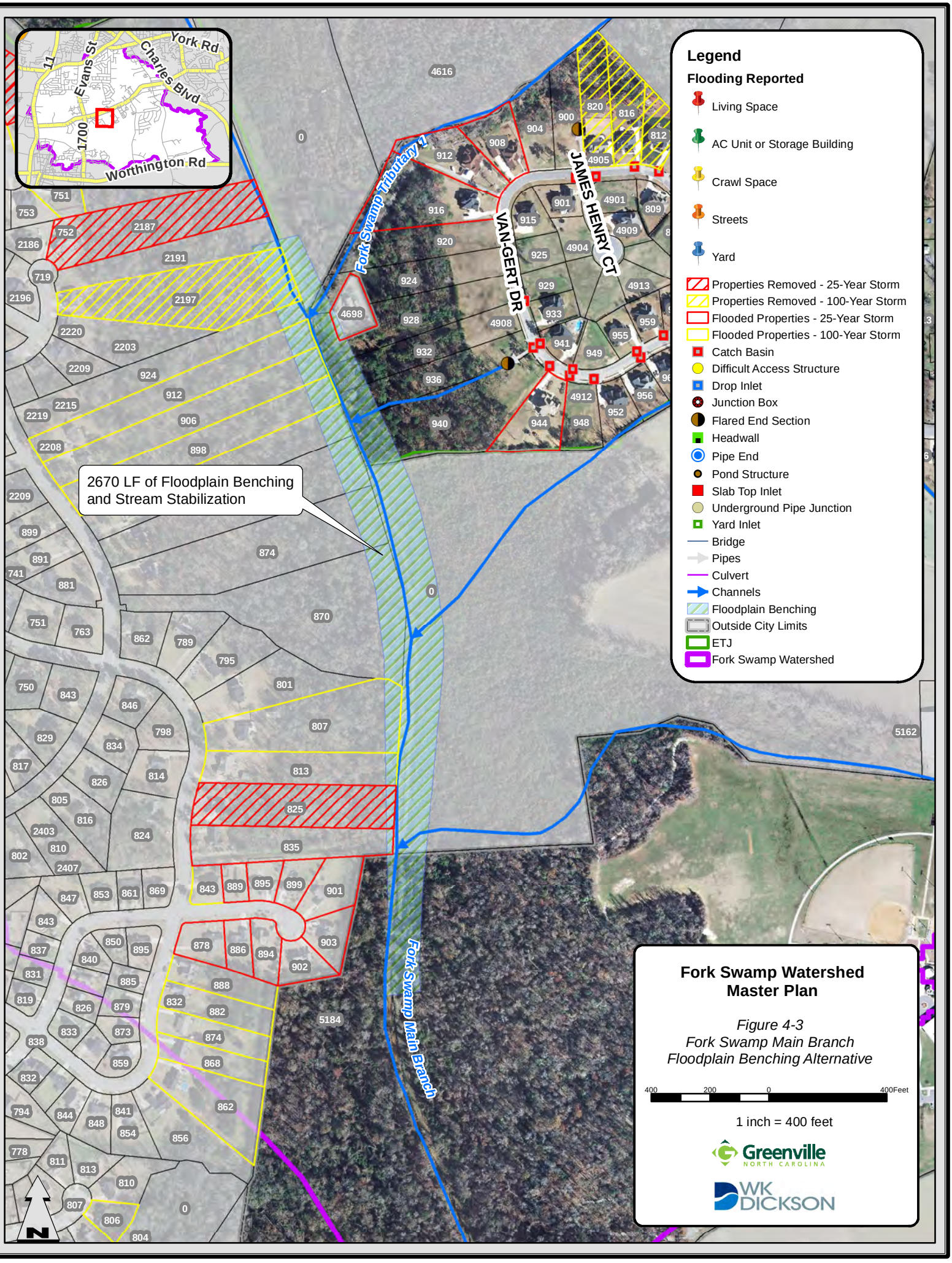
During a field inspection, there were several potential site restrictions and utility conflicts that were identified including overhead power lines that are located above East Fire Tower Road which may possibly be used as a construction entrance. The proposed grading area is heavily wooded in some locations and private easements would be required from approximately fourteen (14) property owners, however the land requiring easements does not currently seem to be utilized by the property owners. There are two sanitary sewer lines that cross the proposed project area to reach the sanitary main on the east bank. These lines may need to be replaced or relocated based on the elevations and material type of those lines. The total estimated cost for these improvements is $1,740,000. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project.


East Baywood Lane
Existing: Twin 72" CMP
No Proposed Improvements
Railroad
Existing: Twin 84" CMP
No Proposed Improvements
770 LF of Floodplain Benching
and Stream Stabilization
Evans Street
Existing: Twin 84" CMP
Alternative: Twin 7' x 7' RCBCs
1200 LF of Floodplain Benching
and Stream Stabilization
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Properties Removed - 25-Year Storm
Properties Removed - 100-Year Storm
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Floodplain Benching
Parcels
Fork Swamp Main Branch
WOODHAVEN DR
CUTLER CT
LANDMARK ST
DUNHAVEN DR
BENT CREEK DR
W VICTORIA CT
EVANS ST
WELLINGHAM AV
DUNHAGAN RD
Evans St
Charles Blvd
1700
Worthington Rd
Fork Swamp Watershed
Master Plan
Figure 4-1
East Baywood Lane, Railroad
& Evans Street Alternatives
300 150 0 300Feet
1 inch = 300 feet
Greenville
NORTH CAROLINA
WK DICKSON
N


York Rd
Evans St
Charles Blvd
1700
Worthington Rd
E FIRE TOWER RD
ALBION DR
PINE BRANCHES CL
Fork Swamp Main Branch
HICKORY BRANCHES CL
TREETOPS CI
East Fire Tower Road
Existing: Bridge
Alternative: Addition of Floodplain Benching
2000 LF of Floodplain Benching and Stream Stabilization
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Properties Removed - 25-Year Storm
Properties Removed - 100-Year Storm
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Floodplain Benching
Parcels
Fork Swamp Watershed Master Plan
Figure 4-2
East Fire Tower Alternative
250 125 0 250 Feet
1 inch = 250 feet
Greenville NORTH CAROLINA
WK DICKSON
N

Fork Swamp Main Branch Floodplain Benching – In addition to the improvements proposed at and near the individual road crossings, there is a proposed floodplain benching and stream stabilization project located along the main branch of Fork Swamp downstream of FSUT1 and FSUT2. As shown on Figure 4-3, 2,670 linear feet of floodplain benching is proposed in the left and right overbanks. This will help to lower the tailwater at these two tributaries. Additionally, it will help to offset some of the increased flows generated from upsizing upstream culverts. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Four (4) properties will be removed from the 25-year existing conditions floodplain and one (1) from the 100-year existing conditions floodplain as a result of the proposed floodplain benching. The proposed project is not located in the roadway therefore anticipated impacts to traffic are minimal. In order to gain access and to install the proposed floodplain benching, significant tree removal will be required, which will be costly and can be considered a negative impact of the project to some stakeholders, although the proposed graded area can be replanted after completion of construction. The installation of construction staging areas and entrances will require additional tree removal and temporary construction easements. It should be noted that the majority of the proposed improvements are located on private property therefore easements would be required to complete this project and maintain the bench in the future. The total estimated cost for these improvements is $5,240,000. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project.


York Rd
Evans St
Charles Blvd
11
1700
Worthington Rd
Fork Swamp Tributary 1
JAMES HENRY CT
VAN-GERT DR
2670 LF of Floodplain Benching and Stream Stabilization
Fork Swamp Main Branch
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Streets
Yard
Properties Removed - 25-Year Storm
Properties Removed - 100-Year Storm
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Floodplain Benching
Outside City Limits
ETJ
Fork Swamp Watershed
Fork Swamp Watershed Master Plan
Figure 4-3
Fork Swamp Main Branch
Floodplain Benching Alternative
400 200 0 400Feet
1 inch = 400 feet
Greenville
NORTH CAROLINA
WK DICKSON
N

A summary of the hydraulic performance for the improvements proposed along Fork Swamp are included in Tables 4-1 and 4-2. The water surface elevations shown assume all proposed primary system improvements for Fork Swamp are constructed. The level of improvement will be reduced if all projects are not implemented.

Table 4-1: Hydraulic Performance for Fork Swamp Main Branch Alternative

Location	Minimum Elevation at Top of Road (feet NAVD	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
East Baywood Lane (Existing Twin 72″ CMPs)	66.01	25-year	63.87	66.00	**66.55**	**68.10**	**70.91**
Railroad (Existing Twin 84″ CMPs with Proposed Floodplain Benching)	70.89	100-year	63.03	65.03	66.42	68.02	70.87
Evans Street (Proposed Twin 7′ x 7′ RCBCs with Floodplain Benching)	66.51	50-year	60.29	61.90	62.86	63.78	64.99
East Fire Tower Road (Existing Bridge with Proposed Extended Floodplain Benching)	58.23	50-year	54.40	56.10	57.53	58.22	**58.58**

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.
** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

Table 4-2: WSEL Reductions and Properties Removed from Floodplains – Fork Swamp Main Branch Alternative

Location	WSEL Reduction (feet NAVD)		Properties Removed/ Properties in Floodplain	
	25-Year	100-Year	25-Year	100-Year
East Baywood Lane	2.22	0.45	N/A*	N/A*
Railroad	2.32	0.48	15/121	18/792
Evans Street	2.92	2.21	0/0	0/0
East Fire Tower Road with Floodplain Benching	0.28 - 2.31	0.33 - 1.12	4/6	12/22

*No proposed improvements at this location.

4.1.2 FORK SWAMP UT1

Picture 4-2. Trafalgar Drive – South Culverts

Trafalgar Drive – South – As determined by the existing conditions analysis, the twin 60" CMPs at this crossing are undersized and not meeting the desired 25-year level of service. The culverts are in good condition. To provide the 25-year level of service and reduce the frequency and severity of flooding for the residents adjacent to the Trafalgar Drive – South culvert crossing, the installation of a 60" floodplain culvert with a new headwall is proposed (See Figure 4-4). The existing CMPs shown in Picture 4-2 will be left in place.

There are three (3) downstream properties in the 100-year existing conditions floodplain, that have the potential to experience yard, LAG, or structural flooding. These properties are as follows: 1405, 1407, and 1409 Trafalgar Drive. The proposed improvements will reduce the water surface elevations for the 25-year storm by 0.56 to 0.67 feet upstream of Trafalgar Drive – South. The water surface elevation will be reduced for all of these properties, only 1405 and 1407 Trafalgar Drive will be removed from the 100-year floodplain. The property at 1409 Trafalgar Drive will remain in the floodplain and continue to be subject to yard, LAG, or structural flooding but at reduced depths and likely reduced duration.

There are several potential site restrictions and utility conflicts that were identified at this project location. There appears to be sanitary sewer, electric, and gas lines that may need to be replaced or relocated. Impacts to traffic flow during construction were considered. Trafalgar Drive is a two-lane residential roadway. It is anticipated that a road closure or a flagged two-way one-lane operation will be required. The total estimated cost for this project is $180,000.

Trafalgar Drive – North – As determined by the existing conditions analysis, the 60" and 66" CMPs at this crossing are not meeting the desired 25-year level of service. In order to provide a 25-year level of service at this crossing, the recommended alternative is to replace and upsize the culverts at Trafalgar Drive – North.

As part of this alternative, the existing CMPs will be replaced with twin 8' x 5' RCBCs. The upsized culvert will provide the desired 25-year level of service with 0.16 feet of freeboard. Figure 4-4 summarizes the improvements proposed at Trafalgar Drive – North. The resulting upstream water surface elevations will be reduced by as much as 0.95 feet in the 25-year storm event if improvements are also completed at Corey Road as described below.

There are three (3) properties in the existing conditions 25-year floodplain and two (2) additional properties in the 100-year floodplain, that have potential to experience LAG or structural flooding. These properties are as follows: 1210, 1214, 1404 Trafalgar Drive and 4800,

4801 Trevvett Circle. The water surface elevation will be reduced for all of these properties. The property at 1210 Trafalgar Drive and 4801 Trevvett Circle will be removed from the 25-year floodplain while 1404 Trafalgar Drive and 4800 Trevette Circle will be removed from the 100-year floodplain with the implementation of this alternative. The remaining property at 1214 Trafalgar Drive will continue to be exposed to LAG or structural flooding, although depth will be reduced. The total estimated cost for this project is $440,000.

There are several potential site restrictions and utility conflicts that were identified at this project location. There appears to be sanitary sewer, electric, and gas lines that may need to be replaced or relocated. Impacts to traffic flow during construction were considered. Trafalgar Drive is a two-lane residential roadway. It is anticipated that a road closure or a flagged two-way one-lane operation will be required.

Corey Road – Based on the results obtained from the existing conditions analysis, the existing twin 13' x 4.5 CMP arches (See Picture 4-3) at Corey Road are passing the desired 25-year storm. However, in order to lower the tailwater and improve the performance of the culvert at Trafalgar Drive – North, the capacity at Corey Road will be increased. This alternative proposes the installation of twin 48" floodplain culverts along with a new headwall at Corey Road.

Picture 4-3. Corey Road CMP arches

In addition to the proposed floodplain culvert, it is recommended that 2,300 linear feet of floodplain benching be included downstream of Corey Road as shown on Figure 4-4. The floodplain benching will be located in the left and right overbanks. Although the benching is located outside of the City limits, it will help to reduce the tailwater at Corey Road and subsequently Trafalgar Drive which directly impacts City residents. To implement proposed improvements for FSUT1, the Corey Road project should be completed before the Trafalgar Drive improvements.

There are four properties (1203, 1205, 1209, and 1215 Trafalgar Drive) upstream of Corey Road located in the existing conditions 25- and 100-year floodplain. The resident located at 1209 Trafalgar Drive has reported storage building flooding. The property at 1215 Trafalgar Drive will be removed from the 25-year floodplain and 1209 Trafalgar Drive will be removed from the 100-year floodplain. While the water surface elevations will be reduced at remaining properties, they will remain in the 25- and 100-year floodplains. They will continue to experience flooding but the severity and frequency will be reduced.

During a field inspection, there were several potential site restrictions and utility conflicts that were identified. Overhead power lines are located along Corey Road, which may need to be temporarily relocated based on where the contractor accesses the site. There also appears to be

water lines that may need to be replaced or relocated. Impacts to traffic flow during construction were considered. This section of Corey Road is a two-lane minor thoroughfare. It is anticipated that a road closure or a flagged two-way one-lane operation will be required. In order to gain access and to install the proposed floodplain benching, tree removal would be required. It should be noted that the proposed floodplain benching is located on private property therefore an easement will be required to complete this project and maintain the bench in the future. The total estimated cost for this project is $6,870,000.

A summary of the hydraulic performance for the improvements proposed along Fork Swamp are included in Table 4-3, and a summary of the improvements realized for reduction in WSEL and properties removed from floodplains is shown in Table 4-4. The water surface elevations shown assume all proposed primary system improvements for FSUT1 are constructed. The level of improvement will be reduced if all projects are not implemented.

Table 4-3: Hydraulic Performance for FSUT1 – Alternative #1

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
Trafalgar Drive - South (Existing Twin 60″ CMPs with Proposed 60″ Floodplain Culvert)	55.81	25-year	53.14	54.57	55.62	**56.13**	**56.38**
Trafalgar Drive - North (Proposed Twin 8′ x 5′ RCBCs)	54.35	25-year	52.40	53.48	54.19	**54.73**	**55.16**
Corey Road (Existing Twin 13′ x 4.5 CMP Arch with Proposed Twin 48″ Floodplain Culverts)	54.81	25-year	50.95	51.64	52.30	53.00	53.96

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.
** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

Table 4-4: WSEL Reductions and Properties Removed from Floodplains – FSUT2: Alt #1

Location	WSEL Reduction (feet NAVD)		Properties Removed/Properties in Floodplain	
	25-Year	100-Year	25-Year	100-Year
Trafalgar Drive - South	0.67	0.25	2/3	2/3
Trafalgar Drive - North	0.95	0.62	2/3	2/5
Corey Road	1.96	1.47	1/4	1/4

Proposed Regional Detention Pond

Corey Road
Existing: Twin 13' x 4.5' CMP Arch
Alternative: Twin 48" Floodplain Culverts
(Keep existing and add headwall)

Trafalgar Drive - North
Existing: 60" CMP and 66" CMP
Alternative: Twin 8' x 5' RCBCs

2300 LF of Floodplain Benching and Stream Stabilization

Trafalgar Drive - South
Existing: Twin 60" CMPs
Alternative: 60" Floodplain Culvert
(Keep existing and add headwall)

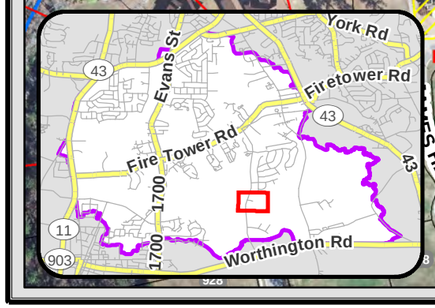
BUCKINGHAM DR
LADY DI DR
COREY RD
VAN-GERT DR
J HICKS RD
S HENRY CT
TREVETT CI
TRAFALGAR DR
ST JOHN DR
Fork Swamp Tributary 1

Legend

- AC Unit or Storage Building
- Crawl Space

Flooding Reported

- Flooding Reported
- Yard
- Properties Removed - 25-Year Storm
- Properties Removed - 100-Year Storm
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Flared End Section
- Headwall
- Pipe End
- Pond Structure
- Slab Top Inlet
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Pipes
- Culvert
- Channels
- Floodplain Benching
- Proposed Detention Pond
- Parcels
- Outside City Limits



Fork Swamp Watershed Master Plan

Figure 4-4
FSUT1 - Corey Road, Trafalgar Drive - North and South Alternatives

250 125 0 250Feet

1 inch = 250 feet

Greenville NORTH CAROLINA

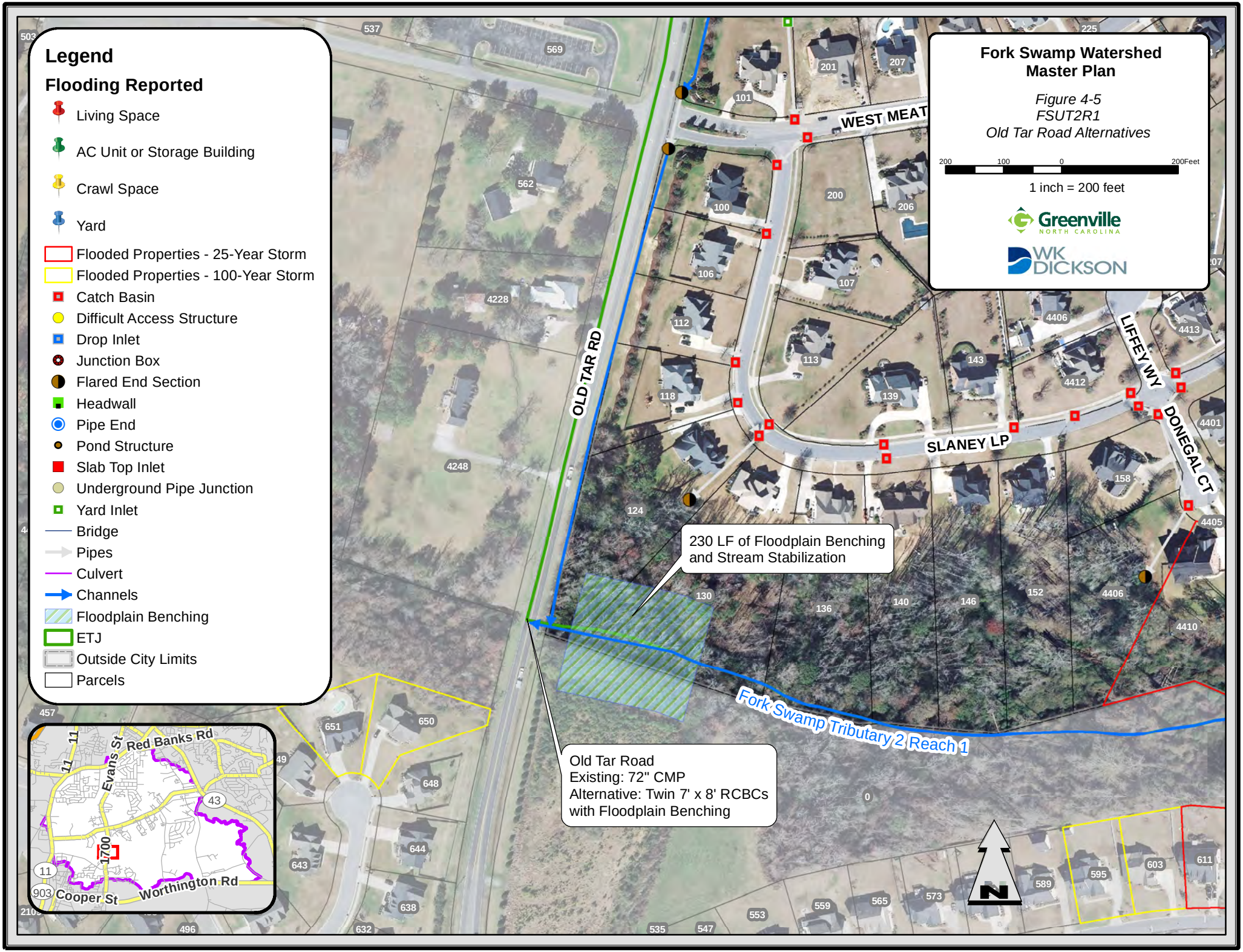
WK DICKSON

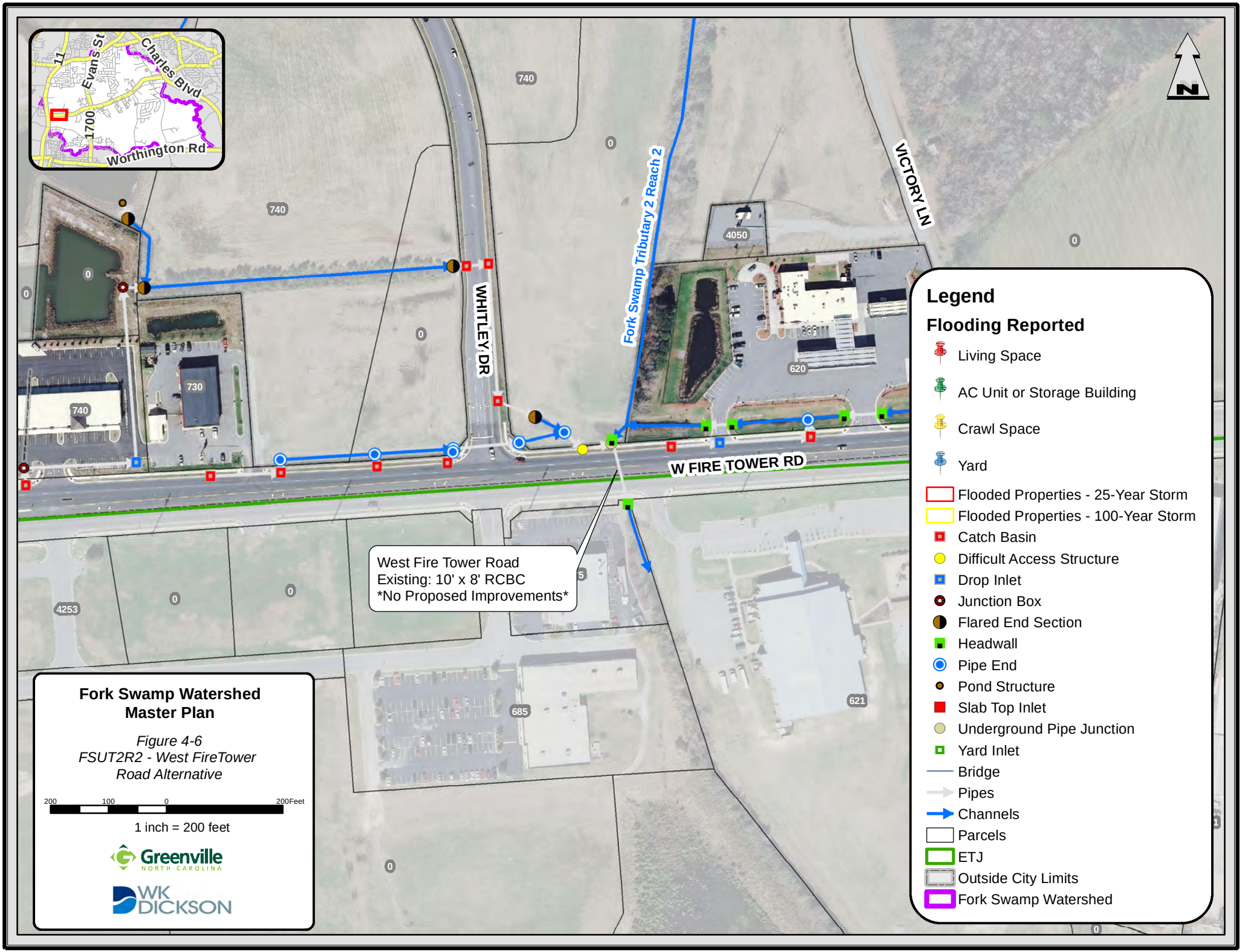
4.1.3 FORK SWAMP UT2R1

Old Tar Road – The existing 72" CMP at this crossing is currently operating at a 2-year level of service. In order to meet the desired 50-year level of service, the existing CMP will need to be replaced with twin 7' x 8' RCBCs with 230 linear feet of floodplain benching in the left and right overbanks proposed downstream of Old Tar Road (See Figure 4-5). Old Tar Road is located immediately west of the existing City limits and the City's ETJ. A portion of the proposed floodplain benching along the left bank would be inside the City limits. Old Tar Road is also a DOT maintained road. Based on the location of the road crossing outside the City limits, the Old Tar Road project is not included as a capital project for the City of Greenville. It is recommended that the City consider initiating discussions with NCDOT to determine if upgrades to the culvert could be considered to reduce the risk to City and County residents that travel along the roadway.

4.1.4 FORK SWAMP UT2R2

West Fire Tower Road – The existing 10' x 8' RCBC at West Fire Tower Road meets the desired 50-year level of service. The culvert is in good condition and passes the future 100-year flows with over one foot of freeboard. Consequently, no improvements are proposed for this location.


Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Floodplain Benching
ETJ
Outside City Limits
Parcels
Fork Swamp Watershed Master Plan
Figure 4-5
FSUT2R1
Old Tar Road Alternatives
200 100 0 200Feet
1 inch = 200 feet
Greenville NORTH CAROLINA
WK DICKSON
OLD TAR RD
WEST MEAT
SLANEY LP
LIFFEY WY
DONEGAL CT
230 LF of Floodplain Benching and Stream Stabilization
Old Tar Road
Existing: 72" CMP
Alternative: Twin 7' x 8' RCBCs with Floodplain Benching
Fork Swamp Tributary 2 Reach 1
Red Banks Rd
Evans St
Cooper St
Worthington Rd
1700
N


Evans St
Charles Blvd
11
1700
Worthington Rd
740
0
730
4050
620
4253
685
621
WHITLEY DR
Fork Swamp Tributary 2 Reach 2
VICTORY LN
W FIRE TOWER RD
West Fire Tower Road
Existing: 10' x 8' RCBC
No Proposed Improvements
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Channels
Parcels
ETJ
Outside City Limits
Fork Swamp Watershed
Fork Swamp Watershed Master Plan
Figure 4-6
FSUT2R2 - West FireTower Road Alternative
200 100 0 200Feet
1 inch = 200 feet
Greenville
NORTH CAROLINA
WK DICKSON

4.1.5 FORK SWAMP UT3

Fork Swamp UT3 includes a total of seven (7) crossings from County Home Road to East Fire Tower Road north of the confluence with Fork Swamp. Generally, projects should be constructed from downstream to upstream, although there may be instances when this general approach can be deviated from based on budgets, potential benefits, easement acquisition, and permitting concerns. Project sequencing will be discussed with the prioritization discussion.

Coleman Drive – The existing triple 10' x 4' RCBCs at this crossing are in good condition and currently meet the desired 25-year level of service. With the downstream improvements recommended along FSUT3, the RCBCs will continue to pass the 25-year storm. Therefore, no capital improvements are proposed at this location. (See Figure 4-7)

Picture 4-4. County Home Road RCPs

County Home Road – Based on the results obtained from the existing conditions analysis, the existing twin 48" RCPs at County Home Road shown in Picture 4-4 overtop during the 25-year event, therefore not providing the desired 50-year storm level of service. The proposed alternative entails adding a 42" floodplain culvert. The increased capacity provided by the floodplain culvert at County Home Road coupled with downstream floodplain benching will provide the desired 50-year level of service at County Home Road.

The proposed 243 linear feet of floodplain benching is proposed along the left bank downstream of County Home Road to provide additional capacity in the floodplain and to lower the tailwater for the culverts. The location of the proposed 40-foot-wide floodplain bench is shown on Figure 4-7. The resulting upstream water surface elevation will be decreased by as much as 1.34 feet in the 25-year storm event and 0.51 feet in the 100-year storm event. There are six (6) properties upstream of County Home Road located in the 25- and 100-year existing conditions floodplain. These properties are as follows: 1900 East Fire Tower Road and 1903, 1907, 1911, 1915, and 1923 Arlington Park Drive. Two of the six properties (1903 and 1907 Arlington Park Road) will be removed from the 25-year floodplain and two from the 100-year floodplain (1911 and 1915 Arlington Park Road). While the water surface elevations will be reduced at the remaining properties, they remain in the 25- and 100-year floodplains. The properties will continue to be floodprone during large events however the severity and frequency of flooding will be reduced.

During a field inspection, there were several potential site restrictions and utility conflicts that were identified. There appears to be sanitary sewer, water, gas, and electric lines that may need to be replaced or relocated for installation of the floodplain culvert. Impacts to traffic flow during construction were considered. County Home Road is a major multi-lane thoroughfare maintained by NCDOT. It is anticipated that a flagged two-way two-lane operation will be

required and coordination with NCDOT will be required. Additional impacts from the construction of the floodplain benching will include tree removal along the left bank and easements. Tree removal along the right bank should be minimized to provide a visual buffer between the gas station and the residential areas on the left bank. The total estimated cost for this project is $210,000.

East Fire Tower Road – U/S – The next crossing downstream of County Home Road is East Fire Tower Road, which is also maintained by NCDOT. As determined by the existing conditions analysis, twin 54" RCPs at this crossing are currently providing a 2-year level of service. In order to provide the desired 50-year level of service at this crossing, the recommended alternative is to replace and upsize the culverts at East Tower Road – U/S. The detention pond upstream of East Fire Tower Road was considered for expansion to avoid further infrastructure improvements, however it was not considered feasible without acquisition of commercial property along East Fire Tower Road which would likely be cost prohibitive.

As part of this alternative, the existing RCPs will be replaced with twin 6' x 6' RCBCs. While the existing culverts were in good condition there is limited space available for infrastructure improvements at this location, therefore box culverts are proposed to maximize flow capacity in a narrow corridor. The proposed culvert will provide the desired 50-year level of service with 0.21 feet of freeboard. Figure 4-7 summarizes the improvements proposed at East Tower Road –U/S. The resulting upstream water surface elevations will be reduced by as much as 1.45 feet in the 25-year storm event and 0.58 in the 100-year storm event.

There are three (3) properties in the existing conditions 25-year floodplain and one (1) additional property in the 100-year floodplain, that have potential to experience LAG or structural flooding. These properties are as follows: 1600 and 1604 East Fire Tower Road, 1751 Old Fire Tower Road, and 2100 Esther Circle. The water surface elevation will be reduced for all of these properties and the Insurance Agency located at 1604 East Fire Tower Road will be removed from the 25-year floodplain with the implementation of this alternative. The remaining properties will continue to be exposed to LAG or structural flooding during the 25-year event, although the depth, duration and frequency will be reduced.

Picture 4-5. East Fire Tower Road –U/S RCPs

During a field visit, there were several potential site restrictions and utility conflicts that were identified at this project location including light poles and electrical boxes (See Picture 4-5) which will need to be replaced. There appears to be sanitary sewer (8" ductile iron) and electric lines that may also need to be replaced or relocated. East Fire Tower

Road is a major thoroughfare roadway maintained by NCDOT. Coordination with NCDOT may require additional time for permitting and design. There will be significant impacts to traffic flow during construction. The total estimated cost for this project is $680,000.

Wimbledon Drive – Immediately downstream of East Fire Tower Road, the channel follows the property line and then turns west around the Wasabi 88 restaurant towards Wimbledon Drive. The existing twin 60" CMPs at Wimbledon Drive are currently providing a 2-year level of service. The culverts are in fair condition although some rust on the ends of the pipes were observed. In order to meet the desired 25-year level of service, it is proposed that the culverts at Wimbledon Drive be upsized with twin 10' x 5' RCBCs coupled with 245 linear feet of floodplain benching in the right overbank downstream of Wimbledon Drive (See Figure 4-7). The floodplain benching will reduce the tailwater at Wimbledon Drive allowing the proposed culverts to convey additional flow. In addition, the floodplain benching can be coupled with the recommended Stream Stabilization Project #4 recommended in Section 5.1 of this report. As noted in that section, portions of this stream have significant erosion and limited to no vegetative buffer. The proposed improvements will provide the desired 25-year level of service with 0.57 feet of freeboard.

There is one (1) property at 1605 East Fire Tower Road (Wasabi 88) that is in the existing conditions 25-year floodplain that has potential to experience LAG or structural flooding. With the implementation of this alternative, this property will be removed from the floodplain.

During a field visit, there were several potential site restrictions and utility conflicts that were identified at this project location. There appears to be sanitary sewer and water lines that may need to be replaced or relocated. Wimbledon Drive is a two-lane residential roadway. It is anticipated that a road closure or a flagged two-way one-lane operation will be required. In order to gain access and to install the proposed floodplain benching, tree removal would be required. It should be noted that the proposed floodplain benching is located on private property therefore an easement will be required to complete this project and maintain the bench in the future. The installation of construction staging areas and entrances will require additional tree removal and temporary construction easements. The total estimated cost for this project is $610,000.

Tower Place – Tower Place is located approximately 450 feet downstream of Wimbledon Drive. The existing twin 66" CMPs shown in Picture 4-6 are currently operating at a 2-year level of service and as noted in Section 5.1, the channel is eroding for approximately 230 feet upstream of Tower Place and downstream of Tower Place due in part to an absence of trees and vegetation to stabilize the banks. Additionally, the absence of a headwall has resulted in erosion between the edge

Picture 4-6. Tower Place CMPs

of the road and the culvert that will eventually threaten the integrity of the roadway. In order to meet the desired 25-year level of service, it is proposed that the culverts at Tower Place be replaced with twin 10′ x 5′ RCBCs (See Figure 4-7). The upsized culvert will provide a 25-year level of service with 0.68 feet of freeboard.

There are twelve (12) properties upstream of the Tower Place crossings in the Tower Village complex that are in the 25- and 100-year existing floodplains. Installing this alternative will reduce the upstream water surface elevation by as much as 0.96 feet in the 25-year storm and 0.32 feet in the 100-year storm. This will remove two properties (2001 Tower Place and 1409B Angels End) from the 25-year floodplain and 1409A Angels End from the 100-year floodplain. The remaining properties in Tower Village will continue to be exposed to LAG or structural flooding, although the depth, duration, and frequency of flooding will be reduced.

During a field visit, there were several potential site restrictions and utility conflicts that were identified at this project location. There appears to be sanitary sewer, gas, and electrical lines that may need to be replaced or relocated. Tower Place is a two-lane residential roadway. It is anticipated that a road closure or a flagged two-way one-lane operation will be required. The installation of construction staging areas and entrances will require tree removal and temporary construction easements. If possible, the proposed Tower Place improvements should be coupled with the stream stabilization recommendations shown as Project #4 in Section 5.1. The total estimated cost for the Tower Place culvert improvements is $640,000.

Summerhaven Drive – Immediately downstream of Tower Place is the Summerhaven Drive crossing. As determined by the existing conditions analysis, the 66″ CMPs at this crossing are undersized and currently providing a 2-year level of service. To provide the desired 25-year level of service at this crossing, the recommended alternative is to replace and upsize the culverts at Summerhaven Drive.

As part of this alternative, the existing CMPs will be replaced with quad 6′ x 6′ RCBCs. The upsized culvert will provide the desired 25-year level of service with 0.20 feet of freeboard. To allow additional capacity and reduce the tailwater on the Summerhaven culverts, 115 linear feet of floodplain benching has been proposed downstream of the crossing along the left overbank (See Figure 4-7). The resulting upstream water surface elevation will be decreased by as much as 1.18 feet in the 25-year storm event and 0.51 feet in the 100-year storm event. There are thirteen (13) properties upstream of Summerhaven Drive located in the 25- and 100-year existing conditions floodplain. Seven (7) properties will be removed from the 25-year floodplain. While the water surface elevations will be reduced at the remaining properties, they remain in the 25- and 100-year floodplains. The properties will continue to experience flooding but the severity and frequency will be reduced.

During a field visit, there were several potential site restrictions and utility conflicts that were identified at this project location. There appears to be water and electrical lines that may need to be replaced or relocated. Summerhaven Drive is a two-lane residential roadway. It is

anticipated that a road closure or a flagged two-way one-lane operation will be required. In order to gain access and to install the proposed floodplain benching, tree removal would be required. It should be noted that the proposed floodplain benching is located on private property therefore an easement will be required to complete this project and maintain the bench in the future. The installation of construction staging areas and entrances will require additional tree removal and temporary construction easements. The total estimated cost for this project is $650,000.

East Fire Tower Road – D/S – East Fire Tower Road is the most downstream crossing for FSUT3. Currently, the existing twin 10' x 7' corrugated metal ellipse pipes only pass the 2-year storm. To meet the desired 50-year level of service, it is proposed that the existing culverts be removed and replaced with quad 6' x 7' RCBCs. In addition to the culvert upgrade, a total of 3,240 linear feet of floodplain benching is proposed (990 linear feet upstream of the crossing in the left overbank and 2,250 linear feet downstream of the crossing in the left and right overbanks). The floodplain benching could be coordinated with the proposed Fire Tower to Hub - Connector Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Figure 4-8 summarizes the proposed improvements.

The resulting upstream water surface elevation will be decreased by as much as 1.94 feet in the 25-year storm event and 0.77 feet in the 100-year storm event. There are forty-seven (47) properties between East Fire Tower Road – D/S and Summerhaven Drive located in the 25- and 100-year existing conditions floodplain. Twenty-eight (28) will be removed from the 25-year floodplain and fourteen (14) additional from the 100-year floodplain. While the water surface elevations will be reduced for the remaining five (5) properties, they remain in the 25- and 100-year floodplains. The properties will continue to experience flooding but the severity and frequency will be reduced. The floodplain benching upstream of East Fire Tower Road could also be coupled with Stream Stabilization Project #3 described in Section 5.1 to address both the capacity and erosion issues upstream of East Fire Tower Road.

The downstream water surface elevation will also be decreased as a result of the proposed floodplain benching. The reduction will range between 0.64 and 1.93 feet in the 25-year storm and 0.62 and 2.04 feet in the 100-year storm. There are fifteen (15) properties located in the 25- and 100-year existing conditions floodplains. All of these properties downstream of East Fire Tower Road – D/S will be removed from the floodplain as a result of the proposed improvements.

During a field visit, there were several potential site restrictions and utility conflicts that were identified at this project location including light poles and electrical boxes which will need to be replaced. There appears to be gas and electric lines that may also need to be replaced or relocated. An 18" sanitary sewer line runs parallel to the creek throughout the project area. The proposed floodplain benching will avoid conflicting with the sanitary sewer line to the extent

possible. East Fire Tower Road is a major thoroughfare roadway maintained by NCDOT. There will be significant impacts to traffic flow during construction. Coordination with NCDOT may require additional time for permitting and design. Additionally, FEMA permitting may be required for the southern portion of the floodplain benching. In order to gain access and to install the proposed floodplain benching, tree removal would be required. It should be noted that the proposed floodplain benching is located on private property therefore an easement will be required to complete this project and maintain the bench in the future. The installation of construction staging areas and entrances will require additional tree removal and temporary construction easements. The total estimated cost for this project is $4,000,000.

A summary of the hydraulic performance for the improvements proposed along Fork Swamp are included in Table 4-5, and a summary of the improvements realized for reduction in WSEL and properties removed from floodplains is shown in Table 4-6. The water surface elevations shown assume all proposed primary system improvements for FSUT1 are constructed. The level of improvement will be reduced if all projects are not implemented.

Table 4-5: Hydraulic Performance for FSUT3 – Alternative #1

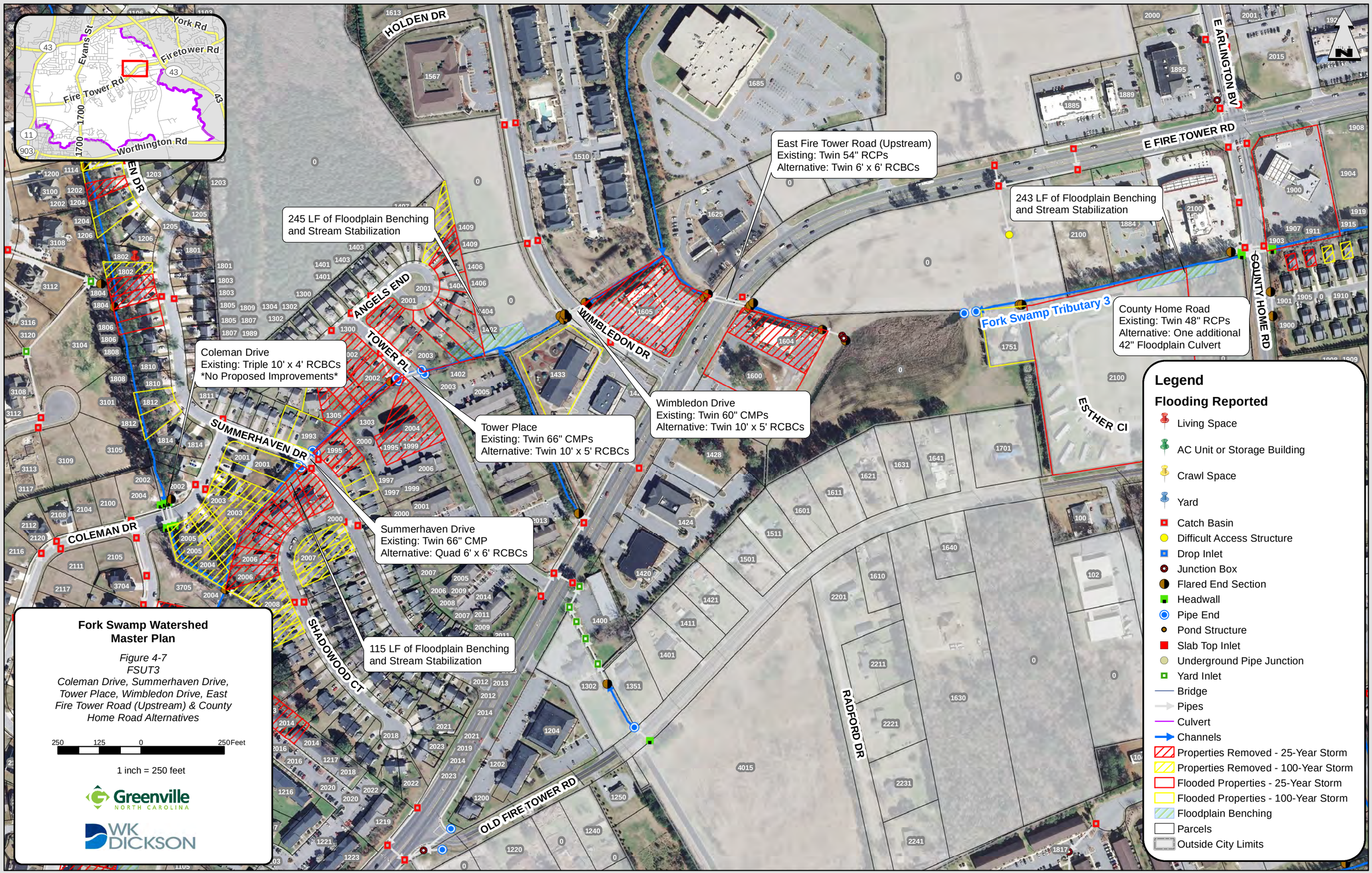
Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
Coleman Drive (Existing Triple 10′ x 4′ RCBCs)	61.97	25-year	57.67	59.47	60.47	61.34	**62.01**
County Home Road (Twin 48″ RCPs with Proposed 42″ Floodplain Culvert)	65.81	50-year	63.12	63.96	64.79	65.62	**66.21**
East Fire Tower Road – U/S (Proposed Twin 6′ x 6′ RCBC)	64.51	50-year	61.06	62.39	63.51	64.31	**64.74**
Wimbledon Drive (Proposed Twin 10′ x 5′)	63.61	25-year	60.40	61.83	63.04	**63.73**	**64.04**
Tower Place (Proposed Twin 10′ x 5′)	63.01	25-year	59.41	61.12	62.33	62.92	**63.26**
Summerhaven Drive (Proposed Quad 6′ x 6′)	61.51	25-year	58.42	60.24	61.31	**62.00**	**62.42**
East Fire Tower Road – D/S (Proposed Quad 6′ x 7′ RCBC)	59.51	50-year	55.77	57.23	58.26	59.15	**59.95**

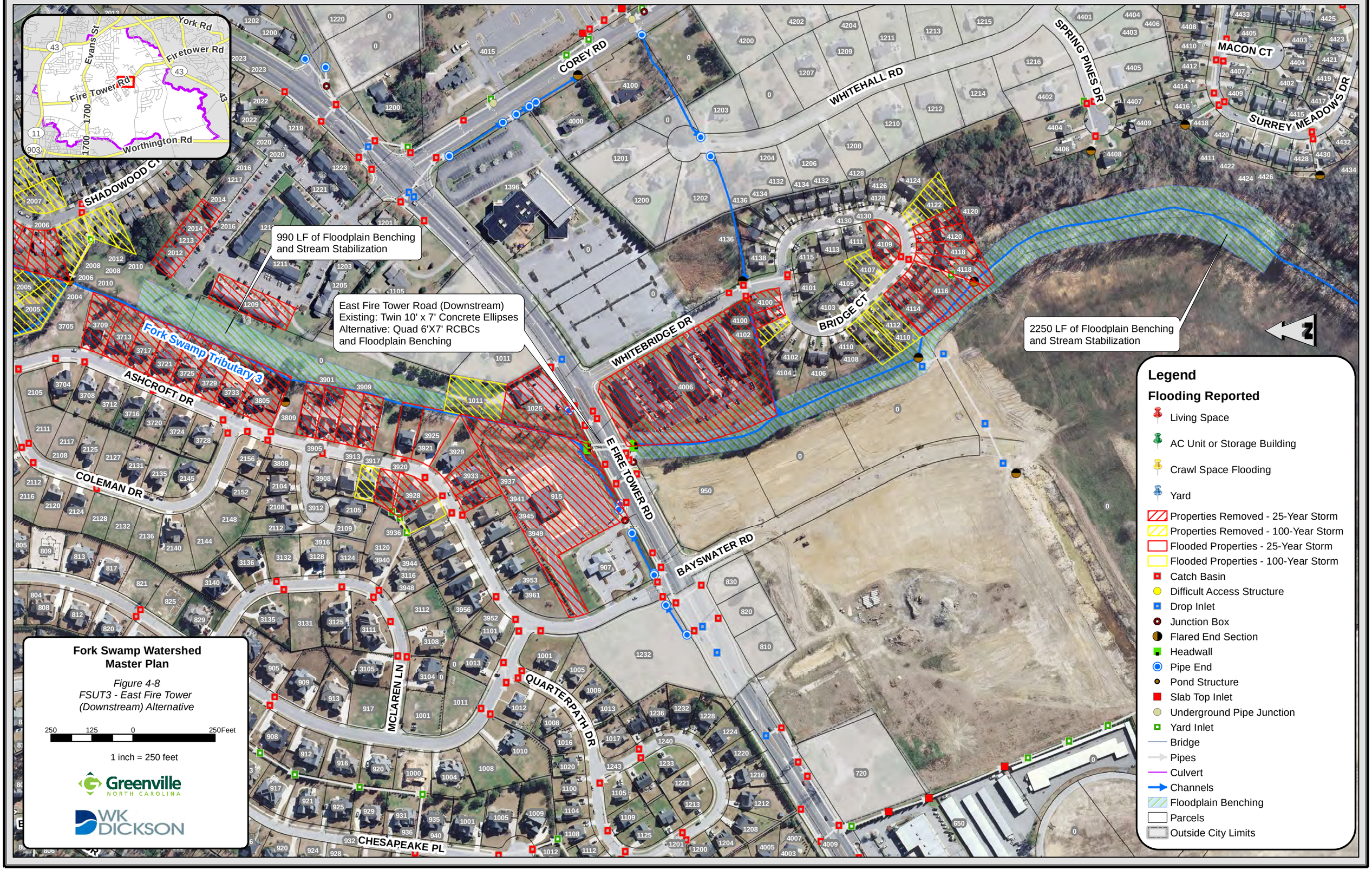
*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.
** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

Table 4-6: WSEL Reductions and Properties Removed from Floodplains – FSUT3: Alt #1

Location	WSEL Reduction (feet NAVD)		Properties Removed/Properties in Floodplain	
	25-Year	100-Year	25-Year	100-Year
Coleman Drive	1.49	0.80	N/A*	N/A*
County Home Road	1.34	0.51	2/6	2/6
East Fire Tower Road (Upstream)	1.45	0.58	1/3	0/1
Wimbledon Drive	1.21	0.40	1/1	0/0
Tower Place	0.96	0.32	1/12	2/12
Summerhaven Drive	1.18	0.51	7/13	0/13
East Fire Tower Road (Downstream)	1.94	0.77	28/47	42/47

*No proposed improvements at this location.


York Rd
Evans St
Firetower Rd
Fire Tower Rd
Worthington Rd
43
1700
11
903
HOLDEN DR
ANGELS END
TOWER PL
WIMBLEDON DR
SUMMERHAVEN DR
COLEMAN DR
SHADOWOOD CT
OLD FIRE TOWER RD
E FIRE TOWER RD
E ARLINGTON BV
COUNTY HOME RD
ESTHER CI
RADFORD DR
Fork Swamp Tributary 3
245 LF of Floodplain Benching and Stream Stabilization
East Fire Tower Road (Upstream)
Existing: Twin 54" RCPs
Alternative: Twin 6' x 6' RCBCs
243 LF of Floodplain Benching and Stream Stabilization
County Home Road
Existing: Twin 48" RCPs
Alternative: One additional 42" Floodplain Culvert
Coleman Drive
Existing: Triple 10' x 4' RCBCs
No Proposed Improvements
Wimbledon Drive
Existing: Twin 60" CMPs
Alternative: Twin 10' x 5' RCBCs
Tower Place
Existing: Twin 66" CMPs
Alternative: Twin 10' x 5' RCBCs
Summerhaven Drive
Existing: Twin 66" CMP
Alternative: Quad 6' x 6' RCBCs
115 LF of Floodplain Benching and Stream Stabilization
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Properties Removed - 25-Year Storm
Properties Removed - 100-Year Storm
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Floodplain Benching
Parcels
Outside City Limits
Fork Swamp Watershed Master Plan
Figure 4-7
FSUT3
Coleman Drive, Summerhaven Drive, Tower Place, Wimbledon Drive, East Fire Tower Road (Upstream) & County Home Road Alternatives
250 125 0 250 Feet
1 inch = 250 feet
Greenville NORTH CAROLINA
WK DICKSON


990 LF of Floodplain Benching and Stream Stabilization
East Fire Tower Road (Downstream)
Existing: Twin 10' x 7' Concrete Ellipses
Alternative: Quad 6'X7' RCBCs
and Floodplain Benching
2250 LF of Floodplain Benching and Stream Stabilization
COREY RD
WHITEHALL RD
SPRING PINES DR
MACON CT
SURREY MEADOWS DR
SHADOWOOD CT
Fork Swamp Tributary 3
ASHCROFT DR
COLEMAN DR
WHITEBRIDGE DR
BRIDGE CT
E FIRE TOWER RD
BAYSWATER RD
MCLAREN LN
QUARTERPATH DR
CHESAPEAKE PL
York Rd
Firetower Rd
Fire Tower Rd
Worthington Rd
Evans St
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space Flooding
Yard
Properties Removed - 25-Year Storm
Properties Removed - 100-Year Storm
Flooded Properties - 25-Year Storm
Flooded Properties - 100-Year Storm
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Floodplain Benching
Parcels
Outside City Limits
Fork Swamp Watershed
Master Plan
Figure 4-8
FSUT3 - East Fire Tower
(Downstream) Alternative
250 125 0 250 Feet
1 inch = 250 feet
Greenville
NORTH CAROLINA
WK DICKSON

4.1.6 COREY ROAD REGIONAL DETENTION FACILITY

While developing the alternatives for the Fork Swamp watershed, opportunities for potential regional detention facilities were explored. There was one area downstream of Corey Road on FSUT1 (See Figure 4-4), that was analyzed to determine its benefits on downstream flooding. Based on the development of a conceptual model, the proposed 20-acre detention pond would lower the flows in the 2-, 10-, 25-, 50-, and 100-year storms by 20 to 25 percent at the confluence of FSUT1 with Fork Swamp. These flow reductions continue through the downstream modeling limits of the Fork Swamp watershed. If the detention is not implemented in conjunction with the other improvements proposed for the primary system, the percent increase at the outfall will be 7 percent in the 25- year storm event.

The implementation of this facility will not impact any of the sizes of the culvert recommended as part of this Master Plan. However, it will reduce downstream flows and help to offset increases that will be created by upsizing upstream culverts. The location of this facility is outside of the City limits close to the border of Winterville. It would be an opportunity to partner with this municipality which would also benefit from the implementation of the regional detention facility. If implemented, the floodplain benching shown downstream of Corey Road (See Figure 4-4) would not be necessary.

During a field inspection, there were several potential site restrictions and utility conflicts that were identified. Overhead power lines are located along Corey Road, which may need to be temporarily relocated based on where the contractor accesses the site. In order to gain access and to install the proposed regional detention facility, tree removal would be required. Tree removal in the upstream portion of the facility nearest Corey Road will require minimal tree removal since it is located in an open, agricultural field as shown in Picture 4-7. It should be noted that the proposed regional detention facility is located on private property therefore an easement will be required to complete this project and maintain the facility in the future. The installation of construction staging areas and entrances will require additional tree removal and temporary construction easements. The total estimated cost for this project is $8,370,000, which does not include land acquisition cost. Based on Pitt County tax records, an additional $1,130,000 would be required to purchase the land bringing the total project cost to $9,500,000.

Picture 4-7. Proposed Site for Regional Detention Facility

4.1.7 HYDROLOGY

The future land use was accounted for during the development of the proposed improvements. The hydrologic parameters including curve numbers were adjusted for the future conditions and alternatives models.

Peak flows for the primary systems were developed for the 2-, 10-, 25-, 50-, and 100-year storm events considering the future conditions and proposed alternatives. The future conditions peak flows are summarized in Table 4-7. In comparison to the existing conditions flows, the future conditions flows increases in the 25-year storm are as follows:

- Fork Swamp – 0 to 7%
- FSUT1 – 8 to 12%
- FSUT2R1 – 10 to 11%
- FSUT2R2 – 0 to 15%
- FSUT3 – 1 to 14%

Table 4-7: Future Conditions Flows from HEC-HMS for Fork Swamp Watershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
FORK SWAMP							
East Baywood Lane	East Baywood Lane	55891	188	352	468	569	681
Railroad	Railroad	55592	251	475	629	765	916
Evans Street	Evans Street	54609	258	488	644	785	939
E Fire Tower Road (Bridge)	East Fire Tower Road	50168	464	877	1,174	1,432	1,718
ADD FSUT3 to FS	Confluence of FSUT3 and Fork Swamp	46863	599	1,124	1,505	1,843	2,211
ADD FSUT2	Confluence of FSUT2 and Fork Swamp	44420	850	1,595	2,121	2,614	3,187
ADD FSUT1	Confluence of FSUT1 and Fork Swamp	43230	1,094	2,102	2,826	3,502	4,237
FORK SWAMP UT1							
U/S Limit FSUT1	Upstream Limit of FSUT1/Trafalgar Drive – South	5103	123	244	332	412	500
Trafalgar Drive	Trafalgar Drive – North	4235	127	252	343	425	517
Corey Road – FSUT1	Corey Road	3380	229	462	630	785	963

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
FORK SWAMP UT2R1							
ADD FSUT2-7B	Old Tar Road	3499	265	502	672	819	985
FORK SWAMP UT2R2							
U/S Limit FSUT2	Upstream Limit of FSUT2	4262	49	90	118	143	171
West Fire Tower	West Fire Tower Road	303	131	241	319	389	465
FORK SWAMP UT3							
U/S Limit FSUT3	Upstream Limit of FSUT3	4360	112	217	294	362	438
Coleman Drive	Coleman Drive	289	152	306	419	519	632
County Home	County Home Road	10420	65	115	150	181	213
East Fire Tower Road – North	East Fire Tower Road – U/S	8790	111	177	230	273	316
Wimbledon Drive	Wimbledon Drive	8238	168	282	369	443	519
Tower Pl_ Summerhaven Dr	Tower Place/ Summerhaven Drive	7694/ 7287	190	332	436	527	623
East Fire Tower Road - South	East Fire Tower Road – D/S	5065	351	653	876	1,069	1,278

The alternative flows were developed from the future conditions taking into account attenuation for the proposed culvert sizes. They differed slightly from the future condition peak flows presented in Table 4-7. The peak flows used for the proposed alternatives are summarized in Table 4-8. A hard copy of the HEC-HMS output is included as Appendix H. The CD found in Appendix J contains a digital copy of the HEC-HMS model for the Fork Swamp watershed.

Table 4-8: Alternative #1 Flows from HEC-HMS for Fork Swamp Watershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
FORK SWAMP							
East Baywood Lane	East Baywood Lane	55891	188	352	468	569	681
Railroad	Railroad	55592	252	475	629	765	916
Evans Street	Evans Street	54609	258	488	644	785	939
E Fire Tower Road (Bridge)	East Fire Tower Road	50168	464	877	1,174	1,432	1,718

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
ADD FSUT3 to FS	Confluence of FSUT3 and Fork Swamp	46863	596	1,137	1,526	1,868	2,246
ADD FSUT2	Confluence of FSUT2 and Fork Swamp	44420	857	1,615	2,178	2,663	3,286
ADD FSUT1	Confluence of FSUT1 and Fork Swamp	43230	1,097	2,129	2,886	3,549	4,285
FORK SWAMP UT1							
U/S Limit FSUT1	Upstream Limit of FSUT1/Trafalgar Drive – South	5103	123	244	332	412	500
Trafalgar Drive	Trafalgar Drive – North	4235	127	252	343	425	517
Corey Road – FSUT1	Corey Road	3380	230	462	636	788	962
FORK SWAMP UT2R1							
ADD FSUT2-7B	Old Tar Road	3499	265	502	672	819	985
FORK SWAMP UT2R2							
U/S Limit FSUT2	Upstream Limit of FSUT2	4262	49	90	118	143	171
West Fire Tower	West Fire Tower Road	303	131	241	319	389	465
FORK SWAMP UT3							
U/S Limit FSUT3	Upstream Limit of FSUT3	4360	112	217	294	362	438
Coleman Drive	Coleman Drive	289	152	306	419	519	632
County Home	County Home Road	10420	65	115	150	181	214
East Fire Tower Road – North	East Fire Tower Road – U/S	8790	113	196	255	297	347
Wimbledon Drive	Wimbledon Drive	8238	174	305	399	469	551
Tower Pl_ Summerhaven Dr	Tower Place/ Summerhaven Drive	7694/ 7287	192	341	452	542	643
East Fire Tower Road - South	East Fire Tower Road – D/S	5065	349	667	898	1,095	1,314

4.1.8 HYDRAULICS

The hydraulic analysis for the proposed conditions was similar to the analysis completed for the existing conditions. The model was updated to reflect the proposed culvert improvements, as well as the floodplain benching locations.

4.2 SECONDARY SYSTEMS

Developing flood control alternatives for the secondary systems typically included increase in pipe capacity and/or rerouting flows where more space was available for improvements. In general, the proposed improvements for the secondary system are less complex from a permitting perspective since they typically do not require FEMA or 401/404 permits. However, the proposed improvements for secondary systems are oftentimes constrained by private property as space is typically limited between houses or other structures. Utility conflicts are another constraint that is typical for secondary system improvements. Secondary system improvements considered feedback from City staff and residents as well as maintenance needs based on findings from the inventory and/or feedback from City staff.

The projects described are the recommended alternatives for each of the secondary systems.

Corey Road Closed System

WK Dickson recommends the following improvements for the Corey Road Closed System as shown in Figure 4-9:

- Replace 147 linear feet of twin 36" RCPs with twin 48" RCPs along Southlea Drive;
- Replace 98 linear feet of 24" CMP with 30" RCP along Corey Road; and
- Replace 83 linear feet of 15" RCP with 24" RCP along Essex Drive (entrance of Windsor subdivision).

The proposed improvements will provide a 10-year level of service for the Corey Road Closed System including Essex Drive, a NCDOT secondary roadway. The majority of the project will be located in the right-of-way; there will minimal impacts to private properties. Sections of the curb and gutter along Southlea Drive will need to be removed and replaced as part of the proposed improvements. Underground electric, water, and sanitary sewer lines were also identified as potential site restrictions and utility conflicts. The total estimated cost for the recommended alternative is $370,000.


Fork Swamp Watershed Master Plan
Figure 4-9
Corey Road
Closed System Alternative
250 125 0 250 Feet
1 inch = 250 feet
Greenville NORTH CAROLINA
WK DICKSON
Replace 36" RCP with Twin 48" RCPs
Replace 24" CMP with 30" RCP
Replace 15" RCP with 24" RCP
SOUTHLEA DR
BEXLEY DR
REDFORD CT
WEST ESSEX DR
ESSEX DR
COREY RD
Evans St
Charles Blvd
Worthington Rd
1700
11
Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Bridge
Pipes
Culvert
Channels
Parcels
N

Lynndale Closed System

As previously mentioned, the Lynndale closed system was evaluated by River & Associates. It was not re-evaluated as part of this Master Plan. Preliminary design plans have been developed by Rivers & Associates. The design shown as Figure 4-10 through 4-13 summarizes the recommendations made by River & Associates.

Based on the recommendations provided by the City via Rivers & Associates, WK Dickson developed costs estimates with the same unit costs used for other projects within this report. WK Dickson also included the Lynndale projects in the overall prioritization ranking for the Fork Swamp watershed. Due to the size of the project, the Lynndale system was divided into three phases as follows:

Phase I: Lynndale Phase I includes the downstream pipe improvements predominantly located along Queen Annes Road as shown on Figure 4-10. Estimated project costs are $1,010,000 for Phase I. Utility conflicts are likely since the majority of the construction is located in the right-of-way. There will also be some private property impacts that will require drainage easements in locations that do not already have easements.

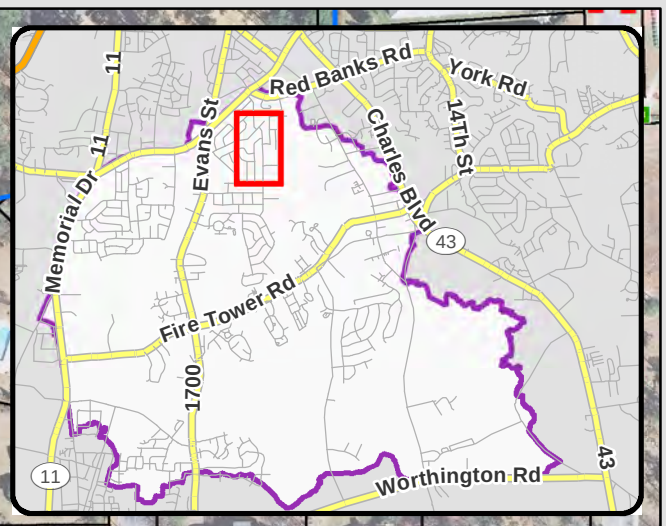
Phase II: Lynndale Phase II includes improvements in the northern portion of the neighborhood as shown in Figures 4-11 and 4-12. Improvements are located along Claredon Drive, Crown Point Road, Granville Drive, and Martinsborough Road. The majority of the improvements are located within the right-of-way, although some private property impacts will occur specifically between Crown Point Road and Lord Ashley Road. Estimated project costs are $3,420,000 for Phase II. Phase II should only be completed after Phase I has been implemented.

Phase III: Lynndale Phase III includes improvements in the northern portion of the neighborhood as shown in Figure 4-13. Improvements are located along Fort Sumter Drive, Williamsburg Drive, Chowan Road, and Martinsborough Road. The majority of the improvements are located within the right-of-way. Estimated project costs are $2,750,000 for Phase III. Phase III should only be completed after Phase I has been implemented, but can be constructed prior to Phase II if desired.

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Yard
- Proposed Structures
- Proposed Pipes
- Phase I Area
- Phase II Area
- Phase III Area
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Flared End Section
- Headwall
- Pipe End
- Pond Structure
- Slab Top Inlet
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Pipes
- Culvert
- Channels



MARTINSBOROUGH RD

REMINGTON DR

Replace 15" CMP with 48 LF of 18" RCP

RUPERT DR

Replace 18" CMP with 197 LF 18" PVC

COMPTON RD

NOTTINGHAM RD

SALEM RD

Replace 54" CMP with 200 LF of 66" CMP

Replace 54" CMP with 26 LF of 72" CMP

Replace 18" CMP with 24 LF of 18" RCP

Phase II Area

Replace 54" CMP with 168 LF of 78" CMP

Replace 30" CMP with 24 LF of 18" RCP

Phase I Area

WILLIAMSBURG DR

Phase III Area

Add 203 LF of 24" PVC

Muck out and fill existing ditch

Add 257 LF of 18" RCP

Retain as Overflow Pipe

CHOWAN RD

QUEEN ANNES RD

Replace 15" CMP with 71 LF of 15" RCP

Add 181 LF of 18" RCP

VASSAR RD

Add 277 LF of 18" RCP

Add 24 LF of 15" RCP

KENILWORTH RD

Add 107 LF of 24" RCP

Add 35 LF of 15" RCP

WESLEY RD

Add 143 LF of 18" RCP

CHESAPEA PL

Fork Swamp Watershed Master Plan

Figure 4-10
Lynndale Subdivision
Proposed Improvements
Phase I

200 100 0 200 Feet

1 inch = 200 feet

Greenville NORTH CAROLINA

WK DICKSON

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Yard
- Proposed Structures
- Proposed Pipes
- Phase I Area
- Phase II Area
- Phase III Area
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Flared End Section
- Headwall
- Pipe End
- Pond Structure
- Slab Top Inlet
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Pipes
- Culvert
- Channels

Add 8 LF of 24" RCP

Replace 35 LF of 18" CMP with 36" RCP

Replace 20 LF of 18" RCP with 24" RCP

Replace 40 LF of 18" RCP with 24" RCP

Replace 626 LF of 24" RCP with 42" RCP

Add 112 LF of 24" RCP

Add 216 LF of 18" RCP

Add 25 LF of 15" RCP

Replace 587 LF of 24" RCP with 48" RCP

Add 28 LF of 15" RCP

Add 289 LF of 18" RCP

Add 8 LF of 15" RCP

Add 34 LF of 15" RCP

Add 218 LF of 24" RCP

Plug and Abandon

Add 26 LF of 15" RCP

Plug and Abandon

Add 71 LF of 30" RCP

Add 672 LF of 24" RCP

Add 122 LF of 54" RCP

Plug and Abandon

Add 26 LF of 48" RCP

Add 28 LF of 15" RCP

Add 25 LF of 15" RCP

Add 291 LF of 18" RCP

Add 24 LF of 15" RCP

Add 117 LF of 36" RCP

Add 87 LF of 24" RCP

Continued on Phase II South

Matchline Phase II South

Matchline Phase II South

RED BANKS RD

CLAREDON DR

GRANVILLE DR

DARTMOUTH DR

CROWN POINT RD

FORT SUMTER DR

MARTINSBOROUGH RD

QUEEN ANNES RD

SE GREENVILLE BLVD

EVANS ST

Memorial Dr

Evans St

Charles Blvd

14Th St

Firetower Rd

Fire Tower Rd

Worthington Rd

Fork Swamp Watershed Master Plan

Figure 4-11
Lynndale Subdivision
Proposed Improvements
Phase II - North

200 100 0 200 Feet

1 inch = 200 feet

Greenville NORTH CAROLINA

WK DICKSON

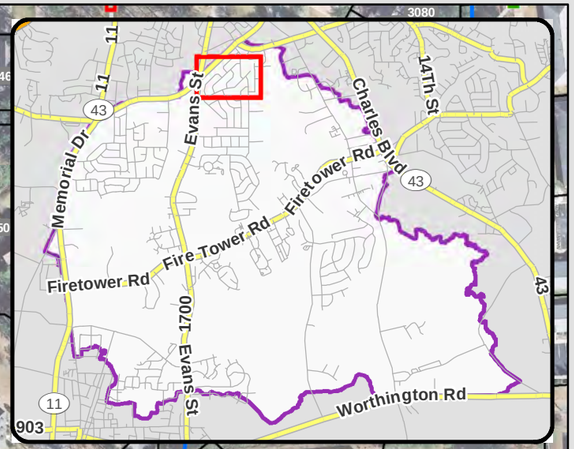
Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Yard
- Proposed Structures
- Proposed Pipes
- Phase I Area
- Phase II Area
- Phase III Area
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Flared End Section
- Headwall
- Pipe End
- Pond Structure
- Slab Top Inlet
- Underground Pipe Junction
- Yard Inlet
- Bridge
- Pipes
- Culvert
- Channels

SE GREENVILLE BV
CLAREDON DR
GRANVILLE DR
CROWN POINT RD
MARTINSBOROUGH RD
CHOWAN RD
WILLIAMSBURG DR
KENILWORTH RD
QUEEN ANNES RD
REMINGTON DR
RUPERT DR
Matchline Phase II North
Continued on Phase II North

Add 28 LF of 15" RCP
Add 528 LF of 24" RCP
Replace 170 LF of 30" CMP with 60" HDPE
Replace 163 LF of 36" CMP with 60" HDPE
Add 36 LF of 15" RCP
Add 209 LF of 15" RCP
Add 30 LF of 15" RCP
Add 748 LF of 54" RCP
Replace 34 LF of 36" CMP with 60" RCP
Add 376 LF of 30" RCP
Add 35 LF of 15" RCP
Add 29 LF of 15" RCP
Add 25 LF of 15" RCP
Replace 33 LF of 42" CMP with 48" RCP
Add 47 LF of 15" RCP
Replace 160 LF of 48" CMP with 66" RCP
Regrade Ditch



Fork Swamp Watershed Master Plan

Figure 4-12
Lynndale Subdivision
Proposed Improvements
Phase II - South

0 50 100 200 Feet
1 inch = 200 feet

Greenville NORTH CAROLINA

WK DICKSON

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Yard
- Proposed Structures
- Proposed Pipes
- Phase I Area
- Phase II Area
- Phase III Area
- Catch Basin
- Difficult Access Structure
- Drop Inlet
- Junction Box
- Flared End Section
- Headwall
- Pipe End
- Slab Top Inlet
- Underground Pipe Junction
- Yard Inlet
- Pipes
- Channels

Fork Swamp Watershed Master Plan

Figure 4-13
Lynndale Subdivision
Proposed Improvements
Phase III

0 50 100 200 Feet

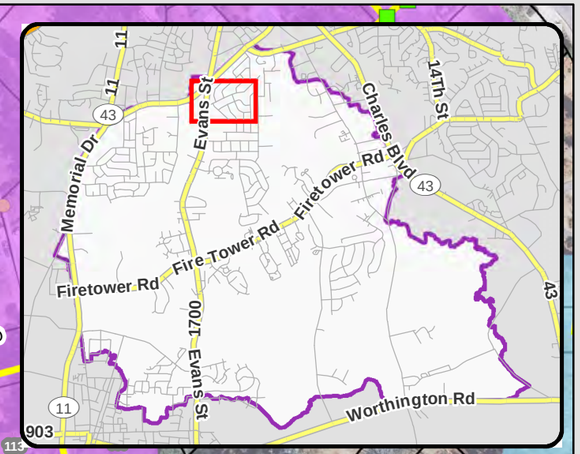
1 inch = 200 feet

Greenville NORTH CAROLINA

WK DICKSON

Add 30 LF of 15" RCP
Add 28 LF of 15" RCP
Add 215 LF of 24" RCP
Add 39 LF of Dual 24" RCP
Add 124 LF of Dual 30" RCP
Add 29 LF of 15" CMP
Add 220 LF of 18" RCP
Add 239 LF of 24" RCP
Add 34 LF of 15" RCP
Add 182 LF of 30" RCP
Add 235 LF of 18" RCP
Add 31 LF of 15" RCP
Add 25 LF of 15" RCP
Add 197 LF of 18" RCP
Add 37 LF of 15" RCP
Add 210 LF of 15" RCP
Replace 12" RCP with 170 LF of 24" RCP
Add 118 LF of 42" RCP
Plug and Abandon 18" CMP
Add 225 LF of 42" RCP
Add 270 LF of 15" RCP
Add 1051 LF of 48" RCP
Add 24 LF of 15" RCP
Plug and Abandon 18" CMP
Add 48 LF of 30" CMP
Add 163 LF of 24" RCP
Replace 15" CMP with 30 LF of 30" RCP
Add 26 LF of 15" RCP
Add 164 LF of 18" RCP
Add 26 LF of 15" RCP
Replace 18" CMP with 170 LF of 30" PVC
Add 30 LF of 15" RCP
Add 37 LF of 24" RCP
Add 32 LF of 15" RCP
Add 145 LF of 18" RCP
Add 110 LF of 36" RCP
Replace 18" CMP with 29 LF of Dual 30" RCP
Replace 24" CMP with 170 LF of 42" HDPE
Add 162 LF of 42" HDPE
Add 241 LF of 42" RCP

CROWN POINT RD
LORD ASHLEY DR
MARTINSBOROUGH RD
CHOWAN RD
WILLIAMSBURG DR
JAMESTOWN RD
ASBURY RD
STANWOOD DR
EVANS ST
GREENVILLE BV



4.3 25-YEAR DETENTION ANALYSIS

In 2014, the City of Greenville enacted legislation requiring attenuation for new development and re-development for the one-year, five-year, and ten-year, 24-hour storm events. In addition, Section 9-9-10 of Ordinance No. 13-054 states the following:

"New development and redevelopment, as described in section 9-9-3, in areas at special risk with well documented water quantity problems as determined by the City Engineer, shall not result in a net increase in peak flow leaving the site from pre-development conditions for the 25-year, 24-hour storm event."

As part of the Fork Swamp Master Plan, an analysis was completed to determine if there are areas within the watershed and the ETJ that should be considered "well documented water quantity problems" requiring detention for the 25-year, 24-hour storm event. Areas may be defined as well documented water quantity problems if either of the following is true:

- Structural flooding has been historically noted by property owners during storms considered smaller than the design event and this structural flooding has been corroborated by either high water marks, City staff input, or model results.
- Model results indicate structural flooding or roadway overtopping during storms smaller than the design storm and model results are corroborated by City staff input.

Portions of the watershed draining to the "well documented water quantity problems" may be considered for 25-year detention if any of the following are true:

- Future condition flows are 10% or greater than existing flows for a given subwatershed upstream of the water quantity problem.
- Proposed capital projects are not deemed to be feasible or cost effective for providing the required level of service for these water quantity problems based on future land use conditions.
- Cost differential between designing for existing conditions and future conditions is deemed to be significant and/or a significant number of structures would become floodprone during the 25-year design storm based on future conditions flows when compared to existing conditions flows.

It is assumed that for this analysis, systems with a 10-year level of service design would not be considered for the 25-year detention since the existing 10-year detention requirements would result in little to no increase in peak flows for the design event. The secondary systems evaluated in Fork Swamp watershed only required a 10-year level of service, therefore requiring upstream 25-year detention would not impact the design of a system that only needs to meet a 10-year design storm.

As noted in Section 3.1, documented flooding issues are located along Fork Swamp Main Branch, Unnamed Tributary 3, and Unnamed Tributary 1 including the area between Baywood

Lane and Treetops Circle along Fork Swamp Main Branch, the area between Corey Road and Trafalgar Drive along Unnamed Tributary 1, and the area between East Fire Tower Road and County Home Road along Unnamed Tributary 3. Large portions of the Fork Swamp watershed are already fully developed, however there are some areas of the watershed where the future conditions 25-year flows could be greater than 10% higher than the current existing flows. These areas are shown in Figure 4-14.

For the purposes of evaluating if 25-year detention is appropriate, the Fork Swamp watershed is divided into four (4) distinct areas based on the drainage feature that conveys runoff from that area. Then the entire Fork Swamp watershed needs to be evaluated to limit increases in runoff from the south end of the City limits entering neighboring communities.

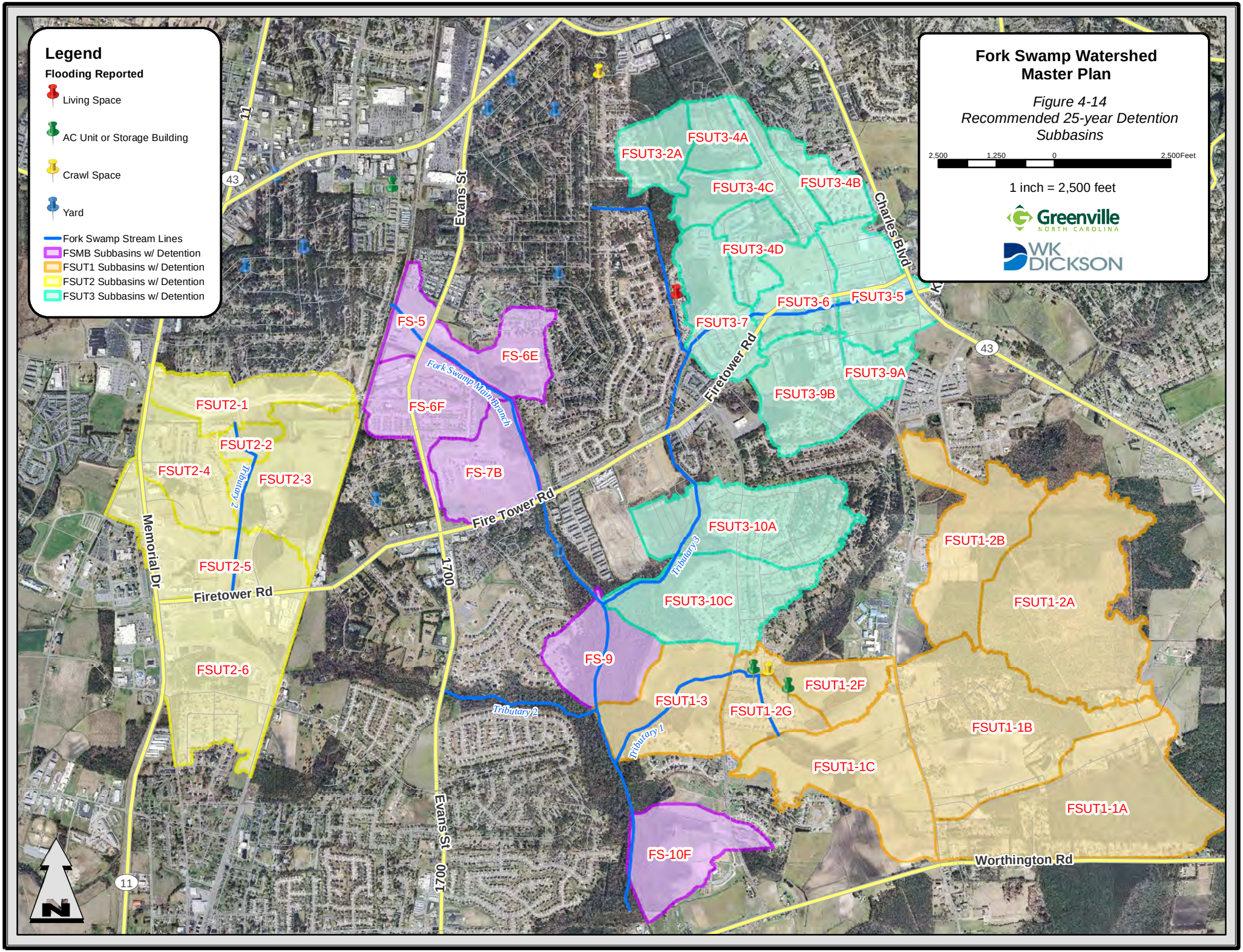
- Fork Swamp Main Stem – Flooding issues along the Fork Swamp Main Stem are predominantly located in the upstream portion of the watershed from the vicinity of East Fire Tower Road up through Baywood Lane and the Westhaven subdivision. The contributing drainage area to these locations is fully developed with the exception of some areas along Evans Road and north of East Fire Tower Road. Requiring 25-year detention in these areas will not substantially impact the proposed capital projects along Fork Swamp Main Stem however since existing flooding problems have been documented in these areas, it is recommended that the highlighted drainage basins shown in the Figure 4-14 within the Fork Swamp Main Stem drainage area require 25-year detention.

- Fork Swamp Tributary 1 – Repetitive flooding has been reported within the Farrington subdivision specifically on Trafalgar Drive along Fork Swamp Tributary 1. Each of the highlighted areas shown in Figure 4-14 have the potential for the 25-year flows to increase by greater than 10% due to the potential future development in these areas. The future condition land use was based on existing zoning. The City should carefully consider rezoning requests within the Fork Swamp Tributary 1 watershed based on the existing known flooding issues. If 25-year detention is required in the proposed areas, the recommended culvert sizes at Trafalgar Drive can be decreased, although the cost savings would not be substantial. However, the severity, frequency, and duration of flooding would be reduced, which would in return provide savings to the property owners.

- Fork Swamp Tributary 2 – The highlighted areas shown in the western portion of the watershed in Figure 4-14 all have the potential for future development that would result in increases greater than 10% in the 25-year peak development flows. While floodprone areas were not identified within the City limits in Tributary 2, the crossing at Old Tar Road downstream outside of the City's jurisdiction is floodprone. Furthermore, 25-year detention in these areas would reduce the increase in runoff at the City boundary under future development conditions.

- Fork Swamp Tributary 3 – The majority of the culvert crossings along Fork Swamp Tributary 3 do not meet the desired level of service for existing conditions and in several locations there is a limited natural floodplain. Furthermore, significant stream erosion has already occurred throughout Tributary 3. The areas shown in Figure 4-14 should be considered for 25-year detention to minimize the size of the culvert improvements to the extent possible. While 25-year detention will not eliminate the need for culvert improvements in the area, the size of the culverts could be reduced in some areas which is particularly valuable given the tight constraints. The areas highlighted in Figure 4-14 have the potential for increasing the 25-year flows greater than 10% in future conditions when compared to existing.

- Overall Fork Swamp watershed – Changes in land use (future build-out conditions) and increasing culvert capacity will increase the 25-year flow at the outlet of the study area (City limits) by approximately 8%, resulting in a 0.22-foot increase in WSEL at the outlet. Downstream communities including Winterville and Pitt County already experience flooding along Fork Swamp in existing conditions, so any increase in flows could potentially increase the duration, severity, and frequency of flooding, although the limits of this study do not evaluate these potential impacts downstream of the City limits. If 25-year detention was required in the highlighted areas in Figure 4-14, the increase in the 25-year flow would be reduced to 1.1%, a reduction in WSEL of 0.17 foot. Therefore, the City could significantly reduce the size of the Corey Road Regional Detention Area described in Section 4.1.6 to effectively ensure no net increase in the 25-year peak flow at the limits of the study. The size of the detention area could be reduced to eight (8) acres which would reduce the cost to $2,670,000, which is approximately $5 million less than the original cost of $7 million.


Legend
Flooding Reported
Living Space
AC Unit or Storage Building
Crawl Space
Yard
Fork Swamp Stream Lines
FSMB Subbasins w/ Detention
FSUT1 Subbasins w/ Detention
FSUT2 Subbasins w/ Detention
FSUT3 Subbasins w/ Detention
Fork Swamp Watershed Master Plan
Figure 4-14
Recommended 25-year Detention Subbasins
2,500 1,250 0 2,500Feet
1 inch = 2,500 feet
Greenville NORTH CAROLINA
WK DICKSON
FSUT3-4A
FSUT3-2A
FSUT3-4C
FSUT3-4B
FSUT3-4D
FSUT3-6
FSUT3-5
FSUT3-7
FSUT3-9A
FSUT3-9B
FS-5
FS-6E
FS-6F
FS-7B
FSUT2-1
FSUT2-2
FSUT2-3
FSUT2-4
FSUT2-5
FSUT2-6
FSUT3-10A
FSUT3-10C
FS-9
FS-10F
FSUT1-2B
FSUT1-2A
FSUT1-2F
FSUT1-2G
FSUT1-3
FSUT1-1B
FSUT1-1C
FSUT1-1A
Fork Swamp Main Branch
Tributary 2
Tributary 3
Tributary 1
Fire Tower Rd
Firetower Rd
Evans St
Charles Blvd
Memorial Dr
Worthington Rd
1700
11
43

WATER QUALITY RECOMMENDATIONS

Traditional stormwater management has typically been designed to reduce flooding, but at times has neglected water quality by collecting runoff directly from impervious surfaces into a closed drainage system. Runoff from impervious areas collects high concentrations of pollutants and nutrients that if left untreated can cause negative impacts to water quality in the receiving waters. Negative impacts may include less biodiversity, hazards to the health of fish and wildlife, as well as human health hazards. Many communities in North Carolina now require some form of water quality treatment for new development; however existing developments typically have little or no water quality treatment. The City of Greenville developed a Stormwater Management Program (September, 2004) to outline its water quality requirements.

Best management practices (BMPs) can be constructed to treat runoff prior to being discharged to the stormwater conveyance system and ultimately the receiving waters of the system. Retrofitting BMPs can be difficult due to limited space and other constraints. Several types of BMPs were evaluated: Bioretention Cells, Stormwater Wetlands, Wet Pond Retrofit, Regenerative Stormwater Conveyance (RSC), Rainwater Harvesting, Permeable Pavement, and Water Quality Swales. Projects identified in the Fork Swamp watershed are described below.

5.1 STREAM STABILIZATION PROJECTS

Based on the basin-wide stream assessment completed as described in Section 3.3, seven (7) stream stabilization projects were identified to help reduce instream erosion. Instream erosion can be a significant source of sediment that ultimately can impair the biodiversity of the downstream receiving waterbodies. Furthermore, in urban watersheds such as Fork Swamp, stream erosion is often a threat to private property and potentially the safety of structures adjacent to the stream. The proposed stream stabilization projects will have impacts to property owners that will require temporary construction easements to complete the work and permanent easements for maintenance access. Proposed projects assume that the riparian buffers can be restored to existing conditions. During final design, the City will need to refer to the current buffer regulations to determine if more significant buffer restoration is required. The projects (not presented in order of importance) are described as follows:

Stream Stabilization Project #1: Live Oak Lane

The Live Oak Lane Project is located east of Evans Street behind the residential properties on Live Oak Lane, upstream of Paramore Park. Stream Stabilization Project #1 begins to the east of Keys Court and runs approximately 1,600 feet downstream along the greenway. The project is located along a third order perennial section of Fork Swamp. As shown on Figure 5-1, this project also includes a highly eroded channel that begins downstream of a 54" RCP culvert just east of Live Oak Lane. This project has a drainage area of approximately 1,100 acres. The most downstream portion of the project lies within the FEMA 100-year floodway.

The project flows to the southeast and is confined within a steep eroded channel feature. Land use immediately surrounding the project is mostly residential with wooded reaches and maintained open area along the channel. The bank conditions are unstable and eroding at an accelerated pace due to loamy sand soil texture and a lack of sufficient bank vegetation along large portions of this reach. The bottom width is approximately 8 feet wide. The right bank is 4.5 feet tall and the left bank is approximately 7 feet tall with bank angles of 70 degrees. The average top channel width is 12 feet wide. Shear stress and channel velocities are above the ideal conditions for a stable sand bed channel, with values reaching 0.48 lb/sq ft, and 3.47 ft/s, respectively. This deeply confined channel has led to a perched outfall (See Picture 5-1) and rapid erosion along a meander of the left bank of the stream. The bank conditions along the channel draining from Live Oak Lane are also unstable and eroding due to loamy sand soil texture and a lack of sufficient bank protection along the right bank (See Picture 5-2).

Picture 5-1. Perched outlet on left bank of Fork Swamp

Picture 5-2. View from culvert at Live Oak Lane looking towards Fork Swamp

The proposed project reach has opportunities for stream stabilization to prevent sediment loading and bank erosion to Fork Swamp. The existing greenway and sewer easement adjacent to this stream segment would make this project easily accessible. To improve bank stability and reduce bank erosion, several tasks could be performed. For both reaches, bank erosion can be reduced by constructing a low flow channel with additional floodplain storage, grading the channel banks back to a minimum 2 to 1 slope, and placing coir erosion control matting along banks and bare areas. In some areas along the greenway, a reinforced retaining wall may be used to restrict the stream from widening towards the existing greenway trail. Downstream of the culvert at Live Oak Lane (ID #FSMB020122), the stream bed should be reinforced by installing an energy dissipater or a riffle grade control structure composed of mixed riprap on filter fabric and located below the stream bed. Once installed, the riffle will act as a grade control below the downstream headwall, which will protect it from being undercut. To reduce water velocity and help stabilize the streambed along both reaches, rock structures can be placed within the stream bed at the toe of the bank. Live staking stream banks along both reaches will also help prevent undercutting and bank failures in the future.

The estimated cost for the Live Oak project is $280,000. The stream stabilization project will run along the backside of several private properties, therefore there may be potential impacts to landscaping and fencing at the following properties:

- 3600 Live Oak Lane;
- 3601 Live Oak Lane;
- 3602 Live Oak Lane;
- 3604 Live Oak Lane;
- 3606 Live Oak Lane; and
- 161 Keys Court (The Trellis Apartments).

Additionally, it should be noted that the project is located within a Pitt County drainage easement. Implementation of this project would require coordination between the City and County. This could impact its overall prioritization rating.

Picture 5-3. Eroding bank at 1205 Trafalgar Drive

Stream Stabilization Project # 2: Corey Road

Stream Project #2 begins in a residential neighborhood along Trafalgar Drive, crosses Corey Road, and runs downstream through an agricultural field. It is not located within the City limits, but is included in the ETJ, therefore this project was not prioritized along with the other proposed projects located in the City. However, Stream Project #2 is still included because it will provide benefits to City residents.

Stream Project #2 is a first order perennial stream section of an unnamed tributary to Fork Swamp. The project includes 400 feet of stabilization in the neighborhood east of Corey Road and approximately 1,450 feet of stabilization and buffer restoration to the west of Corey Road. The drainage area for the project is approximately 1,500 acres. The portion of the project west of Corey Road lies in the FEMA 100-year floodplain.

Picture 5-4. Erosion and lack of riparian buffer downstream of Corey Road

Stream Project #2 flows in a southwesterly direction before running through a wooded stream segment that leads to the confluence with Fork Swamp. The average bottom width along this reach is 12.5 feet and both banks are roughly 4.5 tall. The bank angles are near 65 degrees. The average top channel width along this stretch

is 15 feet. Upstream of Corey Road, the surrounding land use is entirely residential. This section of stream has a minimal riparian buffer along the right bank and the left bank is maintained, residential lawn. As shown in Picture 5-3, the erosion along the left bank is encroaching on the landowner's fence at 1205 Trafalgar Drive. The proposed stabilization continues downstream of the culvert at Corey Road, where the stream flows through an unbuffered agricultural field.

While the culvert is in good condition, shear stress and channel velocities below the culvert are above the ideal conditions for a stable sand bed channel, with values reaching 1.19 lb/sq ft, and 6.32 ft/s, respectively. The agricultural field downstream of the culvert is devoid of any riparian vegetation and there is evidence of slumping banks in many areas (See Picture 5-4). Bank conditions are currently unstable due to a loamy sand soil texture, lack of sufficient bank vegetation, and the lack of a forested buffer on either bank.

Stream Project #2 has opportunities for bank stabilization to prevent bank erosion and sediment loading along to Fork Swamp. Upstream of Corey Road, bank erosion can be reduced by grading channel banks back to a minimum 2 to 1 slope and placing coir matting along banks and bare areas. An open lot (Parcel # 062704) between residential properties on Trafalgar Drive provides good access to this site. Live staking the stream banks along this bend and planting the area with a riparian seed mix will also help prevent future erosion and sediment loading to the channel.

The stream section downstream of the culvert at Corey Road offers the potential for a compensatory mitigation project through the North Carolina Division of Mitigation Services (NC DMS) or private banker. The most likely scenario would involve a stream enhancement and/or nutrient and buffer mitigation project which employs rehabilitation activities to improve water quality and the ecological function of a fluvial system. Examples of stream enhancement could include sloping of stream banks to restore appropriate dimensions, the construction of grade-control structures to stabilize banks, and planting the riparian zones with native vegetation. Live staking stream banks and planting of hardwood species will help prevent undercutting and bank failures in the future and benefit downstream portions of the watershed.

The stream stabilization project upstream of the Corey Road culvert will run along the backside of several private properties, therefore there may be potential impacts to landscaping and fencing at the following properties:

- 1201 Trafalgar Drive;
- 1203 Trafalgar Drive;
- 1205 Trafalgar Drive; and
- 1207 Trafalgar Drive.

The potential mitigation project downstream of the culvert would require coordination with the landowners of Parcels #25822 and #08367 to assure long-term management of the restored site through a protection mechanism such as a conservation easement.

The estimated cost for the Corey Road project is $590,000. It should be noted that the City may realize some cost savings by combining the Corey Road stabilization project with the proposed flood control work upstream and downstream of Corey Road.

Stream Stabilization Project # 3: East Fire Tower Road

Stream Project #3 is located north of East Fire Tower Road near the intersection of Ashcroft Drive and Coleman Drive. The project starts behind the homes on Ashcroft Drive and runs approximately 1,000 feet to the bridge at East Fire Tower Road. Stream Project #3 is a perennial stream section of FSUT3 with a drainage area of 889 acres. In addition to the stabilization along the main channel, this project will also address the severely eroded drainage ditch entering the stream from the parking lot of Bella Salon.

Picture 5-5. Highly eroded ditch at East Fire Tower Road

Land use surrounding the project consists mainly of residential neighborhoods and small business in the immediate area. Stream Project #3 flows to the southwest with average bank heights of 5 feet and average bank angles of 50 degrees. This channel does not have a forested buffer. The bank conditions along this stretch are fairly unstable and eroding at an accelerated pace due to loamy sand soil texture and a lack of sufficient bank vegetation along large portions of this urbanized reach.

Stream Project #3 has opportunities for bank stabilization to prevent the banks from eroding at such an accelerated rate. This project can easily be accessed from East Fire Tower Road or Ashcroft Drive. Bank erosion can be reduced along the main stem and downstream of the Ashcroft outfall by placing coir erosion control matting along banks and bare areas and planting the entire project area with a riparian seed mix to reinforce banks. Live staking stream banks will also help alleviate future erosion. The drainage ditch in the Bella Salon Parking Lot would be a potential site for a stormwater best management practice (BMP), such as a regenerative stormwater conveyance (RSC) system. RSC systems are capable of conveying, storing, and treating runoff through infiltration, media filtration, and detention. RSCs are a linear system of riffles and step pools filled with a porous, carbon-rich bed material where pollutant removal processes may take place physically as well as biologically. The pools provide volume for runoff

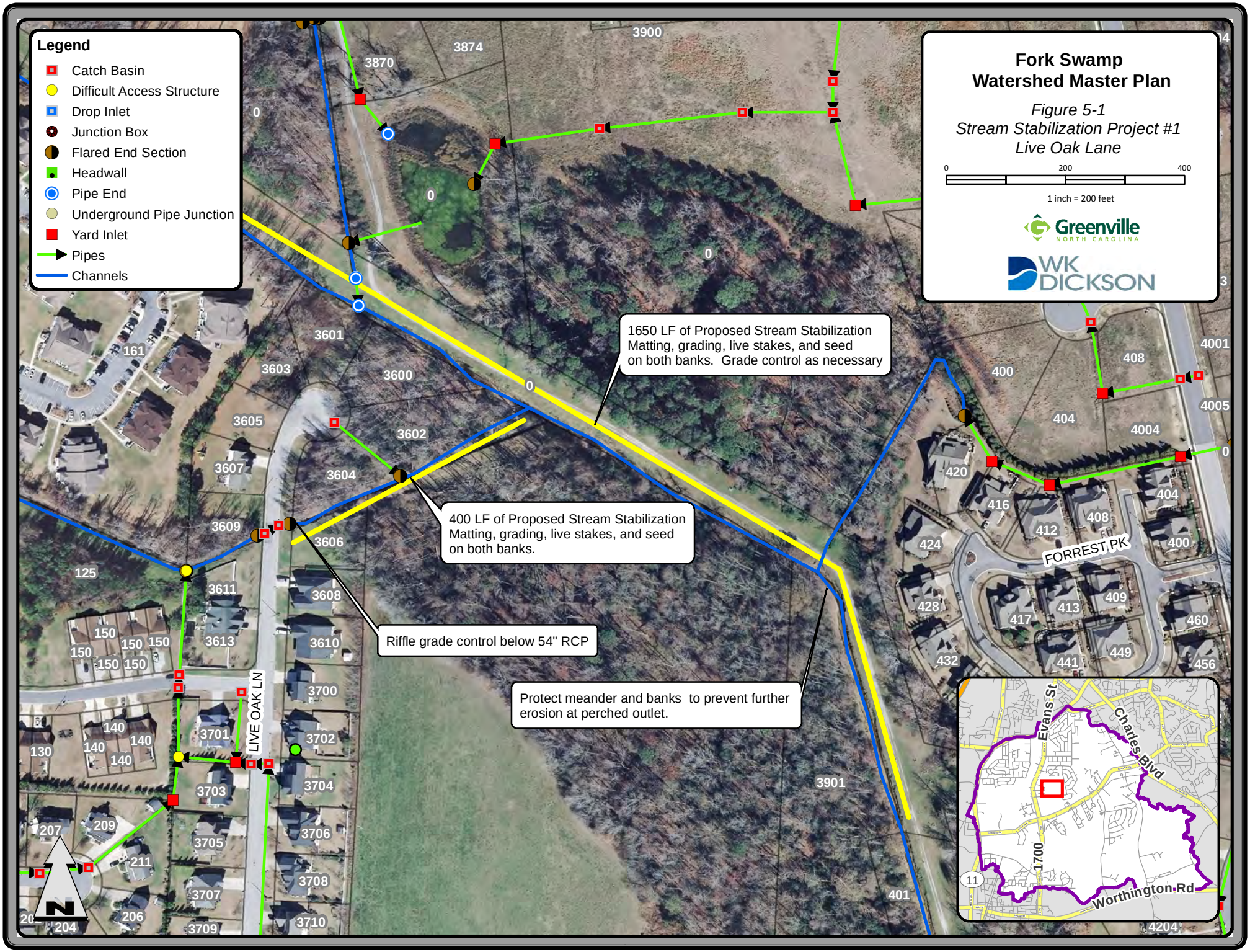
Picture 5-6. Erosion and lack of riparian buffer at Ashcroft outfall

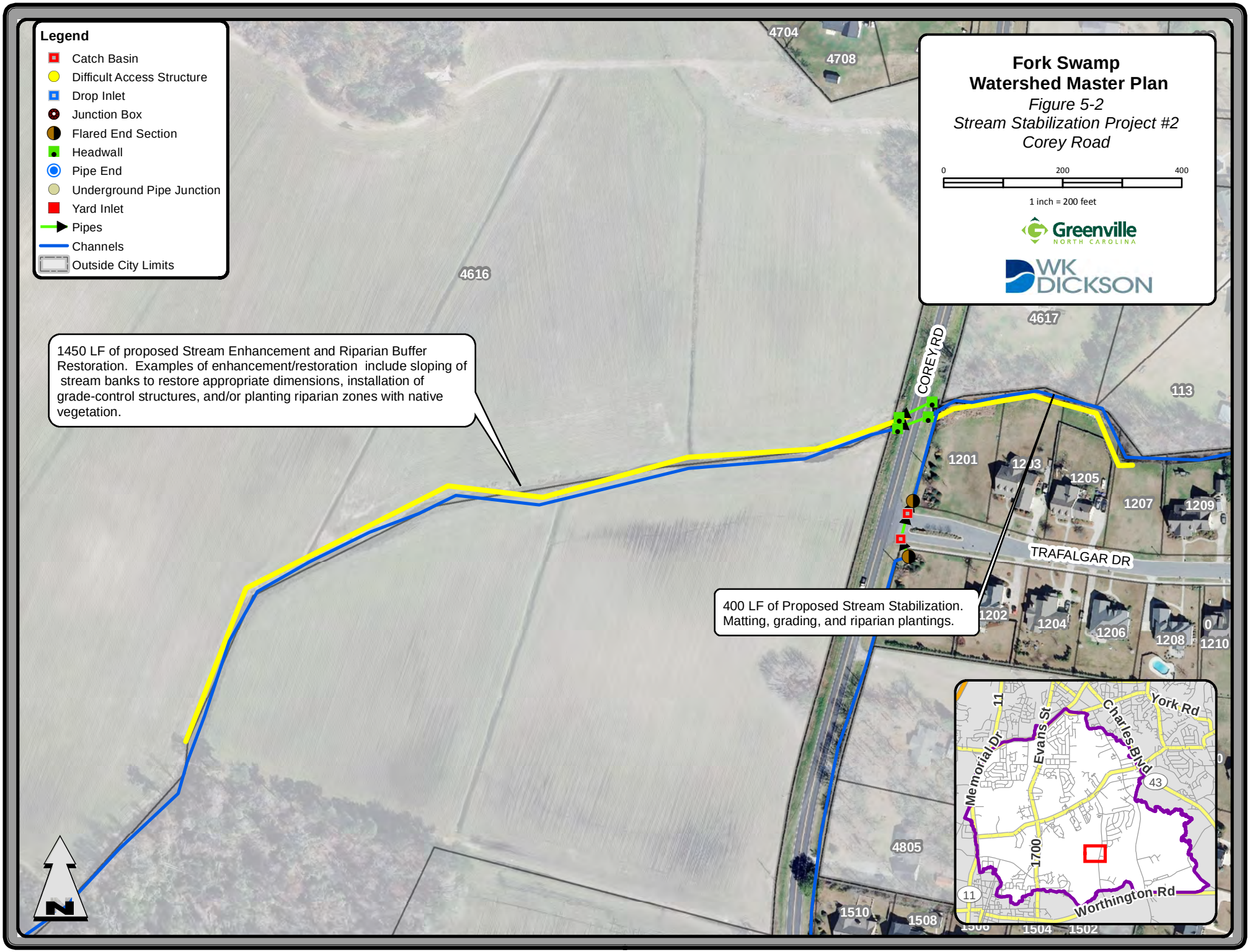
detention and infiltration, while the series of riffles are helpful in providing grade control for areas where steep slopes have caused instances of deep rill erosion or failed stream banks. RSCs can be very helpful in mitigating peak flows, as well as stabilizing channels and stream banks.

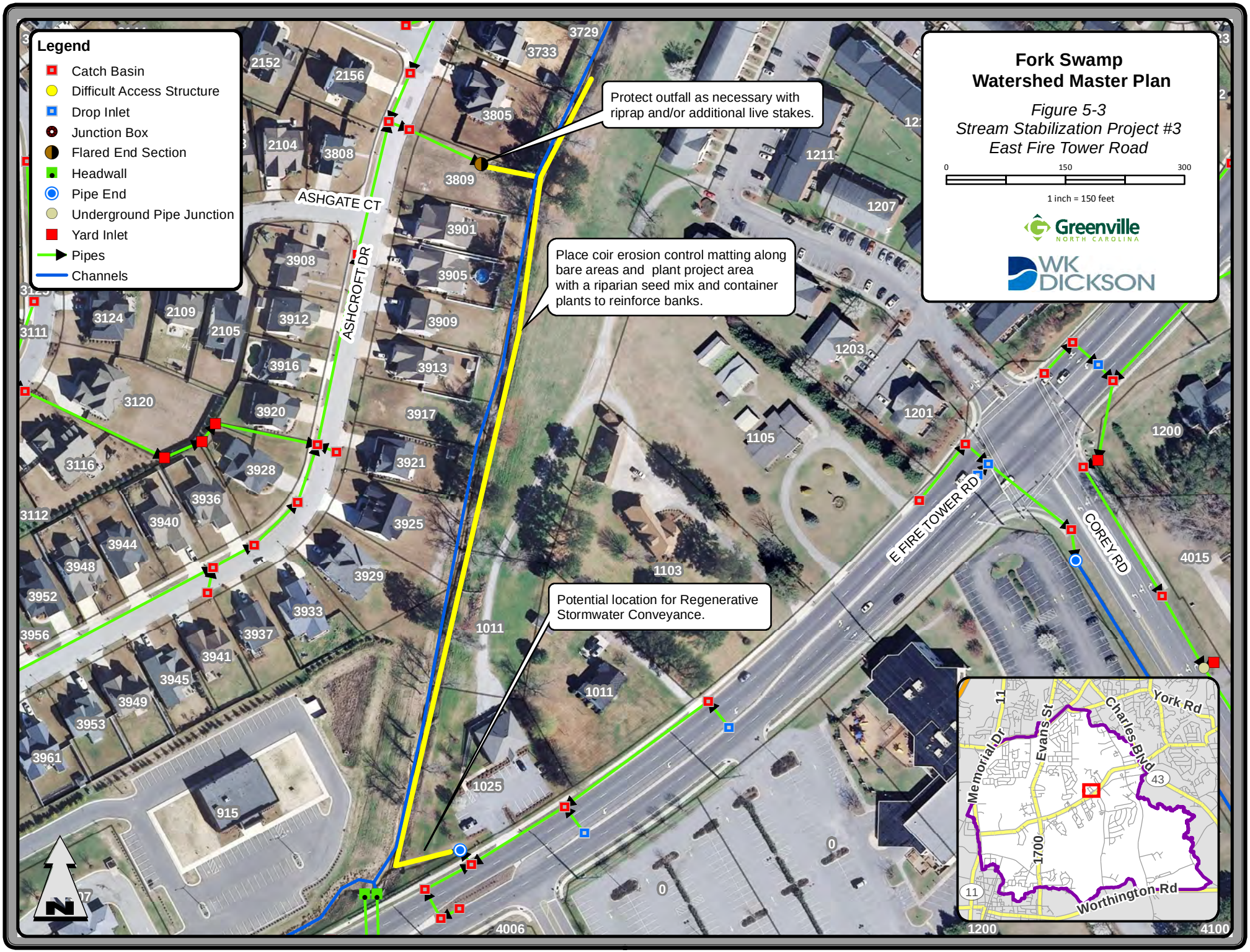
This stream stabilization project could potentially be combined with the proposed floodplain benching along FSUT3 upstream and downstream of East Fire Tower Road as well as the proposed culvert improvements at East Fire Tower Road.

The estimated cost for the East Fire Tower stream stabilization project is $230,000. The stream stabilization project will potentially access the project at the Ashcroft outfall (#FSUT030266). The following properties may be affected:

- 3805 Ashcroft Drive; and
- 3809 Ashcroft Drive.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-1
Stream Stabilization Project #1
Live Oak Lane
0
200
400
1 inch = 200 feet
Greenville
NORTH CAROLINA
WK DICKSON
1650 LF of Proposed Stream Stabilization Matting, grading, live stakes, and seed on both banks. Grade control as necessary
400 LF of Proposed Stream Stabilization Matting, grading, live stakes, and seed on both banks.
Riffle grade control below 54" RCP
Protect meander and banks to prevent further erosion at perched outlet.
LIVE OAK LN
FORREST PK
Evans St
Charles Blvd
Worthington Rd
1700
11
N


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Outside City Limits
Fork Swamp
Watershed Master Plan
Figure 5-2
Stream Stabilization Project #2
Corey Road
0
200
400
1 inch = 200 feet
Greenville
NORTH CAROLINA
WK DICKSON
1450 LF of proposed Stream Enhancement and Riparian Buffer Restoration. Examples of enhancement/restoration include sloping of stream banks to restore appropriate dimensions, installation of grade-control structures, and/or planting riparian zones with native vegetation.
400 LF of Proposed Stream Stabilization. Matting, grading, and riparian plantings.
4704
4708
4616
4617
COREY RD
113
1201
1205
1207
1209
TRAFALGAR DR
1202
1204
1206
1208
1210
4805
1510
1508
1504
1502
York Rd
Charles Blvd
Evans St
Memorial Dr
Worthington Rd
43
11
1700


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Protect outfall as necessary with riprap and/or additional live stakes.
Place coir erosion control matting along bare areas and plant project area with a riparian seed mix and container plants to reinforce banks.
Potential location for Regenerative Stormwater Conveyance.
ASHGATE CT
ASHCROFT DR
E FIRE TOWER RD
COREY RD
Fork Swamp
Watershed Master Plan
Figure 5-3
Stream Stabilization Project #3
East Fire Tower Road
0
150
300
1 inch = 150 feet
Greenville
NORTH CAROLINA
WK DICKSON
York Rd
Charles Blvd
Evans St
Memorial Dr
Worthington Rd
43
11
1700

Stream Stabilization Project #4: Tower Place

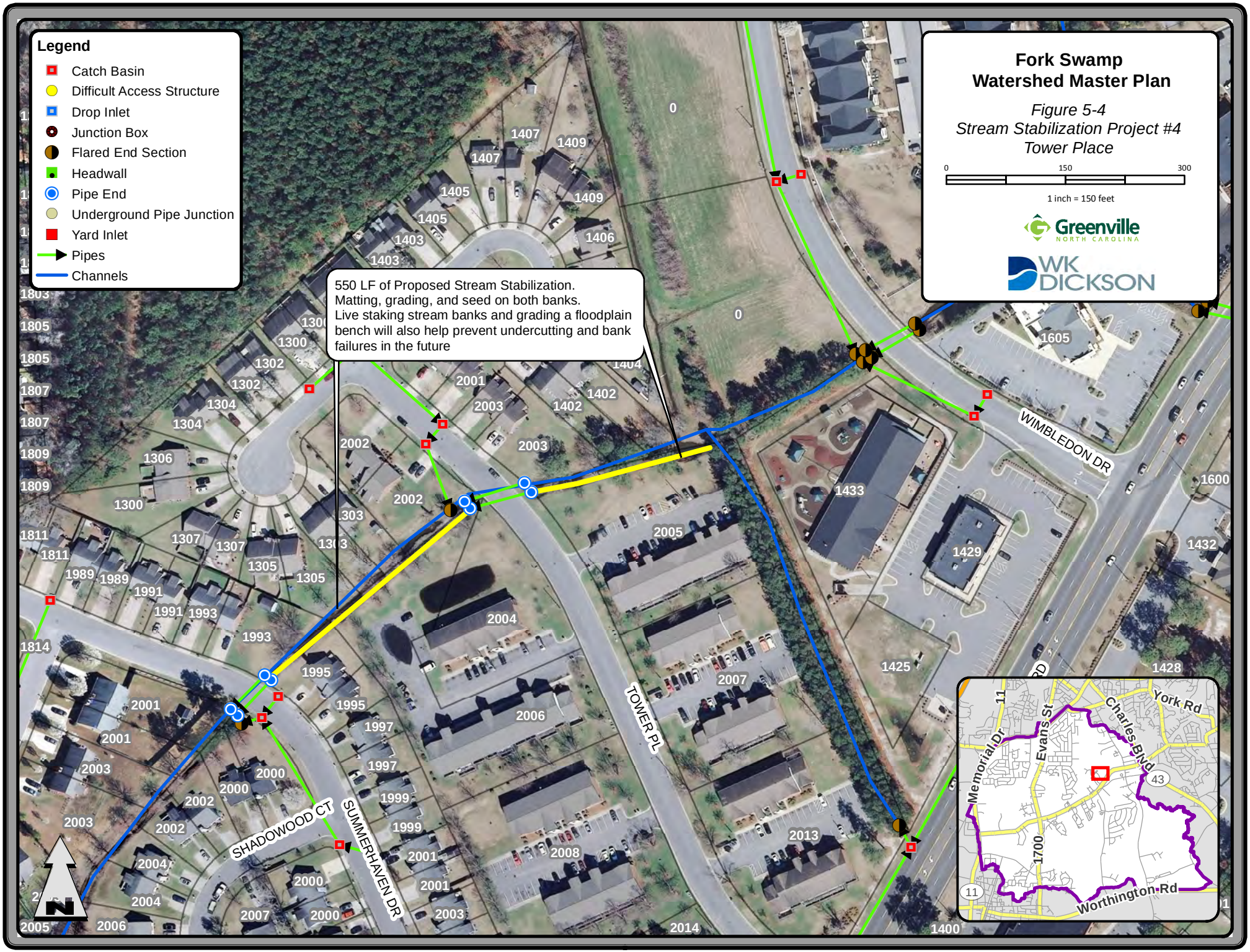
Stream Project #4 runs between Summerhaven Drive and Wimbledon Drive. The project begins behind an apartment complex and runs approximately 550 feet to the crossing at Tower Place. Stream Project #4 is a perennial stream section of FSUT3 with a drainage area of 476 acres.

Land use surrounding Stream Project #4 is mostly residential. This stream segment flows to the west and has an average stream width of 8 feet. The average bank height ranges between 4 and 7 feet and average bank angles are 65 degrees. Bank conditions along this stretch are fairly unstable and eroding due to the lack of a forested buffer along the entire reach. The left bank is a maintained lawn and has nearly 30 continuous feet of slumping banks. The lack of riparian vegetation along this stretch is likely to lead to erosion that may begin to encroach on the apartment complex in the future.

Picture 5-6. Erosion East of Tower Place

Stream Project #4 has opportunities for bank stabilization to prevent sediment loading and bank erosion to this unnamed tributary. To improve bank stability and reduce bank erosion along Stream Project #4, several tasks could be performed. Bank erosion can be reduced by grading channel banks back to a minimum 2 to 1 slope and placement of coir erosion control matting along banks and bare areas. Live staking stream banks and grading a floodplain bench will also help prevent undercutting and bank failures in the future. Also, the entire project area could be planted with a riparian seed mix to reinforce banks. The estimated cost for the Tower Place project is $140,000. If funding allows this stream stabilization project could be combined with the proposed culvert improvements at Summerhaven Drive, Tower Place, and Wimbledon Drive.

Picture 5-7. Erosion East of Tower Place


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
550 LF of Proposed Stream Stabilization.
Matting, grading, and seed on both banks.
Live staking stream banks and grading a floodplain bench will also help prevent undercutting and bank failures in the future
Fork Swamp
Watershed Master Plan
Figure 5-4
Stream Stabilization Project #4
Tower Place
0
150
300
1 inch = 150 feet
Greenville
NORTH CAROLINA
WK DICKSON
WIMBLEDON DR
TOWER PL
SHADOWOOD CT
SUMMERHAVEN DR
York Rd
Charles Blvd
Evans St
Memorial Dr
Worthington Rd
43
11
1700

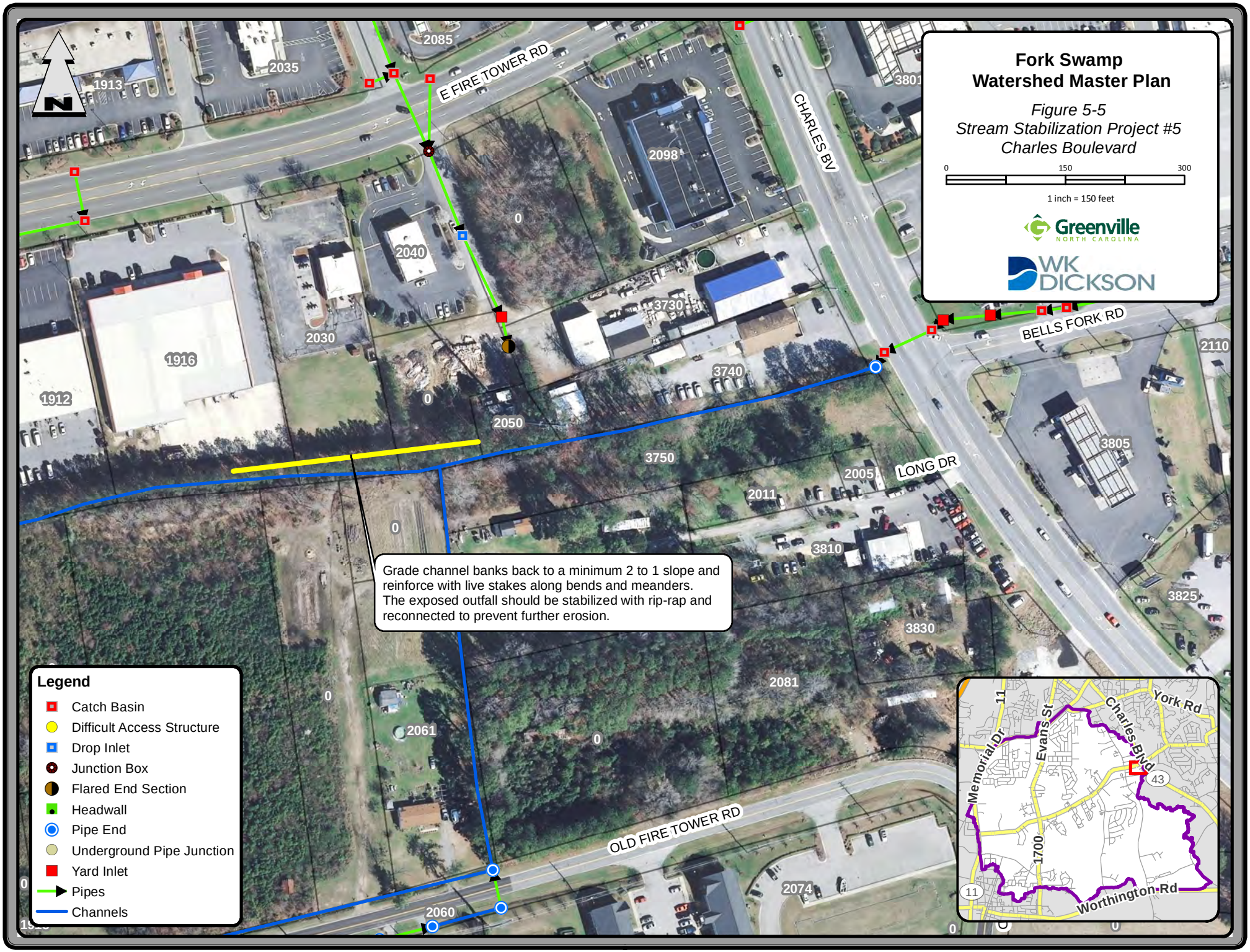
Stream Stabilization Project #5: Charles Boulevard

Stream Project #5 begins west of Charles Boulevard at an incised tributary and runs 300 feet down to a perched culvert with an obstruction and pool formed. Stream Project #5 is a perennial stream section of FSUT3 with a drainage area of approximately 100 acres.

Land use surrounding Stream Project #5 is mostly small businesses and some residential areas downstream. This stream segment flows to the west and has an average stream width of 8 feet. The average bank height ranges between 4 and 7 feet and average bank angles are 65 degrees. The bank conditions along this stretch are fairly unstable and eroding at an accelerated pace due to loamy sand soil texture and a lack of sufficient bank vegetation along large portions of this urbanized reach. Erosion and debris obstructions in this segment have led to a perched culvert that could become further exposed if not addressed.

Picture 5-8. Exposed outfall on right bank

Stream Project #5 has opportunities for bank stabilization and the stabilization of a perched outfall. To improve bank stability and reduce bank erosion along Stream Project #5, several tasks need to be performed. Bank erosion can be reduced by reinforcing banks with live stakes and debris jams in the channel should be removed to prevent channel widening and erosion of banks near the exposed outfall. Several tasks could be performed to stabilize the outfall: the outfall could be stabilized with rip-rap and reconnected to prevent further erosion or a cross vane could be constructed just upstream of the outfall to help establish a pool just below the pipe end. Additionally, the outfall elevation could be lowered or outfall treatment such as RSC could be installed. The estimated cost for the Charles Boulevard project is $90,000.


Fork Swamp
Watershed Master Plan
Figure 5-5
Stream Stabilization Project #5
Charles Boulevard
0
150
300
1 inch = 150 feet
Greenville
NORTH CAROLINA
WK DICKSON
E FIRE TOWER RD
CHARLES BV
BELLS FORK RD
LONG DR
OLD FIRE TOWER RD
Grade channel banks back to a minimum 2 to 1 slope and reinforce with live stakes along bends and meanders. The exposed outfall should be stabilized with rip-rap and reconnected to prevent further erosion.
Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
York Rd
Charles Blvd
Evans St
Memorial Dr
Worthington Rd
1700
11
43

Stream Stabilization Project # 6: Queen Annes Road

Stream Project #6 is located east of Queen Annes Road and north of the houses on Chesapeake Place. Stream Project #6 begins downstream of an armored culvert and runs approximately 500 feet downstream to an armored 90-degree bend in the channel. Stream Project #6 is a perennial stream section of FSUT1 and has a drainage area of approximately 220 acres.

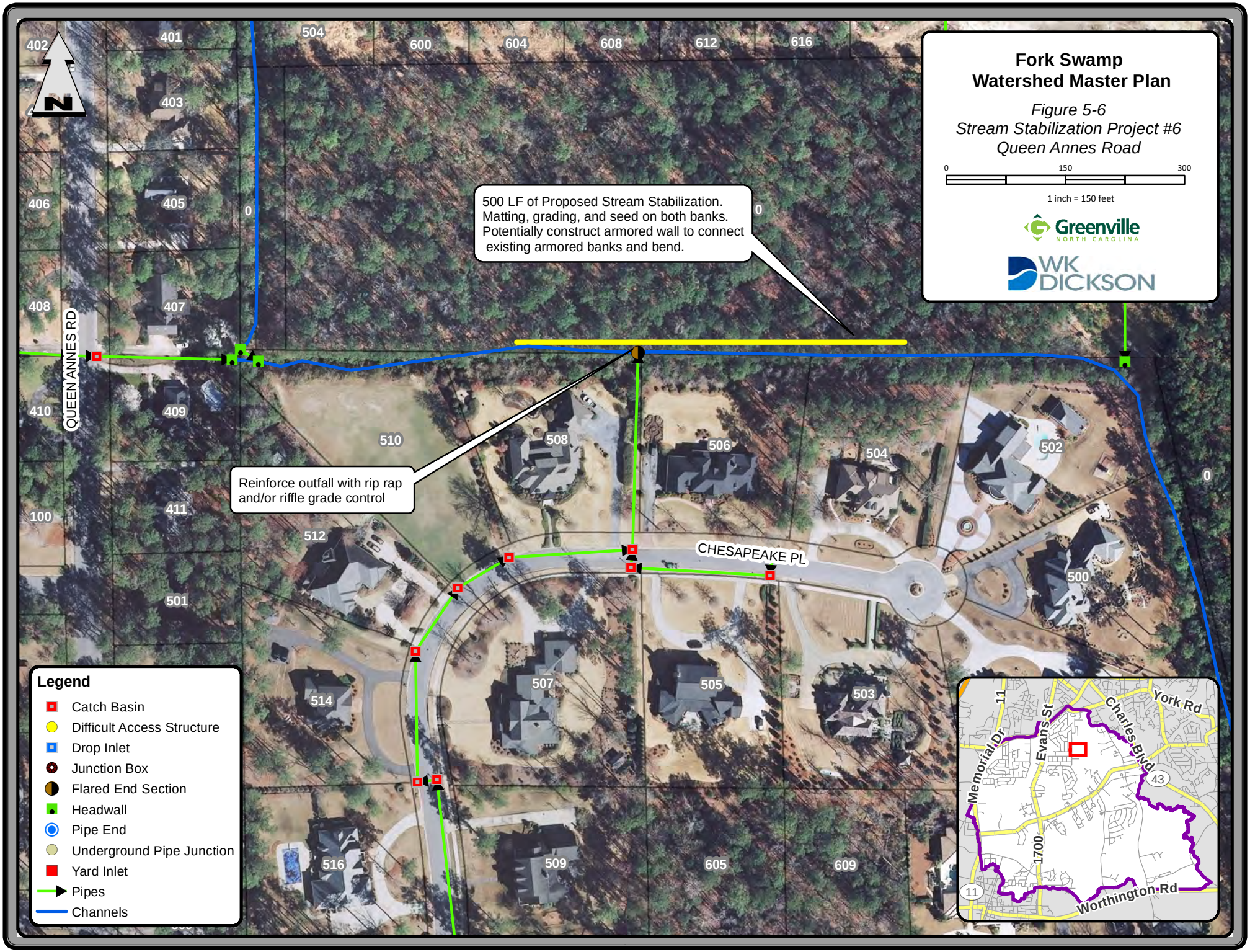
Stream Project #6 flows to the east within a channelized segment of the stream. Land use surrounding the project is mostly residential with reaches of wooded area along the sewer easement. The bottom width is approximately 10 feet wide. The right bank is 10 feet tall and the left bank is approximately 15 feet tall with bank angles of 65 degrees. The bank conditions along this stretch are unstable and eroding due to a lack of sufficient bank protection along this portion of the reach (See Picture 5-9).

Picture 5-9. Eroding left bank between armored sections

Immediately upstream and downstream of this project the left bank is heavily armored with rip-rap (See Picture 5-10). It also appears that log grade control structures previously placed along the right bank are failing (See Picture 5-11). Proposed work would include stream stabilization and potentially connecting the two already armored features along this stretch of FSUT1. To improve bank stability and reduce bank erosion along Stream Project #6, several tasks could be performed. Live staking stream banks or reinforcing banks with riprap along bends and meanders will help prevent undercutting and bank failures in the future. The City might consider reinforcing the entire reach to connect the already enforced segments of the stream. The estimated cost for the Queen Annes Road project is $220,000.

Picture 5-10. Armored 90-degree bend

Picture 5-11. Failing log structures along right bank


Fork Swamp
Watershed Master Plan
Figure 5-6
Stream Stabilization Project #6
Queen Annes Road
0
150
300
1 inch = 150 feet
Greenville
NORTH CAROLINA
WK DICKSON
500 LF of Proposed Stream Stabilization. Matting, grading, and seed on both banks. Potentially construct armored wall to connect existing armored banks and bend.
Reinforce outfall with rip rap and/or riffle grade control
QUEEN ANNES RD
CHESAPEAKE PL
Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
York Rd
Charles Blvd
Evans St
Memorial Dr
Worthington Rd
1700
11
43

Stream Stabilization Project #7: Evans Street

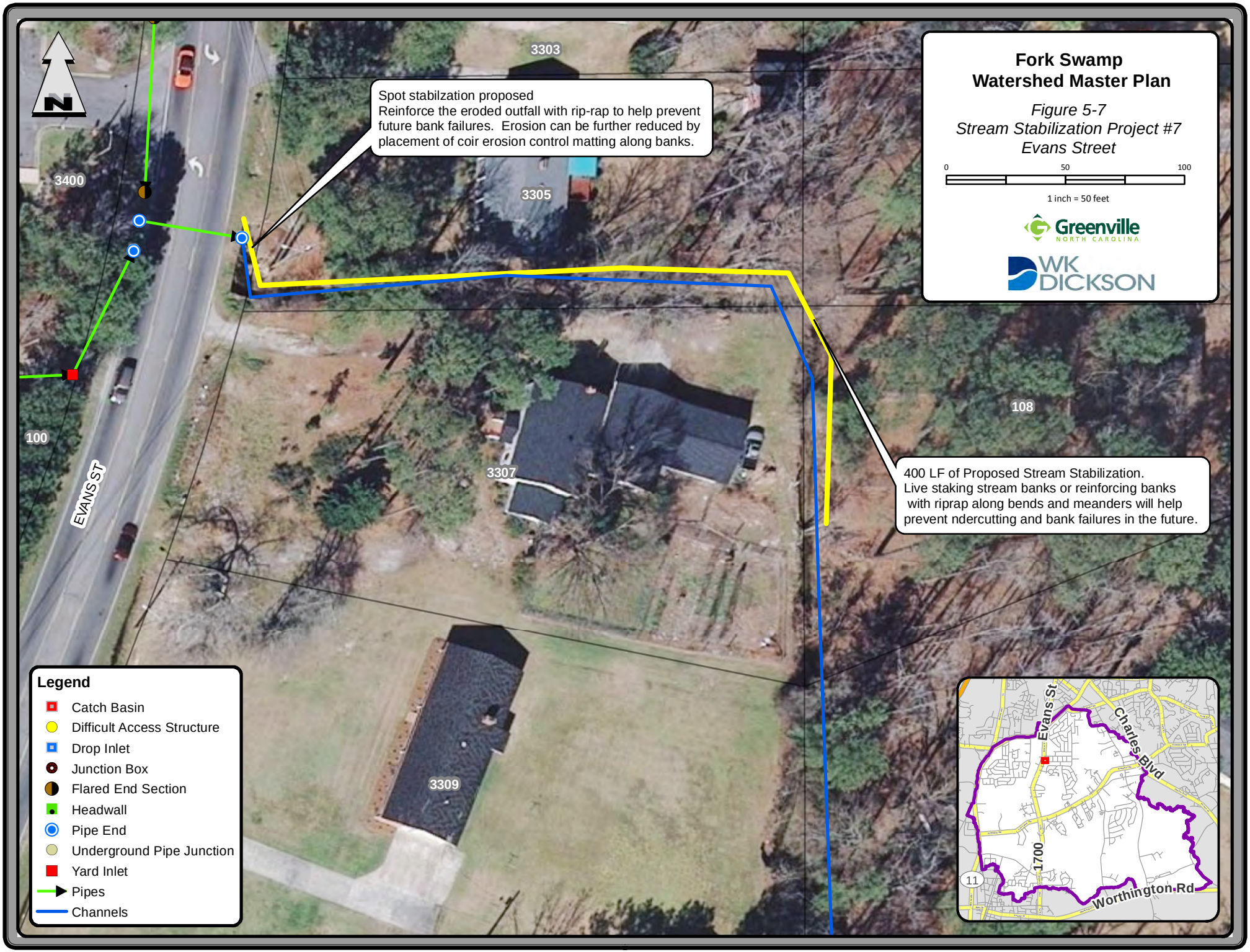
Stream Project #7 is located adjacent to the residence at 3307 Evans Street, where erosion at a stormwater outfall has caused severe erosion and exposed the footing of a telephone pole (See Picture 5-12). In addition to stabilizing the outfall at Evans Street, Stream Project #7 would span approximately 400 feet downstream of the culvert to address unstable conditions along this channel. Stream Project #7 is a perennial stream section and has a drainage area of approximately 125 acres.

Land use surrounding the project is mostly residential. Stream Project #7 flows to the east within a channelized segment and then turns 90 degrees to flow to the south. The bottom width is approximately 5 feet wide. The right bank is 5.5 feet tall and the left bank is approximately 7 feet tall with bank angles of 65 degrees. The bank conditions along this stretch are unstable and eroding due to loamy sand soil texture and a lack of sufficient bank protection along this portion of the reach. The landowner at 3307 Evans Street has installed fencing Stream Project #7 in an effort to stabilize the banks and hinder future erosion.

Picture 5-12. Eroding outfall and exposed telephone pole

Stream Project #7 has opportunities for bank stabilization to prevent increased erosion at the outfall and preventing the telephone pole from collapsing. Proposed work at the outfall could include reinforcing the channel banks with rip-rap to help prevent future bank failures. To improve bank stability and reduce bank erosion along the downstream portion of the project, several tasks could be performed. Live staking stream banks or reinforcing banks with riprap along bends and meanders will help prevent undercutting and bank failures in the future. Also, the entire project area could be planted with a riparian seed mix to reinforce banks. The estimated cost for the Evans Street project is $130,000.

Picture 5-13. Vertical stream bank behind property at 3307 Evans Street


Fork Swamp
Watershed Master Plan
Figure 5-7
Stream Stabilization Project #7
Evans Street
0
50
100
1 inch = 50 feet
Greenville
NORTH CAROLINA
WK DICKSON
Spot stabilzation proposed
Reinforce the eroded outfall with rip-rap to help prevent future bank failures. Erosion can be further reduced by placement of coir erosion control matting along banks.
400 LF of Proposed Stream Stabilization.
Live staking stream banks or reinforcing banks with riprap along bends and meanders will help prevent ndercutting and bank failures in the future.
3303
3400
3305
3307
3309
108
100
EVANS ST
Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Evans St
Charles Blvd
1700
11
Worthington Rd

5.2 BMP PROJECT IDENTIFICATION

BMPs were initially identified using various layers in GIS including the following: aerial photography, parcels, land use, storm water inventory, and topography. Twenty-three (23) potential BMP locations were initially identified. These locations were field visited by WK Dickson staff in November 2015 to determine the feasibility of each site for a BMP. An overview map has been provided showing these sites (See Figure 5-8).

The proposed locations for the BMPs were evaluated based on the following criteria:

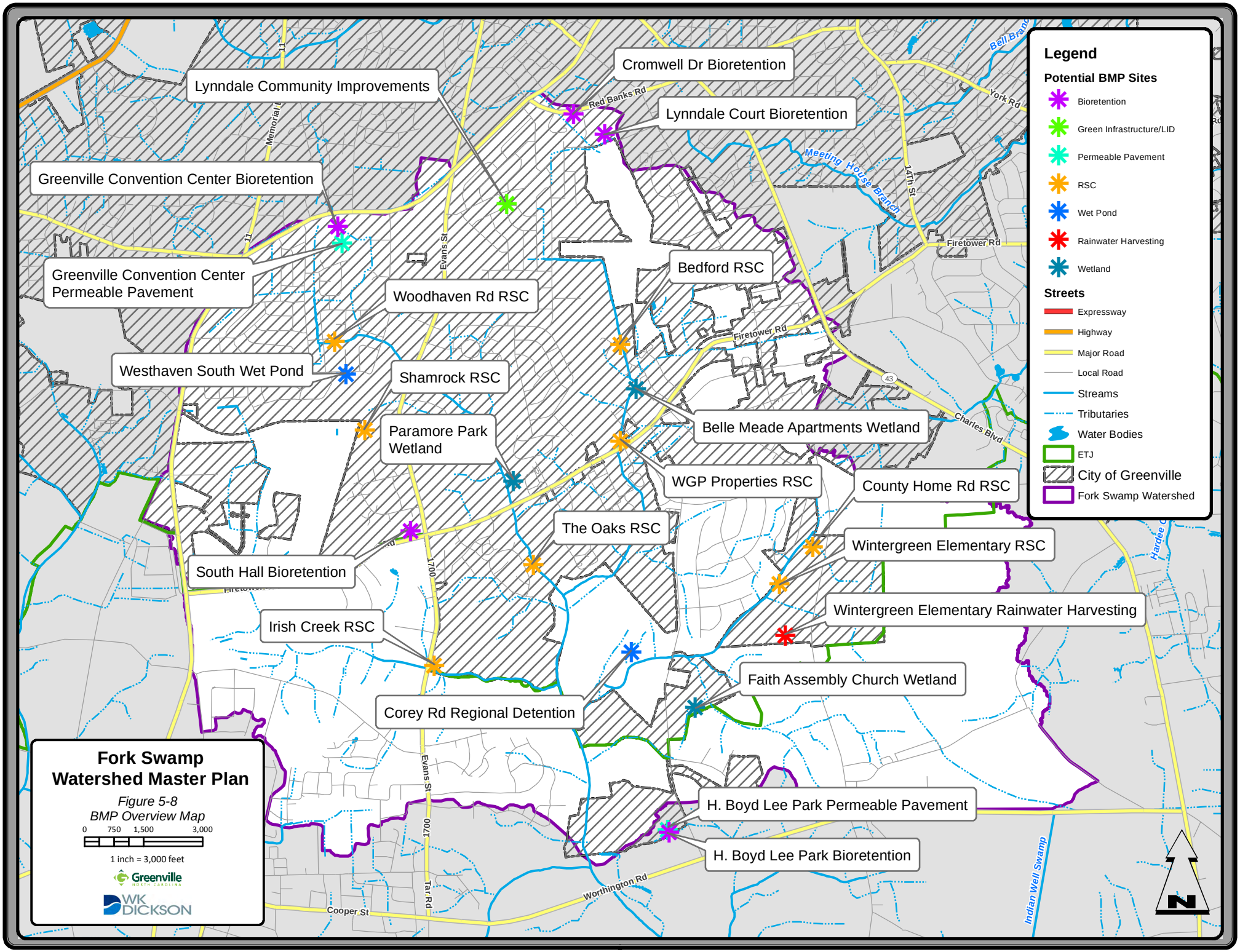
- Watershed Size/Drainage Area – Larger watershed sizes allow an opportunity for more treatment. A significant contributing drainage area would allow the use of a larger, more regional BMP such as a wet pond or extended detention wetland.
- Percentage of impervious area – Areas with high impervious percentages allow an opportunity for more treatment.
- Proximity to existing conveyance system – Runoff will need to be diverted into the BMP and then discharged back to the conveyance system. Locations in close proximity to the existing conveyance system will reduce the cost associated with constructing new drainage structures.
- Land Availability/Ownership – The proposed BMPs will require undeveloped land. Attempts were made to concentrate on publicly owned land because the high cost of private land can make a project unlikely.
- Topography – Sufficient vertical relief, up to 5 feet, is required to allow certain BMPs (i.e., bioretention and wet ponds) to function per NCDEQ design requirements.
- Hydrologic conditions – BMPs such as wet ponds or extended detention wetlands need the proper hydrologic conditions for plants to survive. The soils or existing water table must allow for the BMP facility to permanently hold stormwater runoff.

Public schools, parks, and churches were closely looked at due to the large impervious areas (e.g. parking lots) available for treatment and the educational benefits of installing a BMP on-site. Residents who provided feedback via online survey or by attending the public meeting held in November 2014 were also taken into account. The feedback helped determine several locations where erosion, flooding, or water quality were of concern. Several of the sites identified met multiple criteria for a successful project and were therefore recommended in this Master Plan.

5.3 RECOMMENDED BMPS

Based on field visits and the above criteria, eighteen (18) sites were recommended for BMP retrofits in the Fork Swamp Watershed. Factors that eliminated a site from consideration included the following: limited space, tree density, utility conflicts (e.g. high voltage transformers and other electrical distribution equipment), and insufficient topographic relief.

Preliminary conceptual design calculations completed for each of the eighteen (18) BMPs are included in Appendix I. The design calculations were based on methodologies found in the NCDEQ Stormwater BMP Manual. The size of the BMP is based on the contributing watershed area and the amount of impervious area within the watershed. Per NCDEQ requirements, the recommended BMPs were designed to treat runoff from the first one-inch of rainfall. The treatment volume is directly correlated to the amount of impervious area. Watersheds with larger amounts of impervious area convert more of the rainfall into runoff, thereby requiring a larger sized BMP.


Lynndale Community Improvements
Cromwell Dr Bioretention
Lynndale Court Bioretention
Greenville Convention Center Bioretention
Greenville Convention Center Permeable Pavement
Bedford RSC
Woodhaven Rd RSC
Westhaven South Wet Pond
Shamrock RSC
Paramore Park Wetland
Belle Meade Apartments Wetland
WGP Properties RSC
County Home Rd RSC
The Oaks RSC
Wintergreen Elementary RSC
South Hall Bioretention
Wintergreen Elementary Rainwater Harvesting
Irish Creek RSC
Faith Assembly Church Wetland
Corey Rd Regional Detention
H. Boyd Lee Park Permeable Pavement
H. Boyd Lee Park Bioretention
Red Banks Rd
Meeting House Branch
Firetower Rd
Evans St
Memorial Dr
14th St
York Rd
Charles Blvd
Worthington Rd
Cooper St
Tar Rd
Indian Well Swamp
Legend
Potential BMP Sites
Bioretention
Green Infrastructure/LID
Permeable Pavement
RSC
Wet Pond
Rainwater Harvesting
Wetland
Streets
Expressway
Highway
Major Road
Local Road
Streams
Tributaries
Water Bodies
ETJ
City of Greenville
Fork Swamp Watershed
Fork Swamp Watershed Master Plan
Figure 5-8
BMP Overview Map
0 750 1,500 3,000
1 inch = 3,000 feet
Greenville
WK DICKSON
N

Fork Swamp Water Quality Project #1: Cromwell Drive Bioretention

A bioretention area is proposed in the open space located behind the American Red Cross Blood Donation Center at 700 Cromwell Drive (See Picture 5-14). This area is adjacent to a parking lot and large building that currently drain to an open channel running perpendicular to Red Banks Road. Flow from the building and parking lot can be redirected via curb cuts to be treated before discharging to FSUT3. The bioretention area may be impacted by gas line utilities and will require minimal infrastructure retrofits.

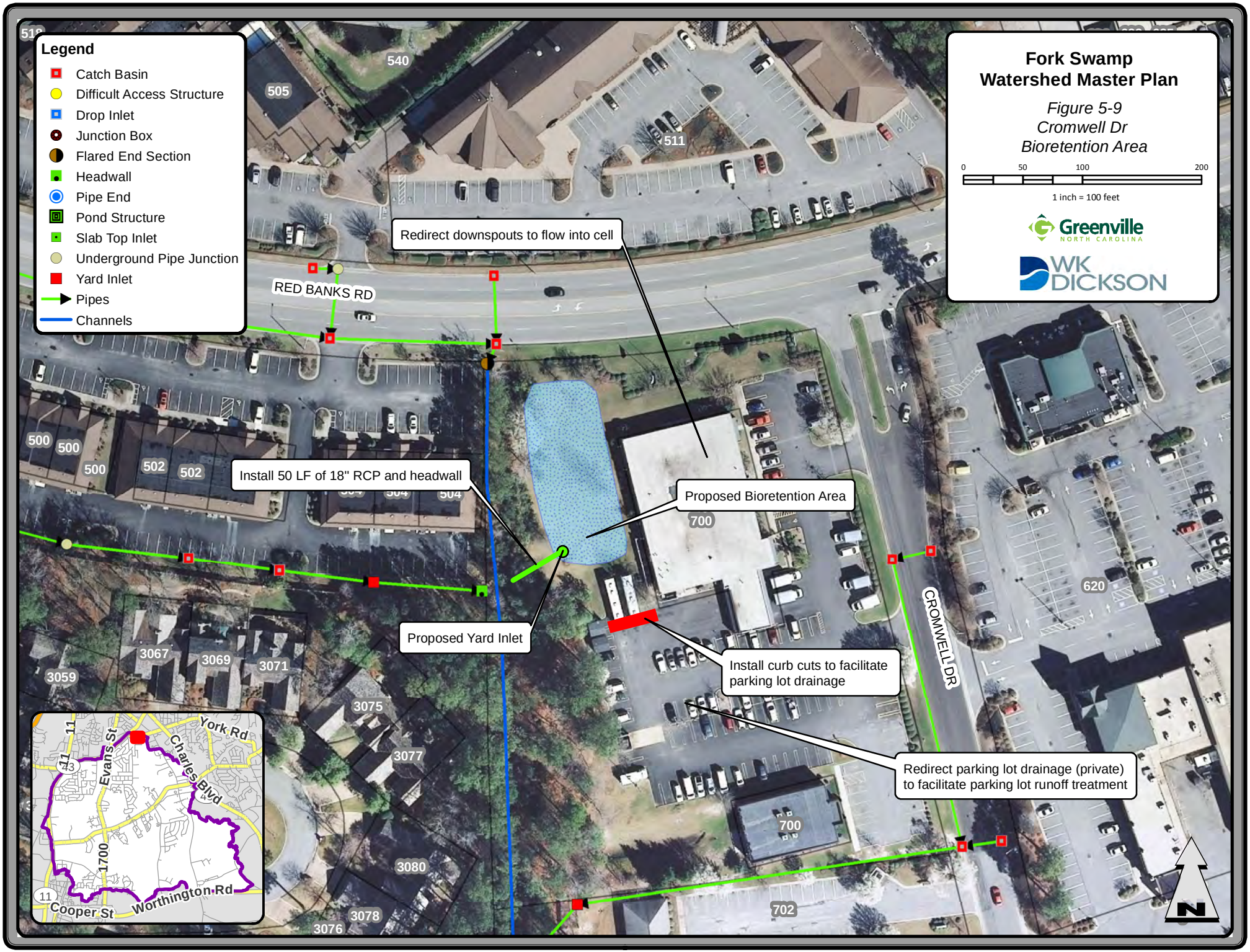
Picture 5-14. Proposed Location for Cromwell Drive Bioretention Cell

The required surface area for the proposed bioretention is approximately 2,600 square feet (0.06 acres). A concept level plan of the proposed improvements is shown in Figure 5-9.

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent parking lot. Impervious area draining to the proposed pond is approximately 0.5 acres.
- Install a yard inlet with an 18" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on private property. In order to construct the bioretention area, an easement agreement would be required with the owner. The estimated construction cost for the bioretention area at Cromwell Drive is $350,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-9
Cromwell Dr
Bioretention Area
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
Redirect downspouts to flow into cell
Install 50 LF of 18" RCP and headwall
Proposed Bioretention Area
Proposed Yard Inlet
Install curb cuts to facilitate parking lot drainage
Redirect parking lot drainage (private) to facilitate parking lot runoff treatment
RED BANKS RD
CROMWELL DR
York Rd
Charles Blvd
Evans St
Worthington Rd
Cooper St
1700
505
540
511
500
502
504
700
620
3059
3067
3069
3071
3075
3077
3080
3078
3076
702

Fork Swamp Water Quality Project #2: H. Boyd Lee Park Bioretention

A bioretention area is proposed in the open space south of the H. Boyd Lee Park parking area (See Picture 5-15). This area drains parking lot and street runoff, athletic fields, and buildings. Some additional drainage infrastructure has been added near the entrance of the park, and will drain towards the proposed bioretention area. Otherwise, there is minimal existing drainage infrastructure. As shown in the picture below, there is some standing water in the field area. The bioretention area will primarily provide water quality benefits by attenuating runoff prior to its discharge into Fork Swamp.

Picture 5-15. Proposed Location for H. Boyd Lee Park Bioretention Area

The required surface area for the proposed bioretention is approximately 7,500 square feet (0.2 acres). A concept level plan of the proposed improvements is shown in Figure 5-10.

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent lot and road. The impervious area draining to the proposed pond is approximately 2.5 acres.
- Install a yard inlet with a 24" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on public property. The estimated construction cost for the bioretention area at H. Boyd Lee Park is $340,000.

Fork Swamp Water Quality Project #3: H. Boyd Lee Park Permeable Pavement

A permeable pavement parking lot is proposed for the unpaved lot at H. Boyd Lee Park (See Picture 5-16). This area drains a parking lot, park buildings, streets, and open fields. As the City may intend to expand the parking area, or to convert the gravel/dirt road into paved area, this would be an opportune time to install permeable pavement instead of traditional asphalt. Field visits suggest that underdrains for the parking lot may be unnecessary however, geotechnical borings will need to be completed to confirm. The permeable pavement will primarily provide water quality benefits by attenuating runoff prior to its discharge into Fork Swamp. Educational signage could be added to both the proposed bioretention area (Project 2) and the permeable pavement since this is a City-owned park.

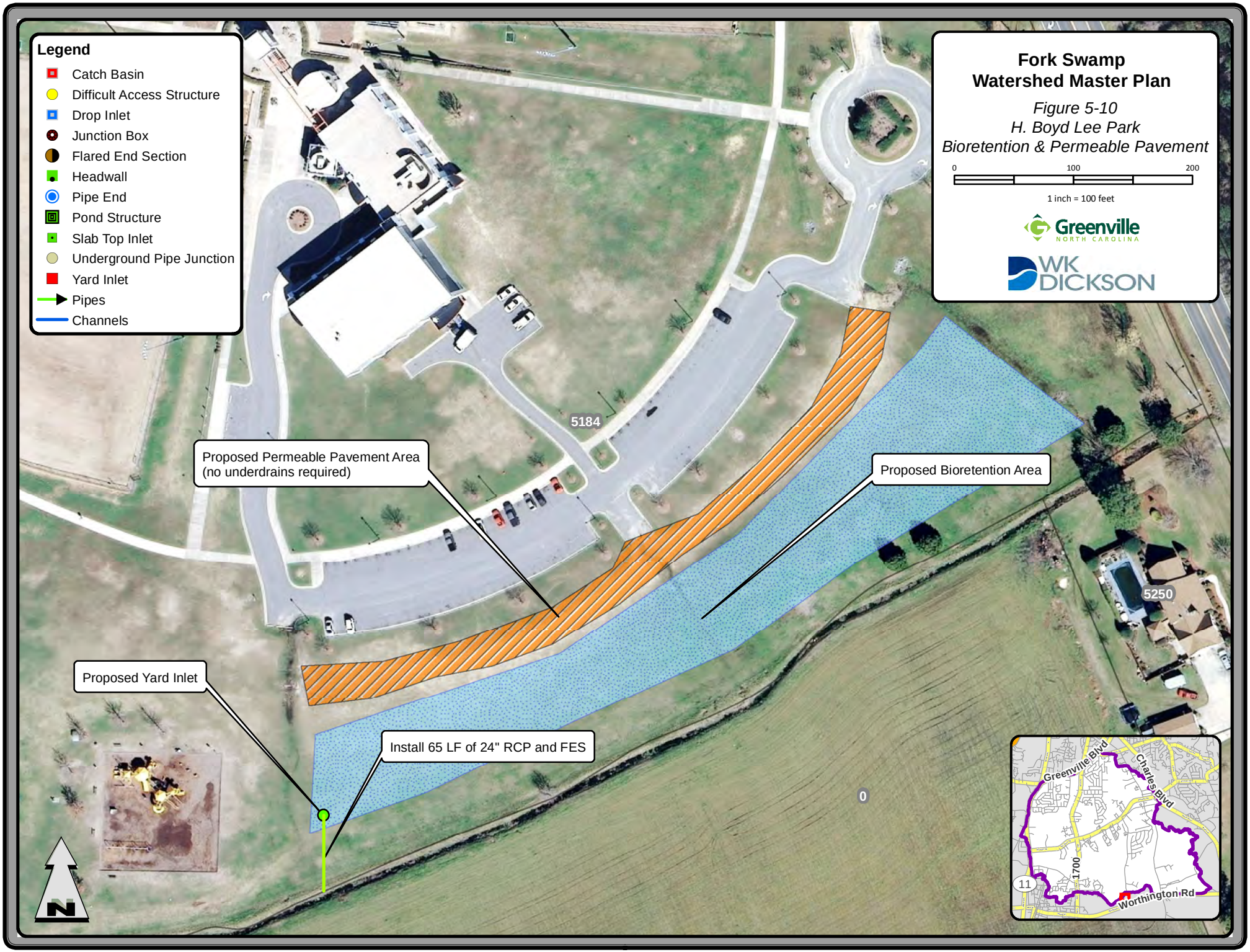
Picture 5-16. Proposed Location for H. Boyd Lee Park Permeable Pavement

The required surface area for the permeable pavement is approximately 17,000 square feet (0.39 acres). A concept level plan of the proposed improvements is shown in Figure 5-10.

The proposed permeable pavement project consists of the following improvements:

- Install 3.5-inch-thick permeable pavers over 2 inches of bedding layer, 4 inches of base aggregate, and 6 inches of gravel casing. Underdrains are not required for this design.
- The proposed impervious areas draining to the proposed pond is approximately 3.5 acres.

The proposed water quality project is located on City property. The estimated construction cost for the bioretention area at H. Boyd Lee Park is $970,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-10
H. Boyd Lee Park
Bioretention & Permeable Pavement
0
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
5184
Proposed Permeable Pavement Area
(no underdrains required)
Proposed Bioretention Area
5250
Proposed Yard Inlet
Install 65 LF of 24" RCP and FES
0
N
Greenville Blvd
Charles Blvd
1700
11
Worthington Rd

Fork Swamp Water Quality Project #4: Faith Assembly Church Pond Retrofit

A stormwater pond retrofit is proposed in the open area behind Faith Assembly Church off Corey Road (See Picture 5-17). This area drains residential lots, church rooftop runoff, driveways, and sidewalks. The proposed design will add approximately 10,000 square feet of additional storage area. There are no known utility conflicts in the area, however access would require use of church land. The neighborhood downstream includes Trafalgar Drive, where several residents have complained of flooding in their living area. Existing infrastructure are located on private property, and thus were not included in the City-wide inventory. Additional analysis of the pond outlet structure would be required to determine if retrofits are feasible. Increasing the pond storage area will primarily provide water quality benefits by attenuating runoff prior to its discharge into FSUT1.

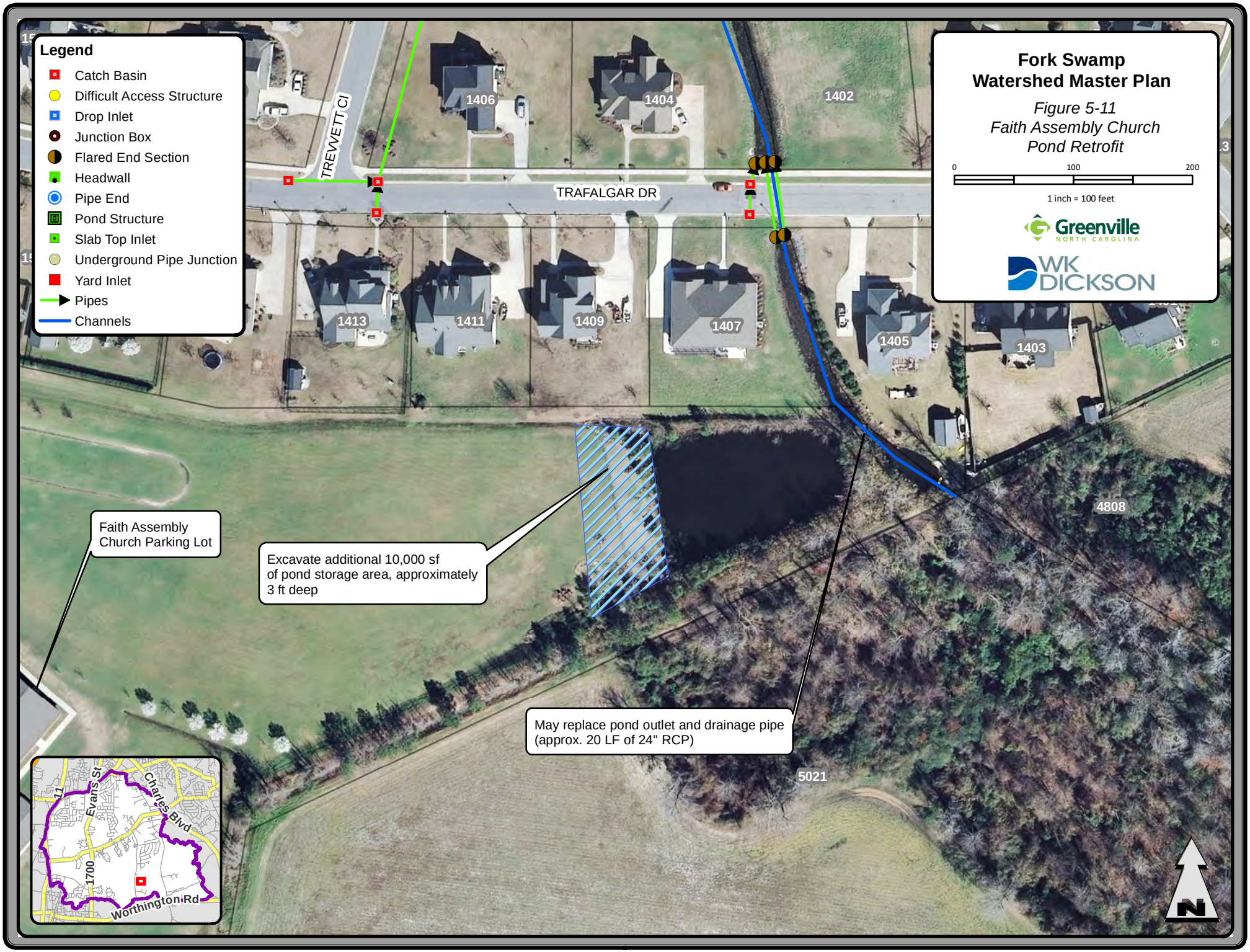
Picture 5-17. Proposed Location for Faith Assembly Church Pond Retrofit

The additional proposed surface area of the pond retrofit is approximately 10,000 square feet (0.23 acres). A concept level plan of the proposed improvements is shown in Figure 5-11.

The proposed wetland project consists of the following improvements:

- Excavate additional pond area designed to treat runoff from the adjacent lot and road. The impervious area draining to the proposed pond is approximately 1 acre.
- Install a yard inlet with an (assumed – no inventory data collected) 24" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on private property. In order to construct the wetland, an easement agreement would be required with the owner. The estimated construction cost for the wetland at Faith Assembly Church is $270,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-11
Faith Assembly Church
Pond Retrofit
0
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
TREVETT CI
TRAFALGAR DR
1406
1404
1402
1413
1411
1409
1407
1405
1403
4808
5021
Faith Assembly
Church Parking Lot
Excavate additional 10,000 sf
of pond storage area, approximately
3 ft deep
May replace pond outlet and drainage pipe
(approx. 20 LF of 24" RCP)
Evans St
Charles Blvd
1700
Worthington Rd
N

Fork Swamp Water Quality Project #5: County Home Road Regenerative Stormwater Conveyance

A Regenerative Stormwater Conveyance (RSC) system is proposed at the outlet of a 36'' CMP near District Park Drive and next to the Pitt County Animal Shelter and a waste collection facility (See Picture 5-18). This area drains some large buildings and parking lots, as well as runoff from County Home Road. Overhead power lines were noted at this location, and would need to be avoided during construction. There were no signs of severe erosion in the channel, however the runoff from the animal shelter and waste dumpsters may benefit from water quality treatment. The RSC will primarily provide water quality benefits by slowing and infiltrating runoff prior to its discharge into Fork Swamp.

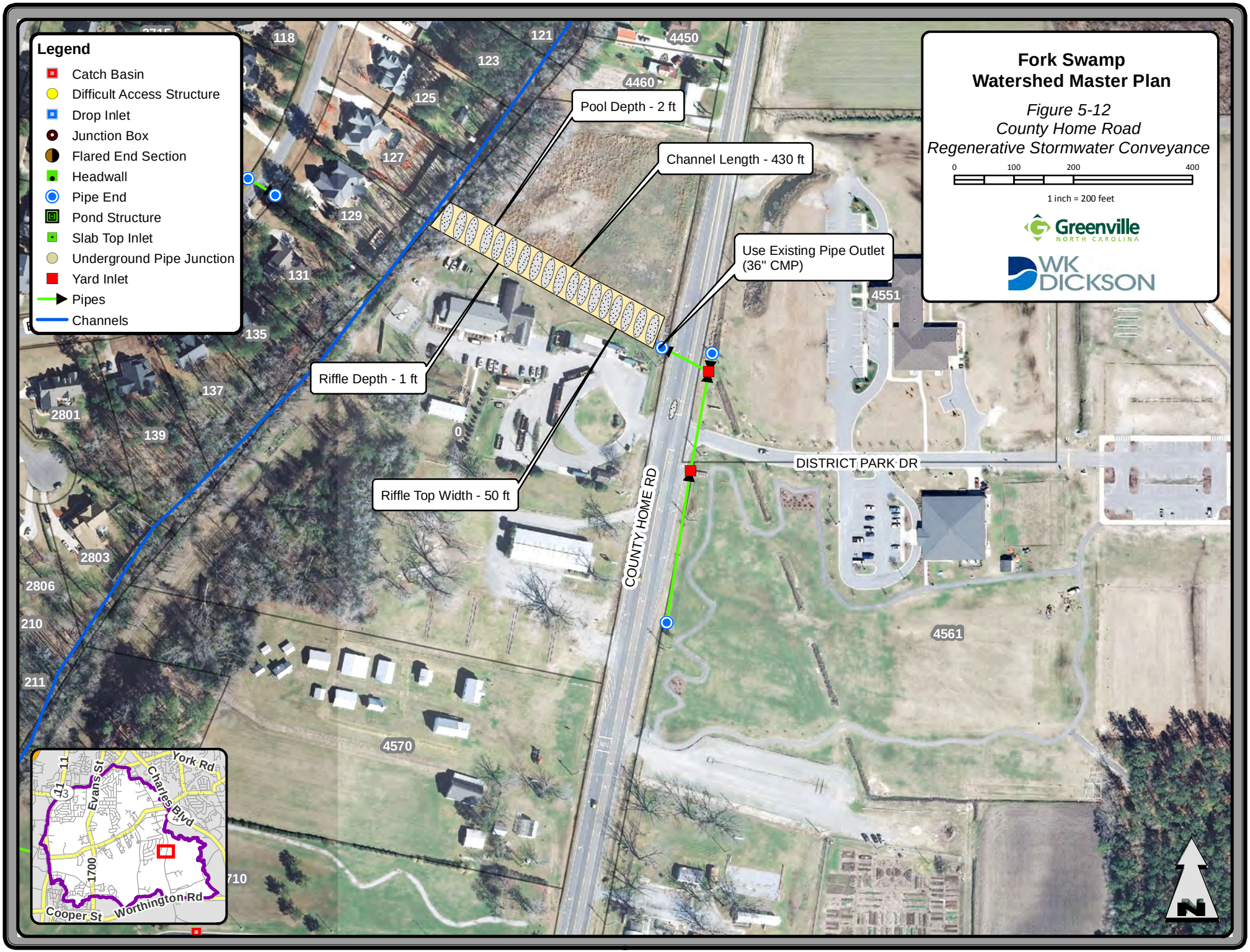
Picture 5-18. Proposed Location for County Home Road RSC

The required surface area of the RSC is approximately 24,500 square feet. A concept level plan of the proposed improvements is shown in Figure 5-12.

The proposed RSC project consists of the following improvements:

- Install RSC channel designed to treat runoff from the adjacent lots and road. The proposed impervious areas draining to the enhanced channel is approximately 4.8 acres.
- Excavate step pools and install required boulders, cobbles, and infiltration media. The quantities are specified in Appendix I.

The proposed water quality project is located on County property. The estimated construction cost for the RSC at County Home Road is $490,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-12
County Home Road
Regenerative Stormwater Conveyance
0
100
200
400
1 inch = 200 feet
Greenville
NORTH CAROLINA
WK DICKSON
Pool Depth - 2 ft
Channel Length - 430 ft
Use Existing Pipe Outlet
(36" CMP)
Riffle Depth - 1 ft
Riffle Top Width - 50 ft
COUNTY HOME RD
DISTRICT PARK DR
118
121
123
125
127
129
131
135
137
139
4450
4460
4551
4561
4570
2801
2803
2806
210
211
0
York Rd
Evans St
Charles Blvd
Worthington Rd
Cooper St
1700
N

Fork Swamp Water Quality Project #6: Irish Creek Regenerative Stormwater Conveyance

A Regenerative Stormwater Conveyance (RSC) system is proposed at the outlet of a 30'' RCP behind the Irish Creek subdivision off Slaney Loop (See Picture 5-19). This area drains low density residential lots and streets. The proposed located is on private property in a newer subdivision, but has no known utility conflicts. The RSC location is also very flat but would provide treatment to runoff that is currently untreated. The RSC will primarily provide water quality benefits by slowing and infiltrating runoff prior to its discharge into FSUT2R1.

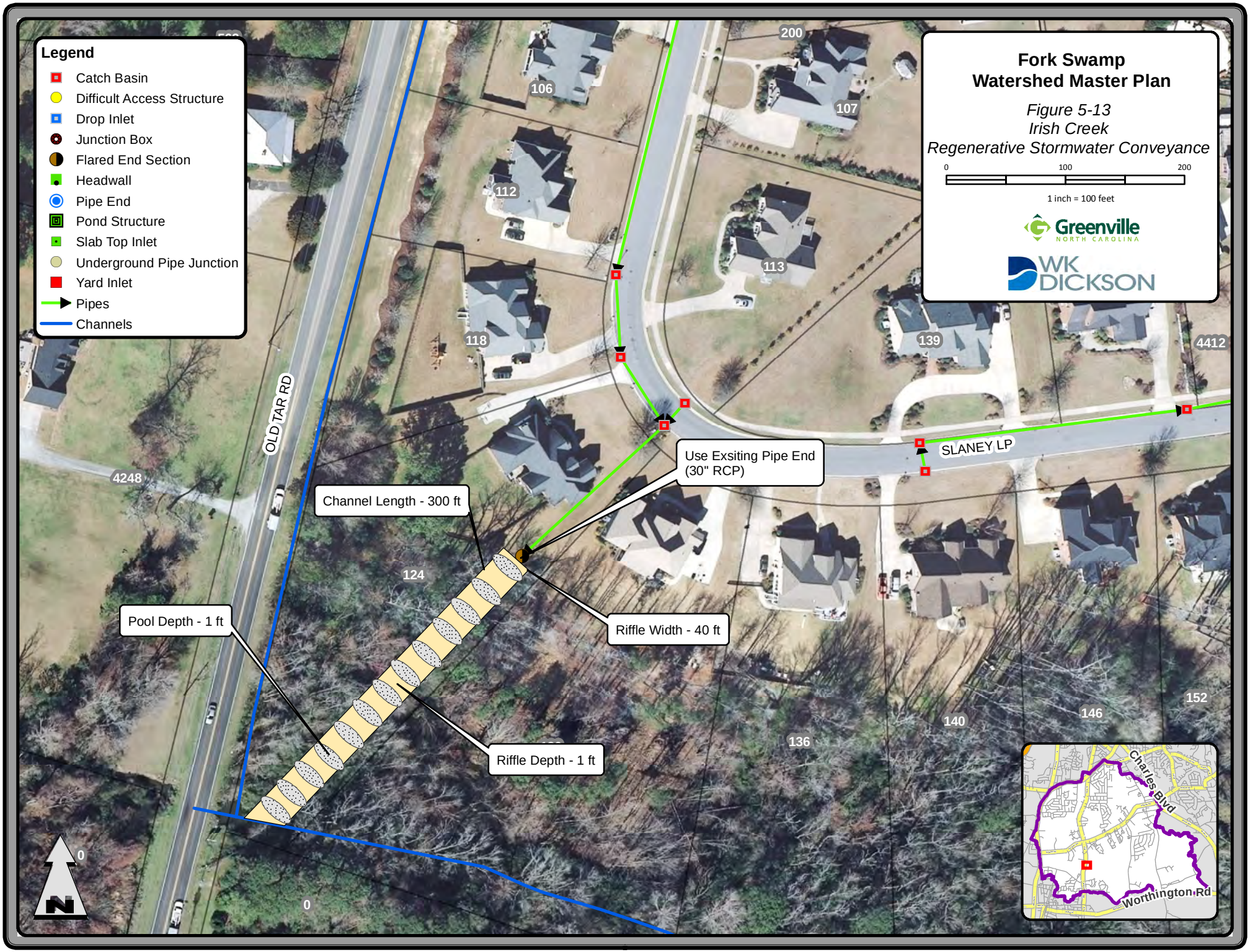
Picture 5-19. Proposed Location for Irish Creek RSC

The required surface area of the RSC is 12,000 square feet. A concept level plan of the proposed improvements is shown in Figure 5-13.

The proposed RSC project consists of the following improvements:

- Install RSC channel designed to treat runoff from the adjacent lots and road. The proposed impervious areas draining to the enhanced channel is approximately 2.6 acres.
- Excavate step pools and install required boulders, cobbles, and infiltration media. The quantities are specified in Appendix I.

The proposed water quality project is located on private property. In order to construct the RSC, an easement agreement would be required with the owner. The estimated construction cost for the RSC at Irish Creek is $250,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-13
Irish Creek
Regenerative Stormwater Conveyance
0
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
OLD TAR RD
SLANEY LP
Use Exsiting Pipe End
(30" RCP)
Channel Length - 300 ft
Pool Depth - 1 ft
Riffle Width - 40 ft
Riffle Depth - 1 ft
106
107
112
113
118
139
4412
4248
124
140
136
146
152
200
0
0
Charles Blvd
Worthington Rd

Fork Swamp Water Quality Project #7: The Oaks Regenerative Stormwater Conveyance

A Regenerative Stormwater Conveyance (RSC) system is proposed at the outlet of a 24'' RCP behind The Oaks subdivision off Treetops Circle (See Picture 5-20). This area drains low density residential lots and streets. The proposed location is on private property, but there have been complaints of flooding in the backyards of lots on Treetops Circle. The proposed location will have minimal impacts to utilities, but access will be limited by proximity of the homes. The RSC would primarily provide water quality benefits by slowing and infiltrating runoff prior to its discharge into Fork Swamp.

Picture 5-20. Proposed Location for The Oaks RSC

The required surface area of the RSC is 7,600 square feet. Some existing pipe may need to be removed or shortened. A concept level plan of the proposed improvements is shown in Figure 5-14.

The proposed RSC project consists of the following improvements:

- Install RSC channel designed to treat runoff from the adjacent lots and road. The proposed impervious areas draining to the enhanced channel is approximately 2.3 acres.
- Excavate step pools and install required boulders, cobbles, and infiltration media. The quantities are specified in Appendix I.

The proposed water quality project is located on private property. In order to construct the RSC, an easement agreement would be required with the owner. The estimated construction cost for the RSC at The Oaks is $200,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-14
The Oaks
Regenerative Stormwater Conveyance
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
Pool Depth - 1 ft
Riffle Depth - 1 ft
Channel Length - 380 ft
Riffle Width - 20 ft
Use Existing Pipe End
(24" RCP)
HICKORY BRANCHES CL
TREETOPS CI
WILLOW BRANCHES CL
4108
4106
4104
4103
4102
4101
4100
4004
4003
4002
4603
4601
4604
4602
4600
4504
4502
4505
4503
4501
4411
210
208
206
204
500
102
Evans St
Charles Blvd
Worthington Rd
1700

Fork Swamp Water Quality Project #8: South Hall Bioretention

A bioretention area is proposed in the open space in the South Hall business park parking lot at West Fire Tower Road and Evans Street, near the South Hall subdivision (See Picture 5-22). This drainage area contains parking lots and several commercial buildings. The area is currently landscaped with a tree and some large shrubs, and is a focal point for the business park. A bioretention cell is an appropriate BMP choice as attractive plants and landscaping can be added to the cell. Curb cuts will need to be added to facilitate parking lot runoff into the cell to be treated. Some gas line utilities are also present near the proposed tie-in location to the existing drainage system. Since the bioretention will require an 18'' RCP outlet, the pipe outlet should tie into the drainage system that exists to the south of the parking lot, and will require two 15'' RCP pipes be upgraded to 18'' RCP.

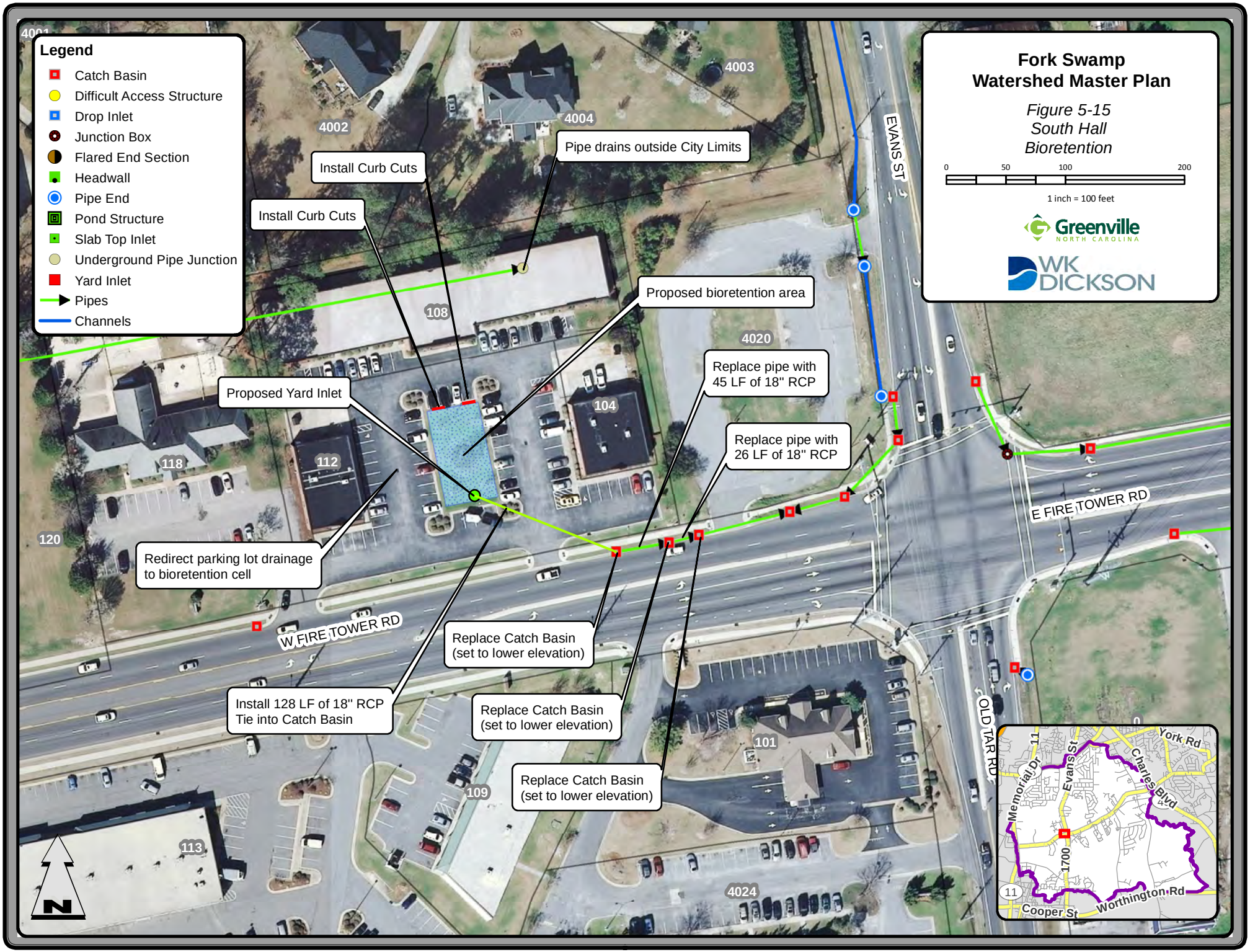
Picture 5-22. Proposed Location for South Hall Bioretention Area

The required surface area for the proposed bioretention is approximately 3,500 square feet (0.07 acres). A concept level plan of the proposed improvements is shown in Figure 5-15.

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent lot and road. The impervious area draining to the proposed pond is approximately 1.5 acres.
- Install a yard inlet with an 18" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on public property. The estimated construction cost for the bioretention area at South Hall is $240,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-15
South Hall
Bioretention
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
Install Curb Cuts
Install Curb Cuts
Pipe drains outside City Limits
Proposed bioretention area
Proposed Yard Inlet
Replace pipe with
45 LF of 18" RCP
Replace pipe with
26 LF of 18" RCP
Redirect parking lot drainage
to bioretention cell
Replace Catch Basin
(set to lower elevation)
Replace Catch Basin
(set to lower elevation)
Replace Catch Basin
(set to lower elevation)
Install 128 LF of 18" RCP
Tie into Catch Basin
EVANS ST
E FIRE TOWER RD
W FIRE TOWER RD
OLD TAR RD
4001
4002
4003
4004
4020
4024
101
104
108
109
112
113
118
120
York Rd
Charles Blvd
Evans St
Memorial Dr
1700
Worthington Rd
Cooper St
11

Fork Swamp Water Quality Project #9: Paramore Park Wetland

A stormwater wetland is proposed in the open area of Paramore Park behind the Sheffield subdivision near Albion Drive and East Fire Tower Road (See Picture 5-24). This area drains residential lots and streets and is located on public park property. A sewer easement runs parallel with the stream, which would provide access but the may require additional coordination with GUC. The wetland would function best by allowing flow from Fork Swamp (to the west) to be directed into the wetland for treatment and storage during larger storm events, and then be discharged back into the stream. This technique is known as 'anabranching' and ideally does not impact normal base flow limiting permanent impacts to the stream. The proposed location for the wetland may also be used as a beneficial place for habitat, education, and improved water quality.

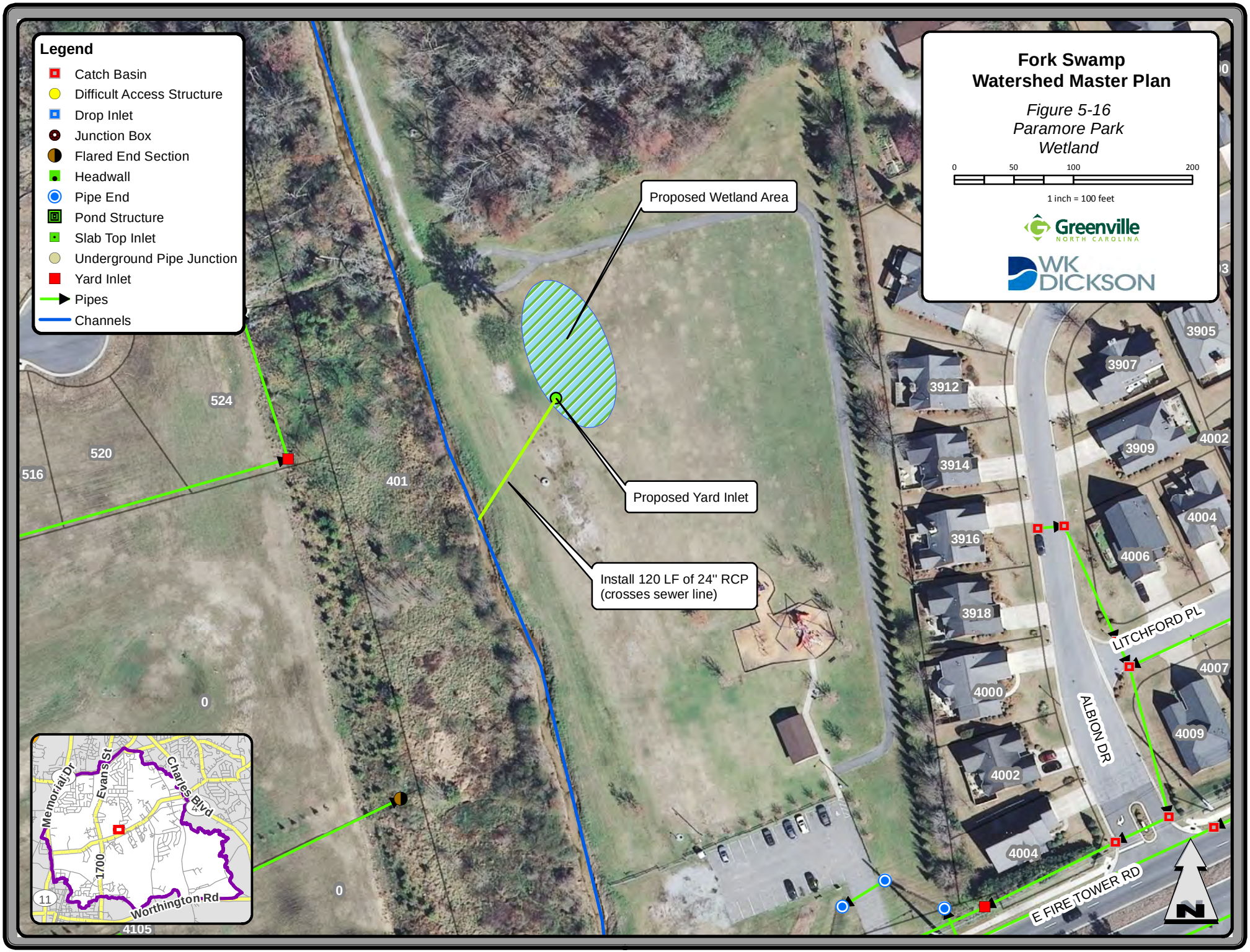
Picture 5-24. Proposed Location for Paramore Park Wetland

The required surface area for the proposed wetland is approximately 6,000 square feet (0.14 acres). A concept level plan of the proposed improvements is shown in Figure 5-16.

The proposed wetland project consists of the following improvements:

- Install a wetland designed to treat runoff from the adjacent lot and road. The proposed impervious areas draining to the proposed pond is approximately 1.6 acres.
- Install a yard inlet with a 24" outfall pipe (or natural channel design with equivalent conveyance) directing flow into an existing conveyance system (stream).

The proposed water quality project is located on City property. The estimated construction cost for the wetland at Paramore Park is $210,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-16
Paramore Park
Wetland
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
Proposed Wetland Area
Proposed Yard Inlet
Install 120 LF of 24" RCP
(crosses sewer line)
524
520
516
401
0
4105
3905
3907
3912
3909
4002
3914
4004
3916
4006
3918
4000
4007
4009
4002
4004
LITCHFORD PL
ALBION DR
E FIRE TOWER RD
Memorial Dr
Evans St
Charles Blvd
1700
Worthington Rd
11
N

Fork Swamp Water Quality Project #10: WGP Properties Regenerative Stormwater Conveyance

A Regenerative Stormwater Conveyance (RSC) system is proposed at the outlet of an 18'' RCP behind the Irish Creek subdivision off Slaney Loop (See Picture 5-25). This area drains a four-lane street (East Fire Tower Road), a small parking lot, and part of a large commercial parking lot. The primary constraint to this location is a sewer cleanout and line that would need to be avoided or relocated. The RSC will primarily provide water quality benefits by slowing and infiltrating runoff prior to its discharge into Fork Swamp.

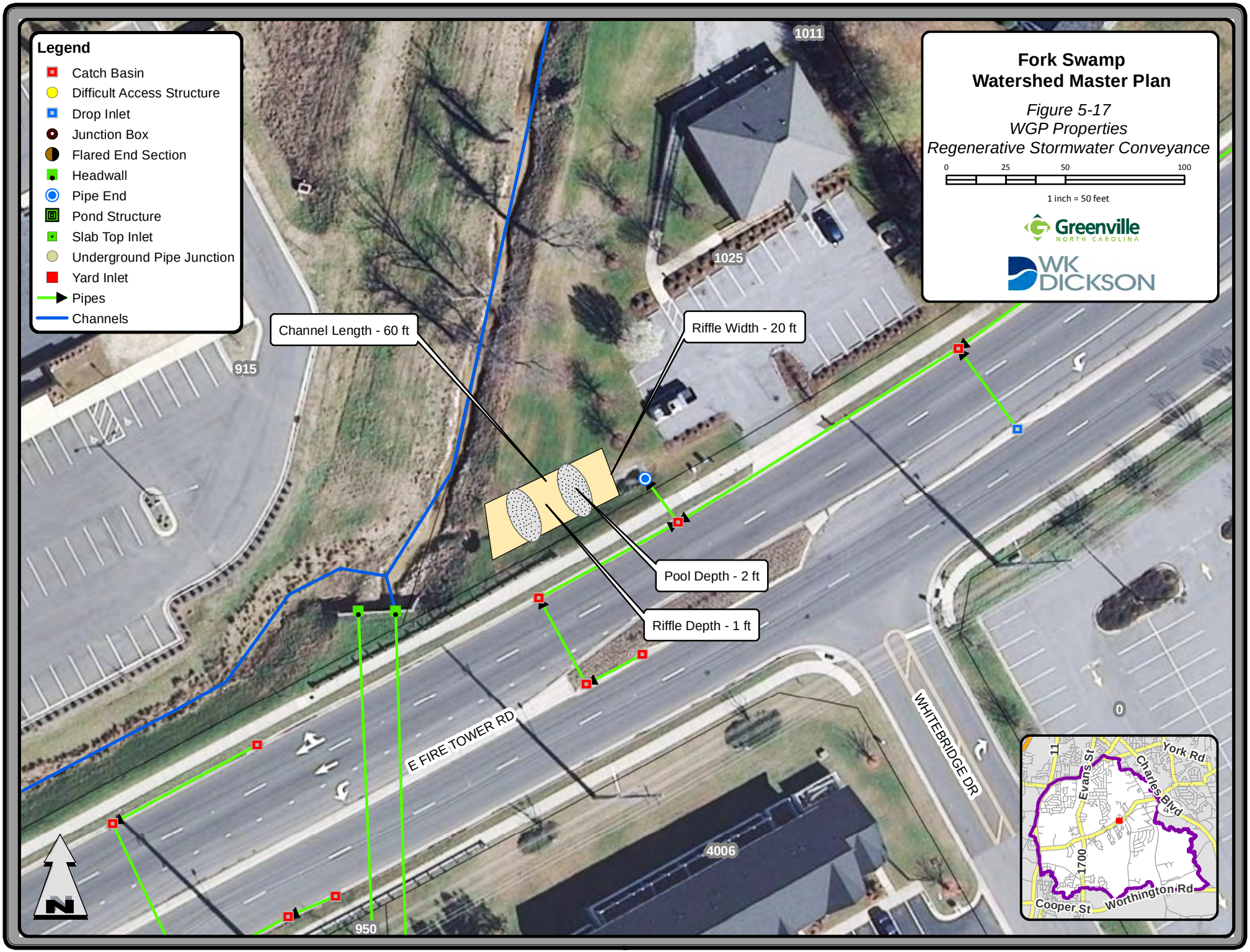
Picture 5-25. Proposed Location for WGP Properties RSC

The required surface area of the RSC is 1,200 square feet. A concept level plan of the proposed improvements is shown in Figure 5-17.

The proposed RSC project consists of the following improvements:

- Install RSC channel designed to treat runoff from the adjacent lots and road. The proposed impervious areas draining to the enhanced channel is approximately 1.8 acres.
- Excavate step pools and install required boulders, cobbles, and infiltration media. The quantities are specified in Appendix I.

The proposed water quality project is located on private property. In order to construct the RSC, an easement agreement would be required with the owner. The estimated construction cost for the RSC at WGP Properties is $60,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-17
WGP Properties
Regenerative Stormwater Conveyance
0
25
50
100
1 inch = 50 feet
Greenville
NORTH CAROLINA
WK DICKSON
Channel Length - 60 ft
Riffle Width - 20 ft
Pool Depth - 2 ft
Riffle Depth - 1 ft
E FIRE TOWER RD
WHITEBRIDGE DR
1011
1025
915
4006
950
0
N
York Rd
Charles Blvd
Evans St
1700
Cooper St
Worthington Rd

Fork Swamp Water Quality Project #11: Wintergreen Elementary Bioretention

The following three projects are all located at Wintergreen Elementary School. Each of the BMP's have unique benefits and costs, which can be discussed with the School System and Administration to determine the most appropriate BMP for the school.

A bioretention area is proposed in the open space adjacent to the parking lot for Wintergreen Elementary on County Home Road (See Picture 5-26). This area has been graded into what appears to be an infiltration basin with a yard inlet at the lower end draining to the nearby stream. The existing drainage infrastructure has enough elevation to excavate a bioretention area and tie-in at existing elevations. The area is next to the school parking lot and main building, therefore landscaping maintenance may be necessary. Some curb cuts are included to facilitate directing parking lot runoff to the area. There are no known utility conflicts in the area. The bioretention area will primarily provide water quality benefits by attenuating runoff prior to its discharge into Fork Swamp.

Picture 5-26. Proposed Location for Wintergreen Elementary Bioretention Area

The required surface area for the proposed bioretention is approximately 6,000 square feet (0.14 acres). A concept level plan of the proposed improvements is shown in Figure 5-18.

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent lot and road. The proposed impervious areas draining to the proposed pond is approximately 0.65 acres.
- Install a yard inlet with a 24" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on public property. The estimated construction cost for the bioretention area at Wintergreen Elementary is $310,000.

Fork Swamp Water Quality Project #12: Wintergreen Elementary Regenerative Stormwater Conveyance

A Regenerative Stormwater Conveyance (RSC) system is proposed at the outlet of a 48'' RCP behind Wintergreen Elementary off County Home Road (See Picture 5-27). This area drains the school parking lot, runoff from school buildings, athletic fields, and County Home Road. The proposed location will cross a sanitary sewer line, which may present a conflict when daylighting the existing pipe. The proposed design will remove 135 LF of 48'' RCP and grade the RSC channel in its place. The yard inlet will be removed and replaced with the appropriate 48'' pipe end and headwall. Located on school property, this installation may be an opportunity for water quality education. The RSC will primarily provide water quality benefits by slowing and infiltrating runoff prior to its discharge into Fork Swamp.

Picture 5-27. Proposed Location for Wintergreen Elementary RSC

The required surface area of the RSC is 4,200 square feet. Some existing pipe segments may need to be shortened or removed. A concept level plan of the proposed improvements is shown in Figure 5-18.

The proposed RSC project consists of the following improvements:

- Install RSC channel designed to treat runoff from the adjacent lots and road. The proposed impervious areas draining to the enhanced channel is approximately 9.3 acres.
- Excavate step pools and install required boulders, cobbles, and infiltration media. The quantities are specified in Appendix I.

The proposed water quality project is located on County property. The estimated construction cost for the RSC at Wintergreen Elementary is $180,000.

Fork Swamp Water Quality Project #13: Wintergreen Elementary Rainwater Harvesting

A Rainwater Harvesting (RWH) system is proposed for the front office building of Wintergreen Elementary (See Picture 5-28). There are six downspouts on the far left building that would drain into the proposed system. Some retrofits may be required to facilitate drainage into the cistern. Additional considerations for the design phase would be the intended use of the reclaimed water, which has a large impact on sizing. Located on school property and near the front of the building, this location would be ideal for water quality education. This system will collect rooftop runoff and provide water quality benefits by capturing and reusing the runoff or allowing for a slower discharge to FSUT1.

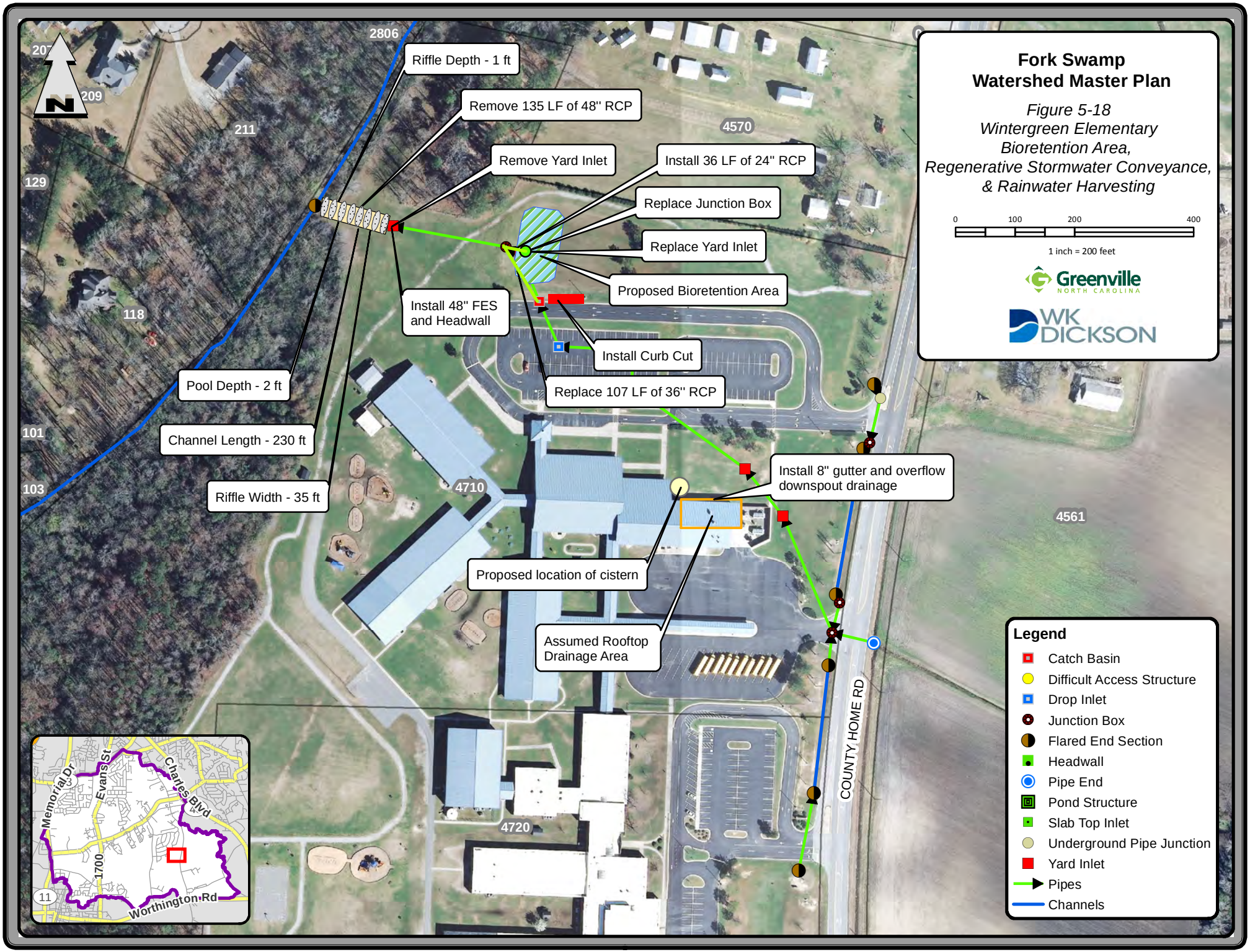
Picture 5-28. Proposed Location for Wintergreen Elementary Rainwater Harvesting

The required volume of the RWH cistern is approximately 3,000 gallons. This estimate will vary depending on the intended use of the stored rainwater. A concept level plan of the proposed improvements is shown in Figure 5-19.

The proposed RWH project consists of the following improvements:

- Install RWH cistern at building location shown in Figure 5-18. The contributing rooftop area is approximately 4,800 square feet (0.11 acres).
- Install gutter system according to Appendix I calculations.

The proposed water quality project is located on County property. The estimated construction cost for the RWH at Wintergreen Elementary is $20,000.


Fork Swamp
Watershed Master Plan
Figure 5-18
Wintergreen Elementary
Bioretention Area,
Regenerative Stormwater Conveyance,
& Rainwater Harvesting
0
100
200
400
1 inch = 200 feet
Greenville
NORTH CAROLINA
WK DICKSON
Riffle Depth - 1 ft
Remove 135 LF of 48" RCP
Remove Yard Inlet
Install 36 LF of 24" RCP
Replace Junction Box
Replace Yard Inlet
Proposed Bioretention Area
Install 48" FES and Headwall
Install Curb Cut
Replace 107 LF of 36" RCP
Pool Depth - 2 ft
Channel Length - 230 ft
Riffle Width - 35 ft
Install 8" gutter and overflow downspout drainage
Proposed location of cistern
Assumed Rooftop Drainage Area
COUNTY HOME RD
2806
4570
4710
4561
4720
Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Memorial Dr
Evans St
Charles Blvd
1700
Worthington Rd

Fork Swamp Water Quality Project #14: Belle Meade Apartments Wetland

A stormwater wetland is proposed in the open area behind the Belle Meade Apartments near Shadowood Court and East Fire Tower Road (See Picture 5-29). This area drains apartment buildings and parking lots, residential lots, and streets. The proposed location is very flat, and includes a channel for private drainage from the apartment parking lot to Fork Swamp. The project could be combined with the proposed floodplain benching on FSUT3 to maximize water quality and quantity benefits. The existing city infrastructure can be reconfigured to direct flow into the wetland for treatment very easily. The site has fairly good access via the Belle Meade parking lot and there do not appear to be any utility conflicts. The wetland will primarily provide water quality benefits by attenuating runoff prior to its discharge into Fork Swamp.

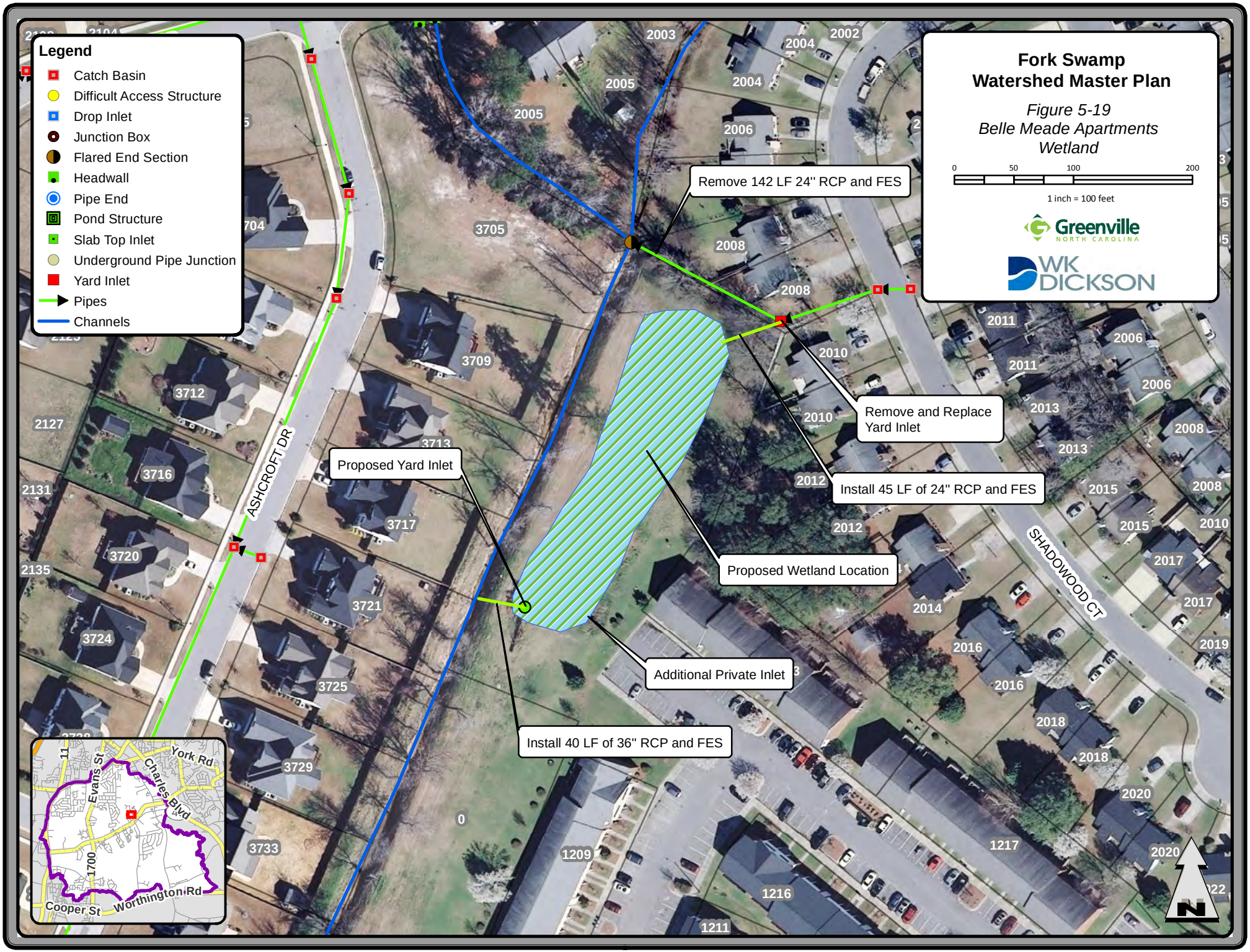
Picture 5-29. Proposed Location for Belle Meade Apartments Wetland

The required surface area for the proposed wetland is approximately 17,700 square feet (0.41 acres). A concept level plan of the proposed improvements is shown in Figure 5-19.

The proposed wetland project consists of the following improvements:

- Install a wetland designed to treat runoff from the adjacent lot and road. The proposed impervious areas draining to the proposed pond is approximately 6.1 acres.
- Remove 24'' existing storm sewer pipe and FES and install 45 LF of 24'' RCP and FES positioned to drain into the proposed wetland.
- Install a yard inlet with a 36" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on City property. The estimated construction cost for the wetland at Belle Meade Apartments is $570,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-19
Belle Meade Apartments
Wetland
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
Remove 142 LF 24" RCP and FES
Remove and Replace
Yard Inlet
Proposed Yard Inlet
Install 45 LF of 24" RCP and FES
Proposed Wetland Location
Additional Private Inlet
Install 40 LF of 36" RCP and FES
ASHCROFT DR
SHADOWOOD CT
York Rd
Evans St
Charles Blvd
1700
Cooper St
Worthington Rd
N

Fork Swamp Water Quality Project #15: Greenville Convention Center Permeable Pavement

A permeable pavement system is proposed in the open area behind the Greenville Convention Center on SW Greenville Boulevard (See Picture 5-30). This area drains the parking lots and some rooftop runoff from the building. If the City has plans to expand the parking area, permeable pavement should be considered as the most appropriate BMP to treat parking lot run-off. To further enhance this area, there is also the option to include bioretention in parking lot islands (not included in this concept plan). The permeable pavement system will primarily provide water quality benefits by attenuating runoff prior to its discharge into Fork Swamp.

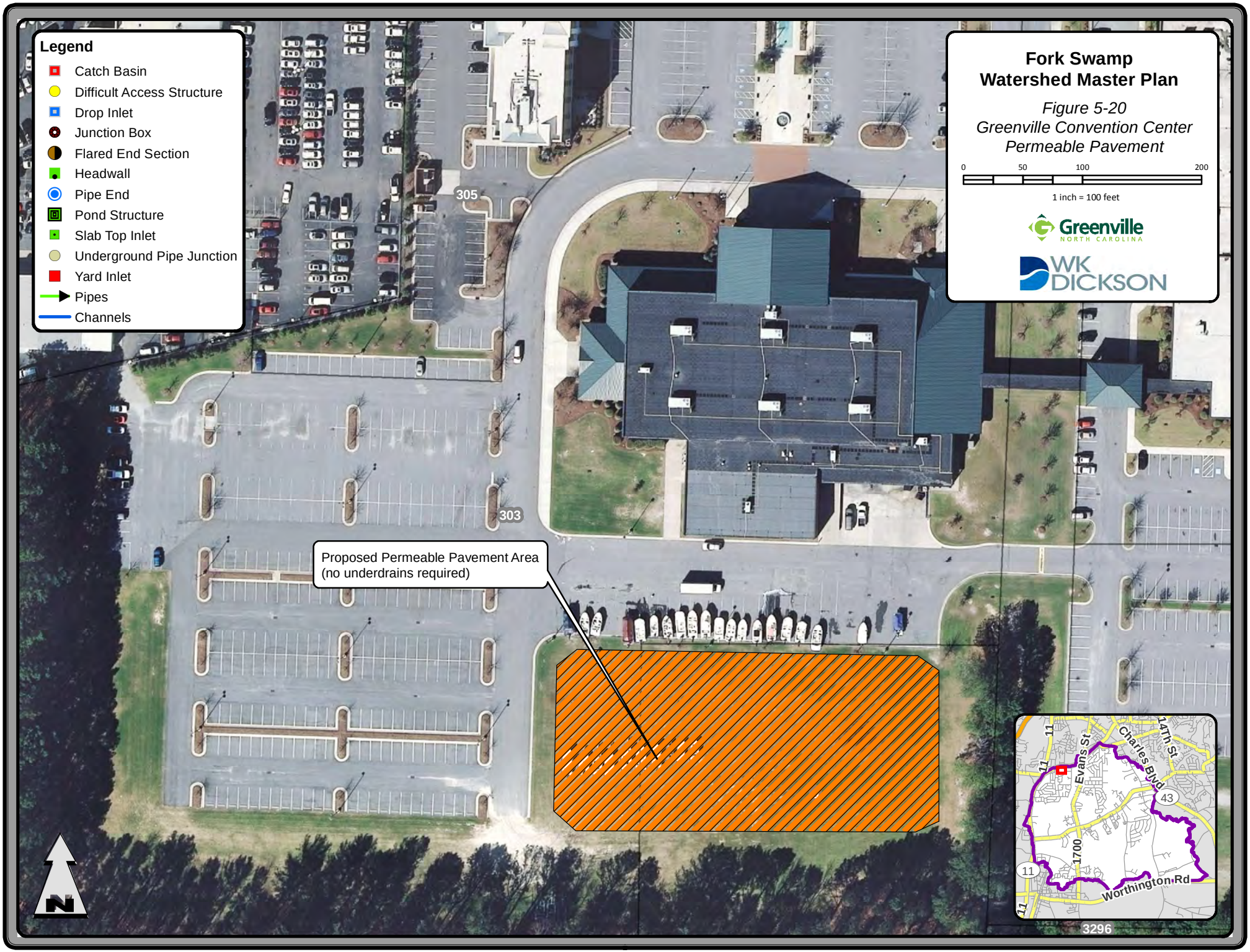
Picture 5-30. Proposed Location for Greenville Convention Center Permeable Pavement

The required surface area for the proposed parking lot is approximately 47,400 square feet (1.1 acres). A concept level plan of the proposed improvements is shown in Figure 5-20.

The proposed permeable pavement project consists of the following improvements:

- Install 3.5-inch-thick permeable pavers over 2 inches of bedding layer, 4 inches of base aggregate, and 6 inches of gravel casing. Underdrains are not required for this design.
- The impervious area draining to the proposed pond is approximately 2.9 acres.

The proposed water quality project is located on City property. The estimated construction cost for the permeable pavement system at the convention center is $2,870,000. While the cost of this BMP is substantial, the actual additional cost for permeable pavement would be reduced if the City intends on adding parking. These BMPs are only recommended as part of a parking add-on and not an independent retrofit.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-20
Greenville Convention Center
Permeable Pavement
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
305
303
Proposed Permeable Pavement Area
(no underdrains required)
N
Evans St
Charles Blvd
14Th St
43
1700
11
Worthington Rd
3296

Fork Swamp Water Quality Project #16: Lynndale Court Bioretention

A bioretention area is proposed in the common area in the landscaped portion of the Gaylord office park on Lynndale Court (See Picture 5-31). The existing drainage infrastructure has enough elevation to excavate a bioretention area and tie in at existing elevations. The area is the entrance to an office park, therefore landscaping maintenance may be necessary. Curb cuts are included to facilitate directing parking lot runoff to the area. There are some utility conflicts in the area to be avoided such as a fire hydrant and sewer cleanouts. There are two water meter boxes that can be relocated. The bioretention area will primarily provide water quality benefits by attenuating runoff prior to its discharge into FSUT3.

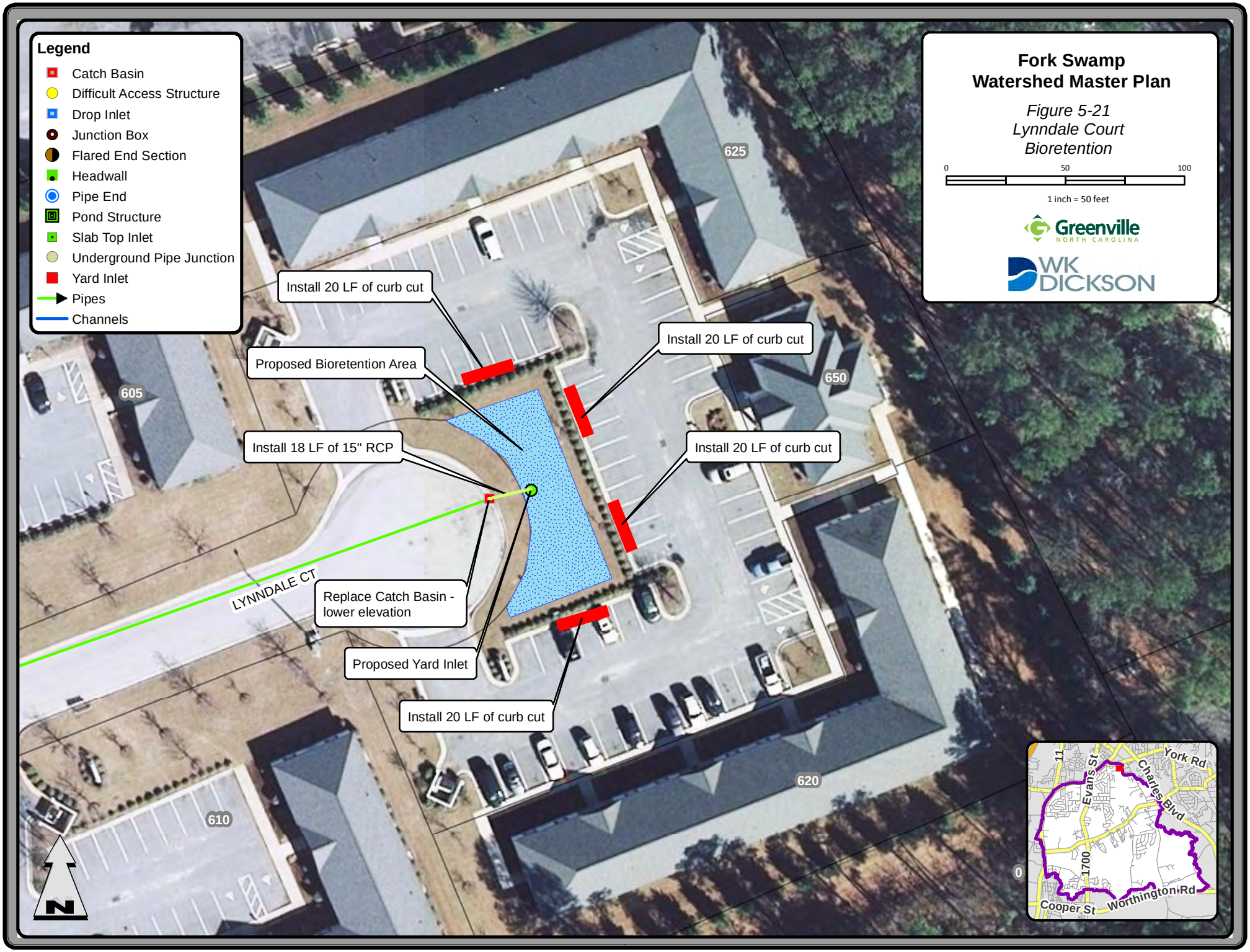
Picture 5-31. Proposed Location for Lynndale Court Bioretention Area

The required surface area for the proposed bioretention is approximately 2,500 square feet (0.06 acres). A concept level plan of the proposed improvements is shown in Figure 5-21.

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent lot and road. The proposed impervious areas draining to the proposed pond is approximately 1.05 acres.
- Install a yard inlet with a 15" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on public property. The estimated construction cost for the bioretention area at Lynndale Court is $150,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Fork Swamp
Watershed Master Plan
Figure 5-21
Lynndale Court
Bioretention
0
50
100
1 inch = 50 feet
Greenville
NORTH CAROLINA
WK DICKSON
Install 20 LF of curb cut
Proposed Bioretention Area
Install 20 LF of curb cut
Install 18 LF of 15" RCP
Install 20 LF of curb cut
LYNNDALE CT
Replace Catch Basin - lower elevation
Proposed Yard Inlet
Install 20 LF of curb cut
625
650
605
620
610
N
York Rd
Evans St
Charles Blvd
1700
Cooper St
Worthington Rd

Fork Swamp Water Quality Project #17: Westhaven South Wetland

A water quality wetland is proposed in the open area south of Cedarhurst Road in the Westhaven subdivision (See Picture 5-32). This area drains several residential lots and some street runoff from Cedarhurst Road. The proposed location is currently used as a community park, but can be enhanced with the addition of the wetland, concrete walkway, and educational signage. There are no known utility conflicts, and the site is accessible through either Cedarhurst Road or Loudon Court. A large wet pond is located upstream of the proposed location, which may present an opportunity to retrofit or treat in series. For concept level design, the wetland has been evaluated as a stand-alone treatment system. The wetland will primarily provide water quality benefits by attenuating runoff prior to its discharge into Fork Swamp.

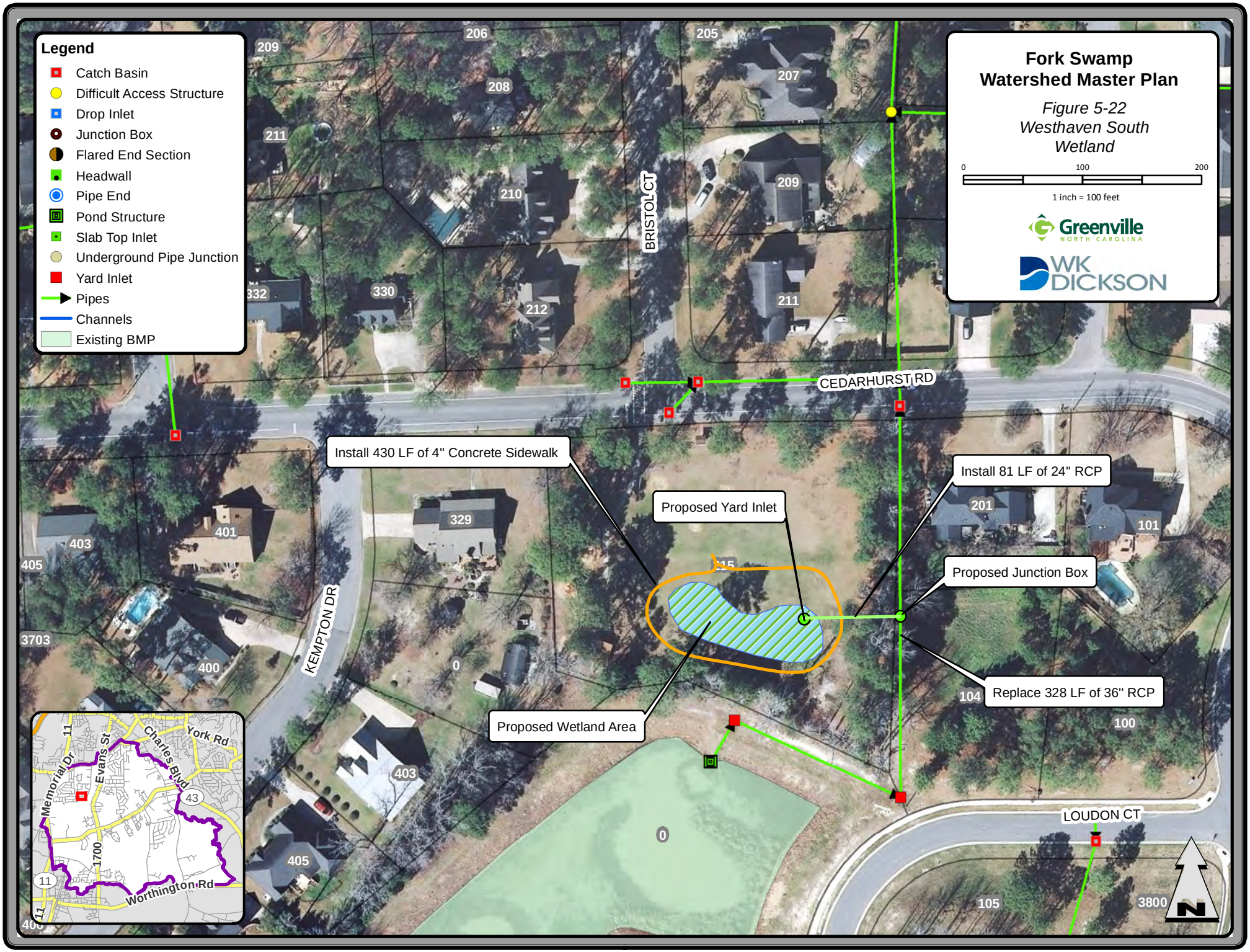
Picture 5-32. Proposed Location for Westhaven South Wetland

The required surface area for the proposed wetland is approximately 4,500 square feet (0.10 acres). A concept level plan of the proposed improvements is shown in Figure 5-22.

The proposed wetland project consists of the following improvements:

- Install a wetland designed to treat runoff from the adjacent lot and road. The impervious areas draining to the proposed pond is approximately 1.5 acres.
- Install a yard inlet with a 24" outfall pipe directing flow into an existing conveyance system.

The proposed water quality project is located on City property. The estimated construction cost for the wetland at Westhaven South is $820,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Existing BMP
Fork Swamp
Watershed Master Plan
Figure 5-22
Westhaven South
Wetland
0
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
Install 430 LF of 4" Concrete Sidewalk
Proposed Yard Inlet
Install 81 LF of 24" RCP
Proposed Junction Box
Replace 328 LF of 36" RCP
Proposed Wetland Area
CEDARHURST RD
BRISTOL CT
KEMPTON DR
LOUDON CT
206
205
209
208
207
211
210
209
332
330
212
211
329
401
403
405
3703
400
0
403
405
104
100
105
3800
York Rd
Charles Blvd
Evans St
Memorial Dr
43
1700
11
Worthington Rd

Fork Swamp Water Quality Project #18: Shamrock Regenerative Stormwater Conveyance

A Regenerative Stormwater Conveyance (RSC) system is proposed at the outlet of a 42'' RCP behind the Shamrock subdivision of Evans Street (See Picture 5-33). This area drains high density residential lots and streets. An existing buried 42'' RCP will be daylighted for the last 70 LF to incorporate the RSC. This new system will no longer require the yard inlet or 15 LF of 42'' RCP downstream and thus should be removed. The slope at the proposed location is more flat than an RSC generally is used for, however water quality benefits will be realized from the series of infiltration beds. There are no known utility conflicts. The RSC will primarily provide water quality benefits by slowing and infiltrating runoff prior to its discharge into FSUT2.

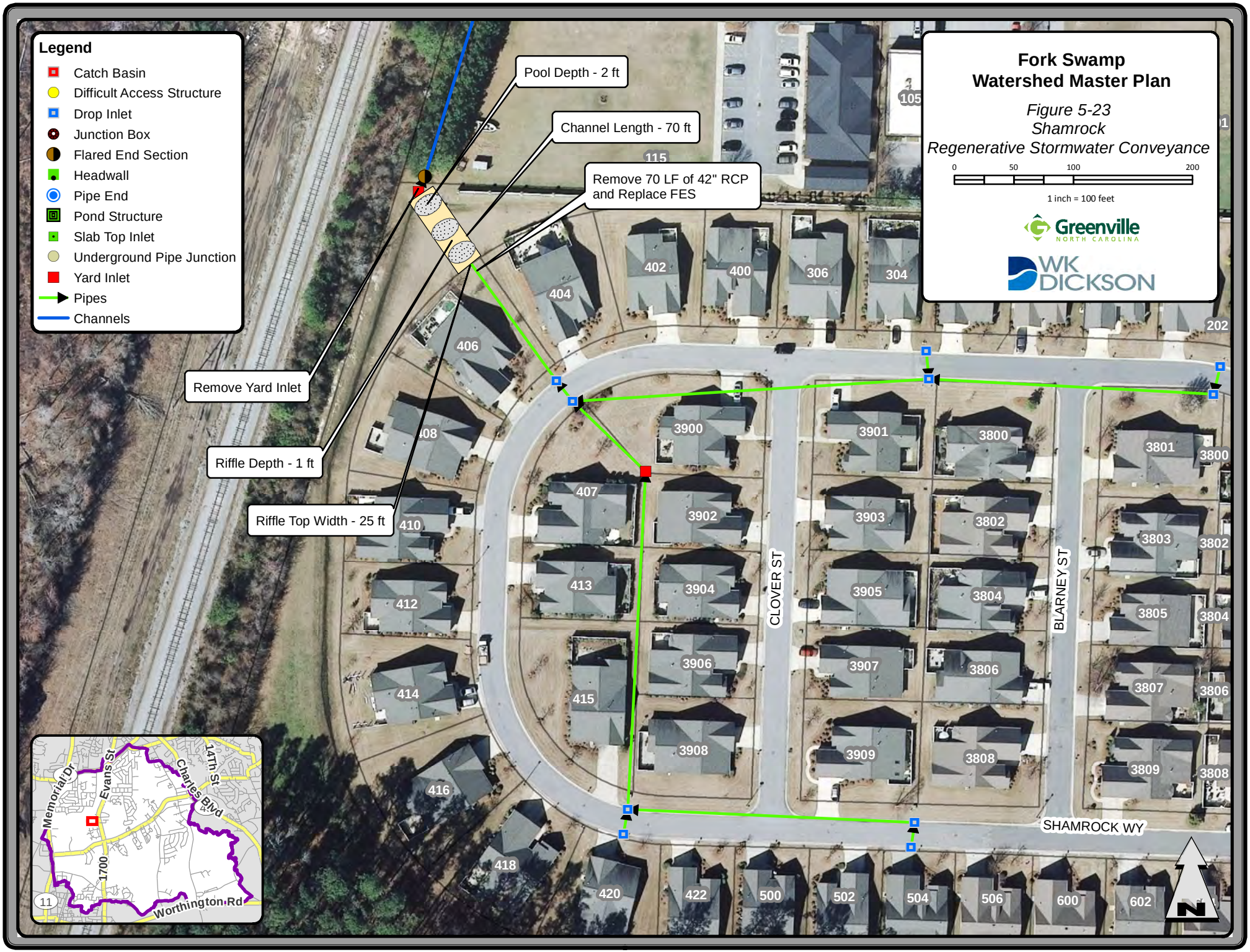
Picture 5-33. Proposed Location for Shamrock RSC

The required surface area of the RSC is 1,750 square feet. Some existing pipe may need to be removed or shortened. A concept level plan of the proposed improvements is shown in Figure 5-23.

The proposed RSC project consists of the following improvements:

- Install RSC channel designed to treat runoff from the adjacent lots and road. The proposed impervious areas draining to the enhanced channel is approximately 6.0 acres.
- Excavate step pools and install required boulders, cobbles, and infiltration media. The quantities are specified in Appendix I.

The proposed water quality project is located on public property. The estimated construction cost for the RSC at Shamrock is $130,000.


Legend
Catch Basin
Difficult Access Structure
Drop Inlet
Junction Box
Flared End Section
Headwall
Pipe End
Pond Structure
Slab Top Inlet
Underground Pipe Junction
Yard Inlet
Pipes
Channels
Pool Depth - 2 ft
Channel Length - 70 ft
Remove 70 LF of 42" RCP and Replace FES
Remove Yard Inlet
Riffle Depth - 1 ft
Riffle Top Width - 25 ft
Fork Swamp
Watershed Master Plan
Figure 5-23
Shamrock
Regenerative Stormwater Conveyance
0
50
100
200
1 inch = 100 feet
Greenville
NORTH CAROLINA
WK DICKSON
CLOVER ST
BLARNEY ST
SHAMROCK WY
Memorial Dr
Evans St
14th St
Charles Blvd
1700
Worthington Rd
11
N

5.4 NUTRIENT REMOVAL CAPACITIES

Along with determining the size and other design parameters for the proposed BMPs, nutrient removal efficiencies were calculated. Total Nitrogen (TN) and Total Phosphorous (TP) were computed based on the removal efficiencies provided in Jordan Lake Nutrient Loading Accounting Tool, version 2.0. While the Jordan Lake tool was developed specifically to address the Jordan Lake and Falls Lake Rules, the tool can apply throughout the State provided the appropriate physiographic location is used. For Greenville and Pitt County the Coastal Plain loading rates are recommended. Benefits of BMP retrofits should be revisited prior to implementation to utilize the most current research as these tools are frequently refined based on updated monitoring results and innovative technologies. The tool is available on NCDEQ website (http://portal.ncdenr.org/web/jordanlake/implementation-guidance-archive).

The tool provided the nutrient effluent concentrations and removal efficiencies for each BMP. It should be noted that the tool does not contain an entry for RSC systems, therefore the 'Sand Filter' option was used since RSCs function similarly to this BMP. Additionally, the RWH was not fully designed to determine a percent of volume reduction as this is highly dependent on the intended use of the reclaimed water. Thus, a volume reduction of 90% was assumed for the system as an intended use has not yet been determined. The percent reduction has a direct effect on the concentration of nutrients in runoff. The calculated removal efficiencies are provided in the table below.

Table 5-1: Proposed BMP Pollutant Removal Efficiency

Project	TN Removed (lb/ac/yr)	TP Removed (lb/ac/yr)
Project #1 – Cromwell Drive Bioretention	3.61	1.19
Project #2 – H. Boyd Lee Park Bioretention	4.46	1.60
Project #3 – H. Boyd Lee Park Permeable Pavement	8.62	3.79
Project #4 – Faith Assembly Church Pond Retrofit	1.86	0.99
Project #5 – County Home Road Regenerative Stormwater Conveyance	1.68	0.89
Project #6 – Irish Creek Regenerative Stormwater Conveyance	1.98	1.21
Project #7 – The Oaks Regenerative Stormwater Conveyance	2.70	1.89
Project #8 – South Hall Bioretention	9.97	3.87
Project #9 – Paramore Park Wetland	2.34	1.38
Project #10 – WGP Properties Regenerative Stormwater Conveyance	4.13	2.95
Project #11 – Wintergreen Elementary Bioretention	4.65	1.63
Project #12 – Wintergreen Elementary Regenerative Stormwater Conveyance	2.63	1.59
Project #13 – Wintergreen Elementary Rainwater Harvesting	10.18	1.41
Project #14 – Belle Meade Apartments Wetland	3.22	2.15
Project #15 – Greenville Convention Center Permeable Pavement	1.73	0.79
Project #16 – Lynndale Court Bioretention	7.63	3.35
Project #17 – Westhaven South Wetland	4.11	1.61
Project #18 – Shamrock Regenerative Stormwater Conveyance	3.02	1.94

PUBLIC EDUCATION AND OUTREACH

Successful implementation of the Fork Swamp Watershed Master Plan and stormwater as a whole requires extensive public education and outreach. The City has taken important steps in public outreach within the Fork Swamp watershed through the use of direct mail questionnaires, web-based applications, and public meetings. Questionnaires were mailed to residents throughout the watershed in August of 2014 requesting feedback on flood-prone areas and any water quality concerns. Compiled results of the questionnaires can be found in Appendix D.

A public meeting was held on November 4, 2014, to introduce the project and facilitate further feedback from the public. The initial public feedback is critical to identifying flood-prone areas and validating model results. A follow-up was held on November 17, 2015 to share results of the Master Plan with the public. As selected projects proceed into design and construction continuous public outreach will be critical to the success of the projects. Additional public meeting and individual property owner meetings will help educate property owners on the benefits of the proposed projects as well as the temporary and permanent impacts from construction.

Aside from the public education and outreach completed for projects specific to the Fork Swamp Watershed Master Plan, the City has several programs dedicated to educating the public about water quality and pollution. The City's website provides information about the Stormwater Program and the development of the Stormwater Utility and associated fees. Another outreach measure that could be considered would be to target those City residents that live adjacent to streams. For this select group, quarterly newsletter could be mailed presenting information regarding the importance of not illegally discharging item (e.g. yard waste, car batteries, and other miscellaneous debris) into the stream. The newsletter should encourage the residents to keep the stream clean and report any blockage.

A different approach could be coordinating with local schools to teach the students about age appropriate stormwater issues. There are many benefits to teaching children about stormwater issues including the students relaying the information to their parents. A presentation could be done in conjunction with an afternoon spent visiting and cleaning up a nearby stream. Adding an educational BMP near a school and park would be another outreach opportunity. The projects proposed at Wintergreen Elementary School and Paramore Park would be an example. This along with the previously mentioned newsletter could be included in the Public Education section of the City's Action Report and Plan that must be completed annually to meet the requirements of the Neuse River Basin stormwater program.

ANTICIPATED PERMITTING

The proposed improvements described in Section 4 may require local, State, and/or Federal permits or approvals prior to the onset of construction. Based on the types of projects identified in the Fork Swamp watershed, permits or approvals may be required for any of the following reasons:

- Stream and/or wetland impacts;
- FEMA floodway impacts;
- Land disturbance; and
- Potable water and sewer line adjustments.

The permitting matrix shown in Table 7-1 shows the different types of permits that are anticipated for each of the proposed flood control projects. The water quality retrofits may require erosion control permits if the area of disturbance is greater than 1.0 acres, but permits or agreements from DWR, USACE, FEMA, and NCDOT are not anticipated for these projects.

The types of 404/401 permits are described below and may vary based on the length of stream impacts and/or acreage of wetland impacts. Wetlands will need to be delineated to determine the acreage of impacts. Permit requirements for a given project may change based on the final design and any changes to the existing regulations. The appropriate permitting agencies should be contacted during the design process to determine if permits will be required for the proposed project.

7.1 NORTH CAROLINA DIVISION OF WATER RESOURCES 401 WATER QUALITY CERTIFICATION AND US ARMY CORPS 404 PERMIT

Proposed improvements within the City of Greenville must adhere to the requirements set forth in Section 401 and 404 of the Clean Water Act. Required permitting can range from activities that are pre-authorized to those requiring pre-construction notification (PCN) for a Nationwide Permit (NWP) to those requiring an Individual Permit (IP). Individual permits may be required for projects with stream impacts greater than 300 feet and wetland impacts greater than 0.5 acres. It is anticipated that NWP #3 (Maintenance) and NWP #13 (Bank Stabilization) may be required to support the projects that include work within channels that are claimed jurisdictional by the US Army Corps of Engineers (USACE). Individual permits may be required for floodplain benches where significant wetland impacts may be encountered. More detailed explanations of the types of 404 permits are provided below.

NWP#3 – Maintenance

This permit authorizes the repair, replacement, or rehabilitation of any previously permitted or currently serviceable structure. A PCN is not required for minor deviations in the structure's configuration or filled area that occur as a result of changes in materials, construction techniques, or safety standards necessary to make repair or replacement, provided environmental impacts are minimal. A PCN to the USACE is required if a significant amount

of sediment is excavated/filled within the channel. NC Division of Water Resources (DWR) does not typically require a PCN for NWP #3 but usually receives one as a courtesy.
Other provisions imposed by the State of North Carolina require that culvert inverts must be buried a minimum of 1-foot below the streambed for culverts greater than or equal to 48 inches in diameter to allow low flow passage of water and aquatic life. Culverts less than 48 inches in should be buried to a depth of 20 percent or greater of the culvert's diameter.

7.2 INDIVIDUAL PERMITS

Individual permits are required when stream or wetland impacts do not meet the conditions of a nationwide permit. Permit applications may be reviewed by multiple agencies including but not limited to USACE, DWR, EPA, SHPO, NCWRC, and USFWS. The application is also made available for public review. There is no defined timeline for review of the application for an IP; therefore, the permitting process for an IP is typically significantly longer that the review time for a NWP. Typically, 404 and 401 Individual Permits are applied for jointly and their review is concurrent.

7.3 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

Streams with a drainage area greater than one square mile are typically modeled and mapped by FEMA for flood insurance purposes. The 100-year floodway and floodplain has been mapped for the following segments of stream:

- Fork Swamp from approximately 0.4 mile upstream of East Fire Tower Road to its confluence with the Swift Creek;
- FSUT1 from Corey Road to its confluence with Fork Swamp;
- FSUT2R1 from Old Tar Road to its confluence with Fork Swamp; and
- FSUT23 from approximately 0.2 miles downstream of East Fire Tower Road – D/S to its confluence with Fork Swamp.

Any proposed projects that will include grading within a FEMA defined floodway will require a Conditional Letter of Map Revision (CLOMR) submitted to FEMA for pre-approval purposes and a Letter of Map Revision (LOMR) upon completion of construction. Table 7-1 identifies projects where FEMA permitting is expected.

7.4 EROSION AND SEDIMENTATION CONTROL

North Carolina Department of Environmental Quality (NCDEQ) is another agency that requires notification before proposed activities are constructed. NCDEQ requires that an erosion and sedimentation control plan be submitted to the Land Quality Section for approval before the start of construction for any disturbance greater than one acres. Erosion and Sedimentation permits are anticipated for most of the proposed projects as shown in Table 7-1.

Table 7-1: Permitting Matrix for Proposed Projects

	FEMA	NCDEQ /NPDES	404/401 (NWP)	404/401 (IP)	NCDOT	RAILROAD
PRIMARY SYSTEM PROJECTS						
Railroad Floodplain Benching and Stream Stabilization (Fork Swamp)		X	X			
Evans Street Culvert Replacement and Floodplain Benching (Fork Swamp)		X	X		X	
East Fire Tower Road Floodplain Benching and Stream Stabilization (Fork Swamp)	X	X	X			
Fork Swamp Main Branch Floodplain Benching (Fork Swamp)	X	X	X			
Trafalgar Drive – South Floodplain Culvert (FSUT1)		X	X			
Trafalgar Drive – North Culvert Replacement (FSUT1)		X	X			
Corey Road Floodplain Culverts and Benching (FSUT1)	X	X	X		X	
County Home Road Floodplain Culverts and Benching (FSUT3)		X	X		X	
East Fire Tower Road – U/S Floodplain Culvert (FSUT3)		X	X		X	
Wimbledon Drive Culvert Replacement and Floodplain Benching (FSUT3)		X	X			
Tower Place Culvert Replacement (FSUT3)		X	X			
Summerhaven Drive Culvert Replacement and Floodplain Benching (FSUT3)		X	X			
East Fire Tower Road – D/S Floodplain Benching and Stream Stabilization (FSUT3)	X	X	X		X	
SECONDARY SYSTEM PROJECTS						
Corey Road		X			X	
Lynndale Closed System Phase I		X				
Lynndale Closed System Phase II		X				
Lynndale Closed System Phase III		X				
STREAM STABILIZATION PROJECTS						
Project #1 – Live Oak Lane	X	X	X			
Project #2 – Corey Road	X	X	X			
Project #3 – East Fire Tower Road		X	X			
Project #4 – Tower Place		X	X			

	FEMA	NCDEQ /NPDES	404/401 (NWP)	404/401 (IP)	NCDOT	RAILROAD
Project #5 – Charles Boulevard		X	X			
Project #6 – Queen Annes Road		X	X			
Project #7 – Evans Street		X	X			
WATER QUALITY PROJECTS						
Project #1 – Cromwell Drive Bioretention		X				
Project #2 – H. Boyd Lee Park Bioretention		X				
Project #3 – H. Boyd Lee Park Permeable Pavement		X				
Project #4 – Faith Assembly Church Pond Retrofit		X				
Project #5 – County Home Road RSC		X				
Project #6 – Irish Creek RSC		X				
Project #7 – The Oaks RSC		X				
Project #8 – South Hall Bioretention		X				
Project #9 – Paramore Park Wetland		X				
Project #10 – WGP Properties RSC		X				
Project #11 – Wintergreen Elementary Bioretention		X				
Project #12 – Wintergreen Elementary RSC		X				
Project #13 – Wintergreen Elementary Rainwater Harvesting		X				
Project #14 – Belle Meade Apartments Wetland		X				
Project #15 – Greenville Convention Center Permeable Pavement		X				
Project #16 – Lynndale Court Bioretention		X				
Project #17 – Westhaven South Wetland		X				
Project #18 – Shamrock RSC		X				

FUNDING OPPORTUNITIES

8.1 WATER QUALITY IMPROVEMENT FUNDING

As the final designs of the proposed improvements are evaluated, the City is encouraged to investigate the potential funding mechanisms that are available for water quality projects. There are wide range of funding mechanisms that may be available to the City. Sources include the Clean Water Act Part 319 funds administered by the US EPA and North Carolina Cleanwater Management Trust Fund (CWMTF). CWMTF funding can include land acquisition costs, design fees, and construction costs to help finance projects that improve and protect water quality. In 2014, $24.8 million to fund projects throughout North Carolina (www.cwmtf.net).

The Clean Water State Revolving Fund (CWSRF) is another option. It offers low-interest loans that can be used to find stormwater projects with water quality components. It should be noted that typically, grants require some type of match funding. The matching requirements vary for each different type of grant. For example, the CWSRF requires a 20 percent match from the State based on the amount of Federal dollars awarded while the CWMTF does not have a specified match requirement.

The NCDEQ Division of Water Resources has a Water Resources Development Project Grant Program. The program provides cost-share grants and technical assistance. The grants are offered for the following purposes: general navigation, recreational navigation, water management, stream restoration, beach protection, land acquisition, and facility development for water-based recreation and aquatic weed control. Spring 2014, the program awarded grants ranging from $1,500 to $450,000. The total awarded across thirty-seven projects/recipients was $2,240,000 (www.ncwater.org).

8.2 FLOOD MITIGATION FUNDING

FEMA's Flood Mitigation Assistance (FMA) is a pre-disaster grant program designed to provide funding to Stated and communities in their efforts to reduce or eliminate the risk of repetitive flood damage to building and structures insured under the National Flood Insurance Program (NFIP). In order to be eligible, communities must have completed and approved Flood Mitigation Plans that assess the flood risk and identify actions to reduce that risk. Any State agency, participating NFIP community, or local agency is eligible to participate and should contact community officials.

Additional project grant eligibility criteria include a project that is:

- Cost effective;
- Cost beneficial to the National Flood Insurance Fund;
- Technically feasible; and

- Physically located in participating NFIP community or reduce future flood damages in an NFIP community.

A project must also comply with (1) the minimum standards of the NFIP Floodplain Management Regulations, (2) the applicant's Flood Mitigation Plan, and (3) all applicable laws and regulations. The State is the grantee and program administrator for FMA. FEMA distributes FMA funds to States that in turn provide funds to communities. FEMA may provide up to 75% of the total eligible costs. The remaining costs must be provided by a non-Federal source of which no more than half can be provided as in-kind contributions from third parties.

8.3 REVENUE AND GENERAL OBLIGATION BONDS

Municipalities in North Carolina have the authority to use binding for capital improvement projects under the State's General Statues. There are two types of bonds available for use – general obligation and revenue bonds. General obligation bonds are funds received after voter approval of bond referendum. A vote is required because general obligation bonds are secured using the City's taxing power. All revenues, including different taxes, can be used to pay off a general obligation debt. Revenue bonds, on the other hands, are backed by income generated by the City through fees collected (e.g., various utility fees including stormwater). Because their security is not as great as that of general obligation bonds, revenue bonds may carry a slightly higher interest rate.

8.4 UTILITY RATE STUDY

The City should consider completing a utility rate study to determine if the current rate is appropriate for funding the required operation of the Stormwater Division as well as capital projects. The enterprise fund was originally established in 2001 with collections beginning in 2003. In May 2013, City staff requested a fee increase of $0.50/ERU each year for the next five years to support capital projects and completion of the City-wide master plan. Currently as of July 1, 2015 the fee is $4.35 per ERU. Once planning is concluded the City should complete a detailed rate study based on the capital needs identified during the planning process.

COST ESTIMATES

The cost estimates provided as part of the Fork Swamp Watershed Master Plan were prepared to assist City staff in making planning level decisions and prioritizing improvements. These cost estimates are not final design cost estimates. These costs were developed using recent bid tabulations from other communities and NCDOT projects within North Carolina. They include easement acquisitions, surveying, engineering, legal, and administrative costs. A detailed breakdown of the costs for the projects listed below in Table 9-1 is included in Appendix G. Projects are not listed based on priority. See Section 10 for a prioritization list. The cost estimates are approximate and are subject to change due to local costs, materials, delivery, construction, and other factors. BMP costs are based on the size of the BMP, the estimated excavation requires, and any associated structure of planting costs.

The stormwater drainage systems evaluated in this report are composed of a series of culverts, closed drainage systems, open channels, floodplain grading, and BMPs. For these drainage systems to function as designed, they must be properly maintained.

Table 9-1: Preliminary Project Cost Estimates

Projects	Preliminary Project Cost
PRIMARY SYSTEM PROJECTS	
Railroad Floodplain Benching and Stream Stabilization (Fork Swamp)	$1,000,000
Evans Street Culvert Replacement and Floodplain Benching (Fork Swamp)	$1,920,000
East Fire Tower Road Floodplain Benching and Stream Stabilization (Fork Swamp)	$1,740,000
Fork Swamp Main Branch Floodplain Benching (Fork Swamp)	$5,240,000
Trafalgar Drive – South Floodplain Culvert (FSUT1)	$180,000
Trafalgar Drive – North Culvert Replacement (FSUT1)	$440,000
Corey Road Floodplain Culverts and Benching (FSUT1)	$6,870,000
Corey Road Regional Detention (FSUT1)	$9,500,000
County Home Road Floodplain Culverts and Benching (FSUT3)	$210,000
East Fire Tower Road – U/S Floodplain Culvert (FSUT3)	$680,000
Wimbledon Drive Culvert Replacement and Floodplain Benching (FSUT3)	$610,000
Tower Place Culvert Replacement (FSUT3)	$640,000
Summerhaven Drive Culvert Replacement and Floodplain Benching (FSUT3)	$650,000
East Fire Tower Road – D/S Floodplain Benching and Stream Stabilization (FSUT3)	$4,000,000
SECONDARY SYSTEM PROJECTS	
Corey Road	$370,000

Lynndale Closed System Phase I	$1,010,000
Lynndale Closed System Phase II	$3,420,000
Lynndale Closed System Phase III	$2,750,000
STREAM STABILIZATION PROJECTS	
Project #1 – Live Oak Lane	$280,000
Project #2 – Corey Road	$590,000
Project #3 – East Fire Tower Road	$230,000
Project #4 – Tower Place	$140,000
Project #5 – Charles Boulevard	$90,000
Project #6 – Queen Annes Road	$220,000
Project #7 – Evans Street	$130,000
WATER QUALITY PROJECTS	
Project #1 – Cromwell Drive Bioretention	$350,000
Project #2 – H. Boyd Lee Park Bioretention	$340,000
Project #3 – H. Boyd Lee Park Permeable Pavement	$970,000
Project #4 – Faith Assembly Church Pond Retrofit	$270,000
Project #5 – County Home Road Regenerative Stormwater Conveyance	$490,000
Project #6 – Irish Creek Regenerative Stormwater Conveyance	$250,000
Project #7 – The Oaks Regenerative Stormwater Conveyance	$200,000
Project #8 – South Hall Bioretention	$240,000
Project #9 – Paramore Park Wetland	$210,000
Project #10 – WGP Properties Regenerative Stormwater Conveyance	$60,000
Project #11 – Wintergreen Elementary Bioretention	$310,000
Project #12 – Wintergreen Elementary Regenerative Stormwater Conveyance	$180,000
Project #13 – Wintergreen Elementary Rainwater Harvesting	$20,000
Project #14 – Belle Meade Apartments Wetland	$570,000
Project #15 – Greenville Convention Center Permeable Pavement	$2,870,000
Project #16 – Lynndale Court Bioretention	$150,000
Project #17 – Westhaven South Wetland	$820,000
Project #18 – Shamrock Regenerative Stormwater Conveyance	$130,000

PRIORITIZATION AND RECOMMENDATIONS

As previously noted, the primary goal of this study is to make improvement recommendations to reduce flooding within the Fork Swamp Watershed. Currently, several conveyance systems do not meet the City hydraulic design requirements. WK Dickson has provided recommendations that help to reduce or eliminate the identified problems. Success criteria goals used to measure the proposed flood control project included the following:

- Providing improved level of service for roadways and structures;
- Economic feasibility;
- Minimizing stream and wetland impacts;
- Confirming physical feasibility using available GIS and survey data; and
- Minimizing easement acquisition.

Two different prioritization lists were developed for the proposed projects identified in Section 4 and 5; Flood Control Improvements and Water Quality/Stream Stabilization Improvements. Projects were prioritized using the Prioritization Matric provided in Appendix L. The improvements were prioritized based on the following factors:

- Public health and safety;
- Severity of street flooding;
- Cost effectiveness;
- Effects of improvements;
- Water quality – BMP;
- Open channel –erosion control;
- Implementation constraints;
- Grant funding; and
- Constructability.

In some instances, project prioritization will be impacted by the required sequencing of projects to provide the highest possible flood reduction benefits and to reduce or negate any downstream impacts for the proposed projects. Downstream impacts are including in the scoring for Implementation Constraints, however upon completion of the scoring process, the prioritization list should be reviewed to ensure the projects are appropriately ranked based on sequencing. Table 10-1 shows the proposed prioritizations for the Flood Control Improvements. The City should re-visit the prioritization lists annually to determine if the priorities should change.

Table 10-1: Flood Control Prioritization – Primary System Projects

Prioritization	Project
1	Railroad Crossing (Fork Swamp)
2	Summerhaven Drive (FSUT3)
3	Evans Street (Fork Swamp)
4	Trafalgar Drive - South (FSUT1)
5	County Home Road (FSUT3)
6	Tower Place (FSUT3)
7	East Fire Tower Road (Fork Swamp)
8	Trafalgar Drive - North (FSUT1)
9	Corey Road (FSUT1)
10	Wimbledon Drive (FSUT3)
11	Fork Swamp Main Branch Floodplain Benching
12	East Fire Tower Road - Downstream (FSUT3)
13	East Fire Tower Road - Upstream (FSUT3)
N/A*	Corey Road Regional Detention (FSUT1)

*This project is located outside the City limits and does not impact the need or size for other capital projects. It is only proposed to avoid increases in flows at the City limits. However, improvements will benefit residents in the City limits.

Table 10-2: Flood Control Prioritization – Secondary System Projects

Prioritization	Project
1	Lynndale Closed System Phase I
2	Lynndale Closed System Phase II
3	Lynndale Closed System Phase III
4	Corey Road Closed System

Table 10-3: Stream Stabilization Prioritization

Prioritization	Project
1	Evans Street
2	Live Oak Lane
3	Tower Place
4	Charles Boulevard
5	East Fire Tower Road
6	Queen Annes Road
N/A*	Corey Road

*This project is located in the ETJ therefore was not ranked. However, improvements will benefit residents in the City limits.

Table 10-4: Water Quality Prioritization

Prioritization	Project
1	WGP Properties Regenerative Stormwater Conveyance
2	H. Boyd Lee Park Bioretention
3	Wintergreen Elementary Rainwater Harvesting
4	Wintergreen Elementary Bioretention
5	South Hall Bioretention
6	Lynndale Court Bioretention
7	Shamrock Regenerative Stormwater Conveyance
8	Paramore Park Wetland
9	H. Boyd Lee Park Permeable Pavement
10	County Home Road Regenerative Stormwater Conveyance
11	The Oaks Regenerative Stormwater Conveyance
12	Wintergreen Elementary Regenerative Stormwater Conveyance
13	Cromwell Drive Bioretention
14	Belle Meade Apartments Wetland
15	Faith Assembly Church Pond Retrofit
16	Westhaven South Wetland
17	Irish Creek Regenerative Stormwater Conveyance
18	Greenville Convention Center Permeable Pavement

Table 10-5 shows the recommended priorities for maintenance projects in the watershed. Maintenance locations were identified based on the condition assessment completed during the stormwater inventory. Structures receiving a condition of "poor" or "repair" are listed below for maintenance. More immediate maintenance needs may present themselves if portions of a conveyance system fail. Projects were prioritized based on the consequences of flooding. Projects requiring structural improvements (i.e. in danger of failing) were given priority over those driven by sediment/vegetation removal needs. Additionally, the impact of flooding and proximity to a citizen input response were also considered in project ranking. Maintenance costs assume that City staff will complete the construction. If maintenance projects are bid to a private contractor, the City should complete a more detailed cost estimate prior to bid.

Table 10-5: Maintenance Recommendations

Prioritization	Project	Estimated Cost
1	Replace 72 LF of twin 60'' CMP - squashed pipe end near 1750 Wimbledon Drive (FSUT030360 and FSUT030361)	$64,800
2	Replace 162 LF of 15'' CMP - rusted out bottom of pipe end near 400 Queen Annes Road (FSUT030769)	$16,200
3	Replace 157 LF of 18'' CMP - rusted bottom of pipe end near 113 Westhaven Road (FSMB030272) and replace 179 LF of 24'' CMP - rusted bottom of pipe end near 107 Westhaven Road (FSMB030279)	$40,800
4	Replace 154 LF of 18'' CMP - rusted bottom of pipe end near 114 Woodstock Drive (FSMB030118) and Replace 194 LF of 15'' CMP - rusted bottom of pipe end near 100 S Baywood Lane (FSMB030121)	$26,600
5	Replace 208 LF of 15'' CMP (sinkholes) near 3906 Southampton Court (CB FSUT020148)	$20,800
6	Repair bent wing wall; replace eroded rip-rap at FES FSMB020543 near 3400 Evans Street; and replace 23 LF of 42'' CMP - crushed pipe end near 101 Sara Lane (FSMB020547)	$18,900
7	Replace box/repair 1' deep hole at bottom of drop inlet box at 3901 Clover Street (FSMB020182)	$6,000
8	Replace 236 LF of 42'' CMP - squashed pipe end near 608 Cedarhurst Road (FSMB030223)	$70,800
9	Replace/repair minor damage and exposed rebar at pipe end near 3702 Evans Street (FSMB020200)	$4,000
10	Repair broken hood/replace catch basin FSUT030560 near 3741 Charles Boulevard	$6,000
11	Repair/replace FES near 508 Chesapeake Place separated from pipe, water is flowing underneath pipe end (FSUT030641)	$4,000
12	Repair/replace FES separating from pipe near 3400 Baywood Lane (FSMB030001)	$6,000
13	Repair/replace FES separating from pipe near 201 Bristol Drive (FSMB030063)	$2,000
14	Replace 48 LF of 18'' RCP eroding around pipe end at 2074 Old Fire Tower Road (FSUT030517)	$5,300
15	Replace catch basin (sinkhole) near 3308 Landmark Street (FSMB030036)	$6,000
16	Replace catch basin (sinkhole) near 2002 Tower Place(FSUT030325)	$6,000
17	Replace catch basin (sinkhole) near 2085 E Fire Tower Road (FSUT030550)	$6,000
18	Replace yard inlets (sinkhole) near 144 Blackwater Drive (FSUT020090) and near 327 West Meath Drive (FSUT020085)	$12,000

Prioritization	Project	Estimated Cost
19	Replace yard inlet (sinkhole) near 3615 Memorial Drive (FSMB030176)	$6,000
20	Replace yard inlet (sinkhole) near 403 Bremerton Drive (FSMB020481)	$6,000
21	Replace catch basin near 209 Pin Oak Court (FSMB020135) sink holes around box	$6,000
22	Replace 134 LF of 15" CMP - rusted bottom of pipe end near 110 Hearthside Drive (FSMB030269)	$13,400
23	Replace 12 LF of 36" CMP - squashed pipe end near 301 Crestline Boulevard (FSMB030180) and Replace 19 LF of 36" CMP - squashed pipe end near 217 Crestline Boulevard (FSMB030186)	$7,400
24	Replace yard inlet (sinkhole) near 120 Fire Tower Road (FSUT020442)	$6,000
25	Replace yard inlets (sinkhole) near 1017 Van Gert Drive (FSMB010070 and FSMB010071)	$12,000
26	Replace yard inlet (sinkhole) near 4222 Dunhagan Road (FSMB020276)	$6,000
27	Replace pipe end, perched outfall recessed approximately 5' under bank near 1108 Holden Drive(FSUT030617)	$4,000
28	Repair loose lid ring and cracked lid at junction box FSMB020506 near 604 Queen Annes Road	$4,000
29	Repair loose lid ring at junction box FSMB020346 near 3505 Huntington Road	$2,000
30	Repair/replace FES separating from pipe near 3104 Amhurst Lane (FSUT030573)	$6,000
31	Replace yard inlet (sinkhole) near 4009 Lucerne Court (FSUT020327)	$6,000
32	Replace catch basin FSMB020356 near 3514 Wallingford Road, bottom eroding away	$6,000
33	Replace broken grate at catch basin FSMB010081 near 949 Van Gert Drive	$6,000
34	Replace yard inlet (sinkhole) near 3614 Gosford Gate (FSMB020410)	$6,000
35	Replace yard inlet (sinkhole) near 913 Chesapeake Place (FSMB020306)	$6,000
36	Replace catch basin (sinkhole) near 127 Greenwood Drive (FSMB030163)	$6,000
37	Replace yard inlet (sinkhole) near 4117 Bridge Court (FSUT030078)	$6,000
38	Repair channel - major erosion of bank nearing road at pipe end near 161 Keys Court (FSMB020197)	$15,000
39	Replace yard inlet near 1801 Arlington Boulevard (FSUT030531) major erosion around box	$6,000

Prioritization	Project	Estimated Cost
40	Replace missing lid at junction box near 1604 Fire Tower Road (FSUT030466)	$6,000
41	Replace missing grate at drop inlet FSUT030825, FSUT030826, FSUT030827, and FSUT030828 near 4112 Bridge Court	$24,000
42	Replace fallen grate at yard inlet near 108 Loudon Court (FSMB030085)	$3,000
43	Replace missing grate for pond structure FSMB020383 near 3870 Dunhagen Road	$7,000
44	Replace broken grate at catch basin FSMB030164 near 1604 Stone Wood Drive	$6,000
45	Replace missing lid at junction box near 1908 Exchange Drive (FSUT030434)	$6,000
46	Maintain channel near pipe end at 4410 County Home Road - fully submerged (FSUT010081 and FSUT010082)	$6,500
47	Maintain channel near pipe end at 1900 Rosemont Drive - fully submerged (FSUT030213)	$6,500
48	Dredge pipe end outlet at 401 Fire Tower Road (FSMB020242)	$2,000
49	Dredge buried pipe end at 301 Guiness Drive (FSUT020457)	$2,000
50	Clear dense vegetation in channel, obstructing pipe end of FSUT020095 near 100 Poplar Branches Circle	$1,000
51	Clear dense vegetation in channel, obstructing pipe end of FSUT020228 and FSUT020241 near 740 W Fire Tower Road	$1,000
52	Remove tree growing on top of pipe end FSMB030139 near 301 Greenwood Drive	$1,000
53	Repair water line dumping into catch basin near 3032 Rolston Road (FSUT030599)	$10,000
54	Repair waterline conflict/obstruction at junction box near 107 Pinewood Road (FSMB020527)	$10,000

REFERENCES

1. Hydraflow Storm Sewers Extension User's Guide Version 8, 2011.

2. Municipal Storm Water Management, by Debo and Reese, 1995

3. National Weather Service
   http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nc_pfds.html

4. Stormwater Best Management Practices; North Carolina Department of Environment and Natural Resources, Division of Water Quality, July 2007.

5. Urban Hydrology for Small Watersheds, United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division, Technical Release 55, June 1986.

6. Booth DB, Jackson CR (1997) Urbanization of aquatic systems: Degradation thresholds, stormwater detection, and the limits of mitigation. Journal of the American Water Resources Association 33(5):1077-1090.

7. Brant, T. R. 1999. Community Perceptions of Water Quality and Management Measures in the Naamans Creek Watershed. *Masters Thesis for the Degree of Master of Marine Policy. 146 pp.*

8. Stepenuck KF, Crunkilton RL, Wang L (2002) Impacts of urban landuse on macroinvertebrate communities in southeastern Wisconsin streams. Journal of the American Water Resources Association 38(4):1041-1051.

9. Environmental Protection Agency
   http://www.epa.gov/caddis/ssr_urb_is4.html

10. North Carolina Department of Environment and Natural Resources
    http://www.ncwater.org/Financial_Assistance/

11. NC Department of Environmental Quality - Stormwater Rules
    http://portal.ncdenr.org/web/wq/ps/nps/tarpamstorm