CITY OF GREENVILLE

Greenville
NORTH CAROLINA

Parker Creek / Johnson's Mill Run Watershed Master Plan

July 2016

FINAL REPORT

CDM Smith

CITY OF GREENVILLE

PARKERS CREEK / JOHNSONS MILL RUN WATERSHED MASTER PLAN

CDM Smith #104324

July 2016

Prepared for
City of Greenville
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The City of Greenville has retained CDM Smith to complete a Master Plan for the Parkers Creek and Johnsons Mill Run (PC/JMR) watersheds. The goals of this master plan include: (1) evaluate the watershed for 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 to reduce sediment loads as a result of erosion. To assist in achieving the goals listed above, CDM Smith also completed a stormwater infrastructure inventory for drainage structures and features within the PC/JMR watersheds.

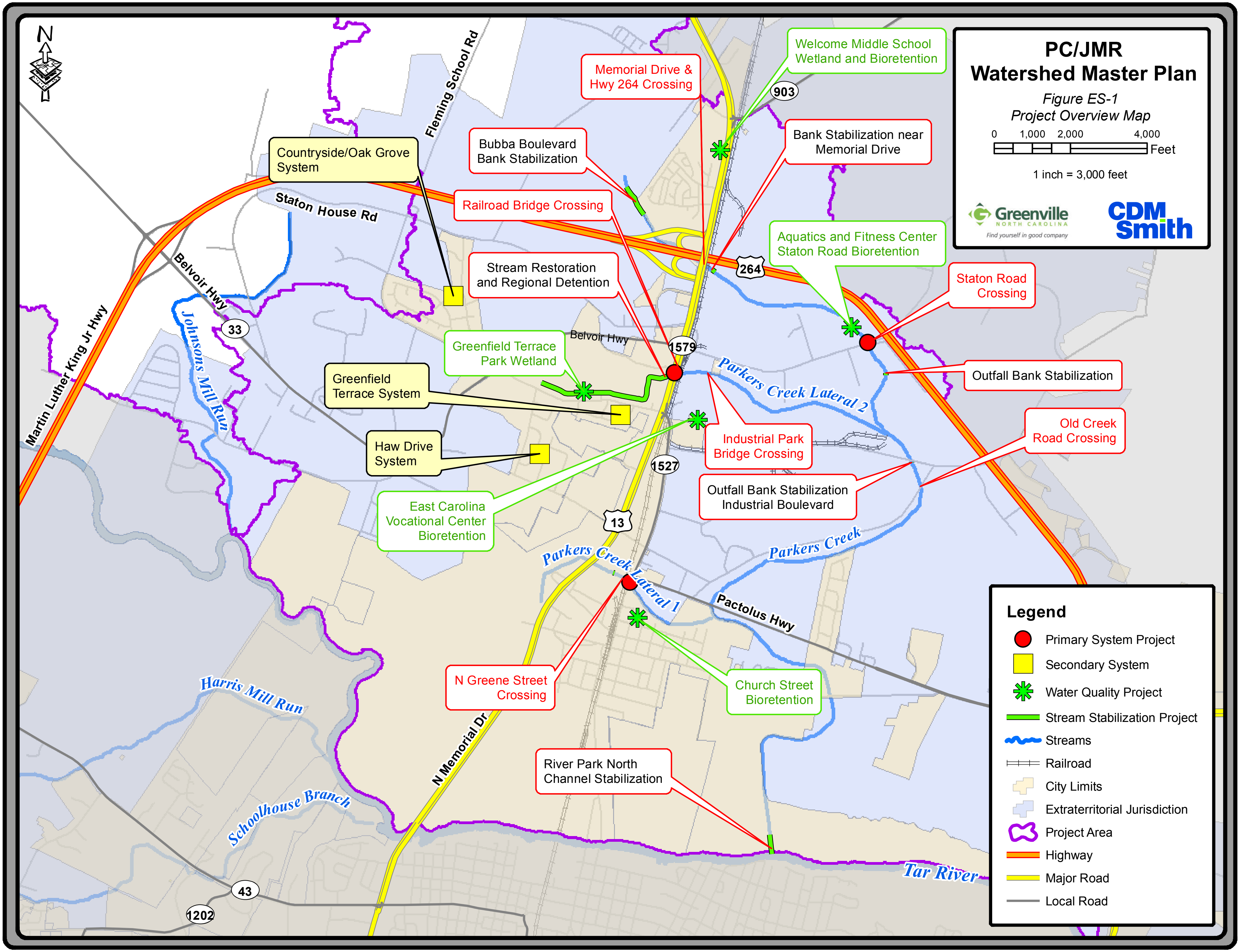
The project included a broad range of stakeholders to collect as much data, information and tacit knowledge of the watershed as possible. The general public was solicited through questionnaires mailed to all property owners in the watershed and two open house public meetings where residents and business owners were encouraged to provide feedback on stormwater issues in the watershed. CDM Smith coordinated with residents that provided site-specific drainage concerns to gather additional information that could be used to both confirm the existing system evaluation and aid in developing improvement recommendations. Information collected from the questionnaires and public meetings can be found in Section 2.1 and Appendix D. City staff served as a critical stakeholder by providing valuable information on historical flooding and erosion problems in the watershed, as well as providing feedback on potential capital improvements and the prioritization of those improvements.

Watershed Conditions

The PC/JMR project watersheds drain approximately 40 square miles and are located in the northern portion of the City. The PC/JMR watersheds share a common boundary near Fleming School Road, running north to south, with both creeks draining south into the Tar River, as shown on **Figure ES-1**. The PC watershed is generally bounded by I-264 to the east and Allpine-Taylor Road to the north. The JMR watershed is generally bounded near Porter Road to the west and US Highway 64 to the north.

The PC/JMR watersheds drain a majority of the City north of the Tar River. There are a few areas within the City limits north of the Tar River and to the east of Highway 264 that are not within these watersheds. These disconnected areas were included in the stormwater inventory, but not in the watershed master plan. Approximately 87 percent of the PC watershed is within the City's extraterritorial jurisdiction (ETJ), 24 percent in the City limits. Approximately 2 percent of the JMR watershed is within the City's ETJ, and 0.15 percent in the City limits.

The PC watershed is comprised mostly of open space with an industrial area and dispersed residential subdivisions. The Memorial Drive and N. Greene Street corridor split the north side of the City with some commercial and institutional land uses. The Tar River floodplain accounts for much of the open space in the watershed, especially since residential homes in the flood buyout zone have been abandoned following the flooding of 1997. Subdivisions such as Greenfield Terrace and Countryside Estates extend the City limits towards the northwest. The PC watershed is currently about 40 percent developed and projected to be closer to 90 percent when fully built-out according to current zoning.



PC/JMR
Watershed Master Plan
Figure ES-1
Project Overview Map
0 1,000 2,000 4,000 Feet
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
Find yourself in good company
CDM Smith
Memorial Drive & Hwy 264 Crossing
Welcome Middle School Wetland and Bioretention
Bank Stabilization near Memorial Drive
Bubba Boulevard Bank Stabilization
Countryside/Oak Grove System
Railroad Bridge Crossing
Aquatics and Fitness Center Staton Road Bioretention
Staton Road Crossing
Stream Restoration and Regional Detention
Greenfield Terrace Park Wetland
Greenfield Terrace System
Outfall Bank Stabilization
Old Creek Road Crossing
Haw Drive System
Industrial Park Bridge Crossing
Outfall Bank Stabilization Industrial Boulevard
East Carolina Vocational Center Bioretention
N Greene Street Crossing
Church Street Bioretention
River Park North Channel Stabilization
Fleming School Rd
Staton House Rd
Belvoir Hwy
Martin Luther King Jr Hwy
Johnsons Mill Run
Parkers Creek Lateral 2
Parkers Creek Lateral 1
Parkers Creek
Pactolus Hwy
Harris Mill Run
Schoolhouse Branch
N Memorial Dr
Tar River
903
264
33
1579
1527
13
43
1202
Legend
Primary System Project
Secondary System
Water Quality Project
Stream Stabilization Project
Streams
Railroad
City Limits
Extraterritorial Jurisdiction
Project Area
Highway
Major Road
Local Road

The JMR watershed is almost entirely undeveloped, with about 1 percent residential land uses and some rural uses such as agricultural and forest land uses. Current zoning allows for up to 20 percent of the watershed within the City's ETJ to be developed as residential and mixed use.

The topography of PC/JMR is very flat with the highest point within the City limits at an elevation of approximately 42 feet, all of which drains to the Tar River, which is only a few feet above sea level. The vast majority of PC and its tributaries are trapezoidal channels, which require consistent maintenance due to the flat conditions and low velocities and result in heavy sediment and debris accumulation. However, the low velocities result in generally stable channel conditions with minimal erosion.

Stormwater infrastructure throughout the watersheds was collected by survey personnel to compile a geographical information system (GIS) stormwater inventory database for the City. This was accomplished by using Global Positioning Systems (GPS) as the primary means of data capture to locate the x, y, and z coordinates of each visible stormwater system structure. Conventional surveying techniques were used to obtain other attributes such as dimensions, material, and length. The data was collected using horizontal datum NAD 1983 and vertical datum NAVD 1988. A total of 1,046 closed system structures and 15 miles of pipe were inventoried in the PC/JMR watersheds within the City limits.

Analysis

CDM Smith conducted an existing conditions analysis in order to evaluate the hydrologic and hydraulic characteristics of the PC/JMR watersheds. Noted in this report as the primary systems, the JMR main stem, PC main stem, and PC Laterals 1 and 2 were modeled as open channels with culverted and bridged crossings. There are 21 creek crossings in the PC/JMR watersheds, 10 of which are crossing a major thoroughfare and 3 crossings of a railroad. Only the Memorial Drive and N. Greene Street crossings are major thoroughfares within the City limits. The railroad crosses PC and each of its two tributaries as it runs parallel to Memorial Drive from south to north.

In addition to the primary systems, select closed pipe drainage systems that drain to PC tributaries were analyzed to determine if those systems meet the City's desired level of service (LOS), as designated in the standard operating procedure (SOP) manual. Along with City staff input, those secondary systems were identified as part of the public education and outreach efforts conducted at key milestones. Initially, the City distributed and collected questionnaires to gather citizen information on flooding and erosion issues throughout the City. Existing conditions and proposed improvements were presented to the public during open meetings. The results and comments from the citizens' input contributed to the identification and prioritization of problem areas, and the validation of model results. Based on feedback from City residents and City staff, Countryside Estates/Oak Grove, Haw Drive, and Greenfield Terrace were included as part of the secondary system analysis.

The modeling analysis consisted of hydrologic and hydraulic modeling in standard public domain software. The US Army Corps of Engineers' (USACE) HEC-HMS model was used to develop design flows for the primary systems. The USACE HEC-RAS model was used to model the channels and floodplains of the primary systems. The secondary systems were modeled in EPA's Storm Water Management Model (SWMM).

Structural flooding and roadway crossing overtopping occurs at multiple locations according to the modeling. Crossings of N. Greene Street and Memorial Drive are shown to overtop for less than a 50-year design storm and potential structures at-risk for flooding were identified in the modeled floodplains for the 25- and 100-year design storms. Existing flood stages were compared with the City's desired LOS. Proposed improvements were developed with the models to attain the designated LOS.

Regional detention was also evaluated as a solution to existing and future flooding issues. Additionally, as part of this project, 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. This evaluation yielded no such areas in PC/JMR that meet the criteria, particularly the criteria for "well documented water quantity problems".

As a result of the existing and future conditions analyses, multiple capital projects were identified to reduce the severity and frequency of flooding, stabilize stream banks, and improve water quality through stormwater treatment practices. Flood control projects were evaluated to meet the desired LOS of roadway overtopping and roadway/structure flooding. Costs for each project were estimated using approved unit costs from the SOP with engineering, administrative, and contingency costs included for construction implementation. Anticipated permitting and funding opportunities were also evaluated for each project. The proposed capital projects are as follows, with the locations of each project shown in Figure ES-1.

Flood Control Projects

Parkers Creek Main Branch Primary System

Staton Road – The Staton Road crossing of the PC main branch does not currently meet the 50-year LOS requirement, overtopping during storm events greater than the 25-year. The crossing currently includes twin 7 foot (ft) diameter corrugated metal pipe. In order to meet the 50-year LOS, the existing culvert should be replaced with twin 9 ft by 9 ft reinforced concrete box culverts (RCBC). It should be noted that the crossing is outside the City limits, but within the ETJ.

Structural Flooding – Several industrial and commercial buildings are located within the 100-year floodplain for PC, based on GIS topography. In order to eliminate the structural flooding, a 60-acre regional detention pond is required, at a cost of approximately $24 million.

Parkers Creek Lateral 1 Primary System

N. Greene Street – The N. Greene Street crossing of PC Lateral 1 does not currently meet the 50-year LOS requirement, overtopping during storm events greater than the 25-year. The crossing currently includes a 7 ft by 5 ft RCBC. In order to meet the 50-year LOS, the existing culvert should be replaced with twin 7 ft by 7 ft RCBCs. It should be noted that the existing culvert appears to be in good condition based on a preliminary visual inspection. There may be an opportunity to reduce project cost by adding a second culvert to the existing, instead of replacing.

Parkers Creek Lateral 2 Primary System

Memorial Drive and Railroad Crossing – The Memorial Drive and railroad crossing of PC Lateral 2 are presented together herein due to their close proximity to each other, approximately 20 feet apart. The crossing of Memorial Drive does not currently meet the 50-year LOS requirement, overtopping during storm events greater than the 25-year. The railroad crossing currently includes three 66-inch diameter reinforced concrete pipe (RCP) culverts and meets the 100-year level of service. It should be noted that the second and third culverts beneath the railroad were installed in 2015. The Memorial Drive crossing currently includes twin 8.5 ft by 5 ft elliptical culverts. However, one of the culverts is currently sealed closed, reportedly to manage flows without causing damage to the immediate downstream railroad crossing.

In order to meet the 50-year LOS, the closed 8.5 ft by 5 ft elliptical culvert should be opened and four 5 ft diameter RCPs should be installed. As an alternative to the additional RCPs, an arch spanned bridge could be utilized. A corresponding increase in capacity of the railroad crossing at this location is also required to achieve the 50-year LOS. Downstream flooding will not be significantly affected by the reduction in storage according to the modeling.

It is recommended that the closed 8.5 ft by 5 ft elliptical culvert be opened now, regardless of whether the other improvements are implemented concurrently. Memorial Drive is currently the bottleneck in the system and the additional culvert capacity will reduce upstream flood elevations, even for smaller storm events. This is important because the Greenfield Terrace neighborhood, which is upstream of Memorial Drive, experiences consistent flooding during small storm events, due in part to the Memorial Drive crossing.

Johnsons Mill Run Primary System

There were no primary or secondary system flooding issues identified through modeling or by citizens in JMR besides residential structures identified in the modeled floodplain associated with the existing conditions of 25-year and 100-year magnitude storm events. Due to the size and undeveloped status of the watershed, upstream improvements are not recommended to mitigate potential flood impacts.

Secondary Systems

Countryside/Oak Grove Estates – Drainage issues, including standing water in the road and ditches along residential yards, have been reported in this area. The Countryside subdivision drains to the west through a culvert under Fleming School Road and to the east beneath Oak Grove Avenue and Glenda Street. Neither the east or west culverts in conjunction with the respective downstream ditches are capable of conveying the 2-year design storm, let alone the 10-year designated LOS. However, the more immediate issues for the residents are associated with standing water occurring with smaller, more frequent rain events. At the end of Old Village Road, standing water is attributed to blockage of the downstream ditch in the County Drainage

District jurisdiction. On both the east and west sides of the area the downstream ditches are maintained by the County Drainage District. On the west side, flooding in District 12484 at the end of Old Village Road is attributed to blockage of the downstream ditch on private property. Low flows are not moving through the ditch and are backing up water all the way to Old Village Road. Removal of vegetation, trash, and sediment are required to maintain this ditch clear to allow drainage of Old Village Road.

Flooding of Oak Grove Avenue is expected during large storms as the system is only able to convey less than the 2-year storm without overtopping the roadway. However, the most frequent and visible issue is poor roadway drainage with standing water in the roadway caused by damaged, uneven, and uncrested pavement associated with original construction and installation of a sewer line beneath the road.

Modeling results of the Countryside- Oak Grove Avenue System indicate that meeting the 10-year LOS is feasible through extensive infrastructure improvements to the existing system. To address regular standing water, roadway improvements along Oak Grove Avenue are recommended to improve drainage along this roadway and direct runoff to the existing drainage system and avoid standing water. Due to the flatness of the area, elliptical pipes are required to attain capacity to convey the runoff from the neighborhood for the 10-year LOS storm with a minimum of 1 foot of ground cover over the pipes. Additionally, widening of the downstream channel is required to alleviate street overtopping flooding conditions for the 10-year LOS storm.

Greenfield Terrace – Issues associated with blockage of the drainage system along Greenfield Boulevard have made this area of greatest public concern in the PC watershed. Maintenance clearing of the blocked stormwater pipe outfalls in 2015 at the ditch to the north has alleviated the roadway flooding occurring on a regular basis. To achieve the designated 10-year LOS, modeled improvements include local pipe upsizing, storage, and the primary system culvert improvements at Memorial Drive. These improvements, once implemented are expected to eliminate flooding for up to the 10-year LOS event, however, surcharging will remain for the 10-year event. Surcharging where the drainage system is full above the top of the pipes and near the top of structures has the potential to cause damage by eroding the layer of soil above the pipes through the joints between the pipes.

- Local Pipe Upsizing: The existing pipe system requires larger diameter pipe to adequately convey runoff from the 10-year design storm from the streets to the downstream ditch.

- Storage: A 13-acre (566,300 cubic feet) detention pond at Greenfield Park was modeled to store the volume entering the system at the peak of the 10-year design storm. The pond will reduce the flood stage for the 10-year storm by nearly 0.5 feet. The pond will alleviate flooding by reducing the peak stage just enough to keep it below the surface of the drainage system on Greenfield Boulevard.

- Primary System Improvements at Memorial Drive: The proposed primary system improvements for Memorial Drive will attain the 50-year design storm LOS without overtopping and almost entirely eliminate any backwater caused by this crossing for smaller design storms.

The above improvements will meet the desired LOS of the drainage system; however, it will not prevent surcharging of the system due to high backwater conditions. Even with the improvements at Memorial Drive, local pipe upsizing, and storage in Greenfield Terrace Park, the flood stage during the 10-year LOS storm will be at an estimated elevation of 22.6 feet—which is just below the surface of Greenfield Boulevard—with the rim of the catch basin at the intersection of Greenfield Boulevard and Beechwood Drive at 22.7 feet.

Haw Drive/E Catawba Road – The existing E Catawba Road drainage system does not meet a 2-year LOS according to the modeling and residents have reported roadway and yard flooding. Recurrent flooding was attributed to blockage of the local drainage system and this problem was fixed by a City roads maintenance crew. However, the system does not meet the desired 10-year LOS and has experienced frequent roadway flooding, also affecting multiple residential yards. A significant portion of the drainage system is currently located in backyards between E Catawba Road and Haw Drive. The system is limited by the downstream capacity of the ditch across the airport property and the local pipe drainage system for larger storms.

The proposed improvements to meet the designated LOS will include new pipes and inlets along E Catawba Road to direct runoff to a conveyance system within the City right-of-way which will more easily facilitate future maintenance of the system and improve the LOS. Proposed pipe improvements range in size from 18-inch RCP to 24-inch RCP. In some locations with limited cover, twin elliptical 24-inch RCPs are proposed. The addition of a connecting drainage feature on the airport property to allow drainage to the south is also required to achieve drainage for this system. Cooperation with the City-owned airport is needed to implement the downstream connection to ensure adequate drainage for larger, less frequent storm events.

Flood Control Prioritization

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

- Public health and safety
- Severity of street flooding
- Cost-effectiveness
- Effect of improvements
- Water quality best management practices (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 greatest possible flood reduction benefits and to reduce or negate any downstream impacts from the proposed projects. While both alternatives are shown for some projects, it is acknowledged that only one of the two alternatives would need to be constructed. Once an alternative has been selected, the remaining alternative for the same project can be removed from the prioritization list. **Table ES-1** shows the proposed prioritizations and conceptual cost estimates for the Flood Control Improvements. The prioritization scoring for each project and a description of the aforementioned categories is included in Appendix M. The total cost for the recommended primary improvements and the secondary system improvements is approximately $3.2 million. Projects outside the City limits or on private property, as identified in the report, are not included in the City's prioritization for inclusion in the list of Capital Improvement Projects for implementation.

Table ES-1: Flood Control Prioritization

Prioritization	Project	Cost
1	Memorial Drive Crossing (Parkers Creek Lateral 2)	$1,170,000
2	Countryside/Oak Grove System (Parkers Creek Lateral 2)	$580,000
3	Greenfield Terrace System (Parkers Creek Lateral 2)*	$5,340,000
4	Haw Drive/Airport System (Parkers Creek Lateral 2)	$330,000
5	N. Greene Street Crossing (Parkers Creek Lateral 1)	$650,000
	Total	$3,180,000

Note: Staton Road and regional detention improvement projects are outside the City limits and are therefore not included in project prioritization for City Capital Improvement Projects.

* Greenfield Terrace System LOS improvements include drainage pipe replacements ($450,00) and detention storage ($4,890,000) in conjunction with Memorial Drive culvert replacement.

Stream Stabilization and Water Quality Project Prioritization

During the existing conditions analysis, the primary system streams were quantitatively assessed for stability. Based on this assessment, six stream stabilization/enhancement projects were identified, as shown in Figure ES-1, three of which are inside the City limits and included in the prioritized list. Components of the stabilization projects include flattening the slope of the channel banks, installing erosion control matting and plantings, and installing rock/log grade control structures. The stabilization projects will protect stream banks from further erosion, prevent wetlands from draining by channel degradation, and substantially decrease the instream sediment loads to downstream receiving waters.

In addition to the stream stability projects, water quality BMP retrofit projects were also identified. Potential project locations were initially identified using available GIS data by focusing on locations with contributing drainage areas that are highly impervious and on publically-owned land. Impervious areas typically generate the highest concentration of pollutants, therefore treating the runoff from these areas would provide more pollutant removal 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 inspected to determine if the site conditions were conducive to a BMP. This inspection typically included verifying that GIS data and aerial photography were accurate and to determine if there were project constraints present that may not be visible from GIS data, such as utility conflicts, private property conflicts, or limited access to the site. If possible, retrofit projects were located on public property to reduce land acquisition costs. Of the nine initial candidate BMP sites evaluated, five are included in the water quality prioritization. The other projects were not selected for further evaluation due to physical constraints or private ownership following discussion with City staff.

The stream stabilization projects and water quality retrofit projects were prioritized using similar categories as the flood control projects. Cost-effectiveness for stream stabilization projects was calculated based on a cost per linear foot of stabilized stream. Cost-effectiveness for water quality retrofit projects was calculated based on a cost per impervious acre treated. **Tables ES-2** and **ES-3** show the prioritization of the stream stabilization and water quality projects, along with preliminary cost estimates, respectively. Additionally, several recommended maintenance locations were identified throughout the watershed, as listed in Section 10. The maintenance items are based on the condition assessment completed during the stormwater inventory and stream assessment.

Table ES-2: Stream Stabilization Prioritization

Prioritization	Project	Cost
1	River Park North Channel Stabilization	$200,000
2	Parkers Creek Bubba Boulevard	$270,000
3	Greenfield Terrace Park Bank and Buffer Enhancement	$150,000
	Total	$620,000
Notes: Other projects identified outside the City limits are not included in project prioritization for City Capital Improvement Projects.		

Table ES-3: Water Quality Prioritization

Prioritization	Project	Cost
1	Welcome Middle School Wetland	$150,000
2	Greenfield Terrace Park Water Quality Wetland	$220,000
3	Staton Road Aquatics and Fitness Center Bioretention	$120,000
4	East Carolina Vocational Center Wet Pond	$140,000
5	Church Street Wetland	$200,000
	Total	$830,000

1.1 Project Description

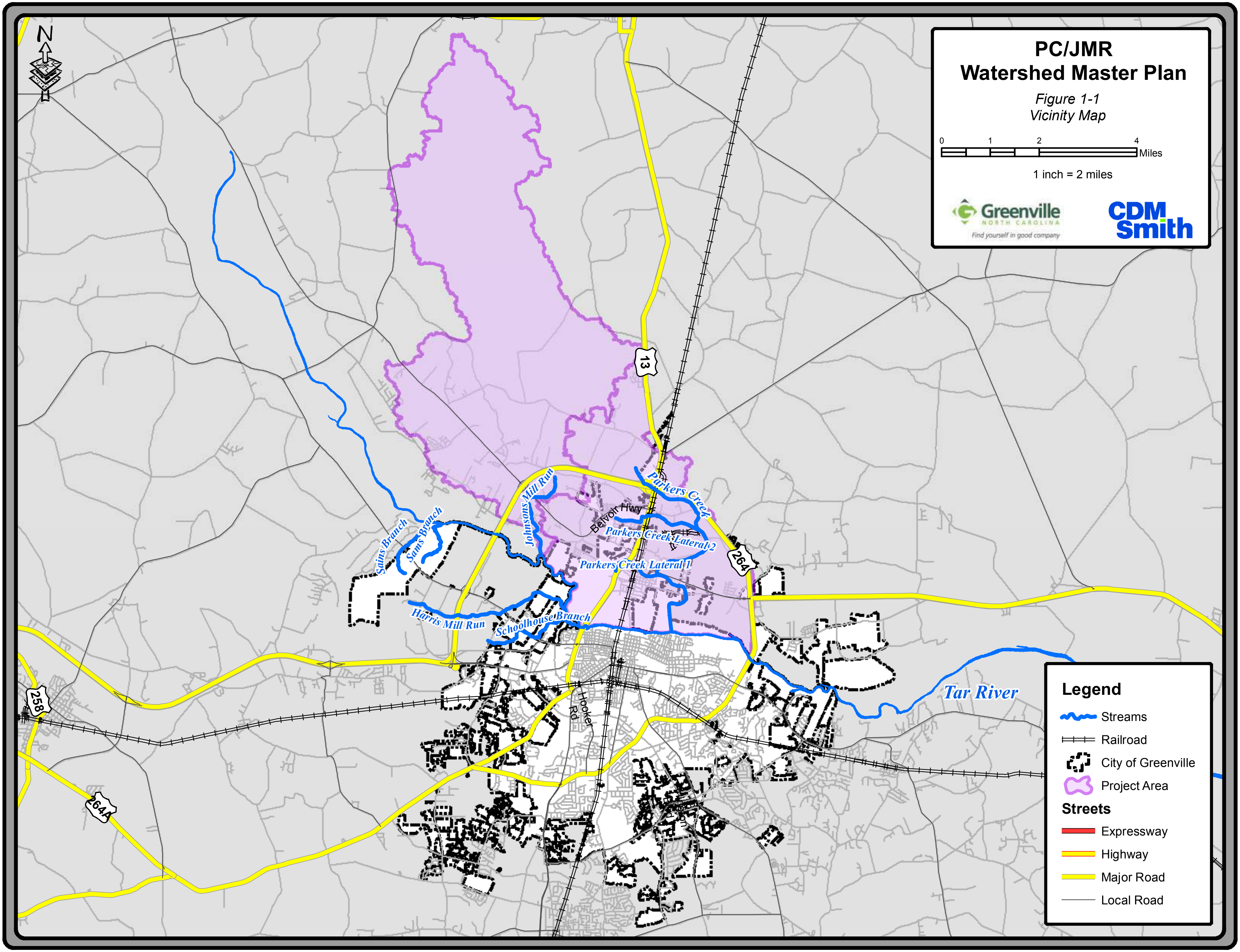
The City of Greenville has retained CDM Smith to complete a Watershed Master Plan for the Parkers Creek and Johnsons Mill Run watersheds, collectively referred to as the PC/JMR Watershed. As shown in **Figure 1-1**, the PC/JMR Watershed is located in the northern portion of Greenville and generally drains from north to south discharging to the Tar River.

The goals of this master plan include: (1) evaluate the watershed for 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 to reduce sediment loads as a result of erosion. To assist in achieving the goals listed above, CDM Smith also completed a stormwater drainage infrastructure inventory for drainage structures and features within the PC/JMR watersheds. The Master Plan includes an evaluation of Parkers Creek from its confluence with the Tar River at the downstream end to approximately 1,700 feet upstream of the Highway 264 northwest access entrance ramp and Johnsons Mill Run from its confluence with the Tar River at the downstream end to approximately 2,800 feet upstream of Mount Pleasant Church Road, as well as several conveyance systems that drain to these two streams. For the purposes of this report, the main stems of Parkers Creek and two tributaries and Johnsons Mill Run will be noted as primary systems and the conveyance systems that drain to them will be noted as secondary systems. A project area map showing the PC/JMR 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 – Parkers Creek
  - Mumford Road Culvert
  - Pactolus Highway Culvert
  - Farm Culverts (2)
  - Old Creek Road Bridge
  - Industrial Boulevard Bridge
  - Station Road Culvert
  - Railroad Bridge
  - Memorial Drive and Highway 264 Culvert
  - Highway 264 Entrance Ramp Culvert

- Primary System – Parkers Creek Tributary 1
  - N. Greene Street Culvert
  - Railroad Bridge
  - Memorial Drive Culverts

- Primary System – Parkers Creek Tributary 2
  - Private crossing (bridge)
  - Railroad Bridge
  - Memorial Drive Culverts
  - Greenfield Agricultural Field Culvert
  - Greenfield Park Entrance


PC/JMR
Watershed Master Plan
Figure 1-1
Vicinity Map
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1 inch = 2 miles
Greenville
NORTH CAROLINA
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Streams
Railroad
City of Greenville
Project Area
Streets
Expressway
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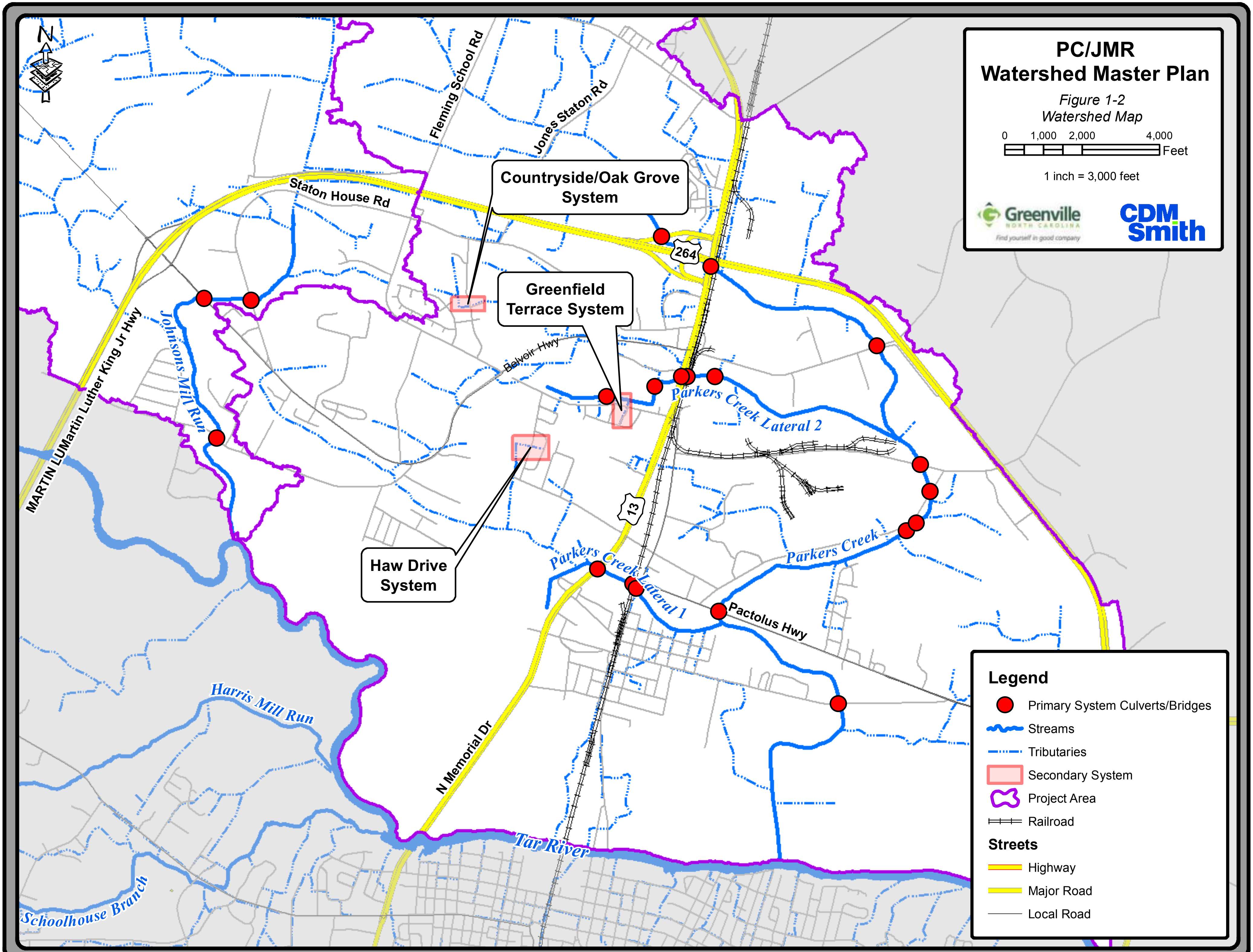
Major Road
Local Road
N
Tar River
Sains Branch
Sams Branch
Harris Mill Run
Schoolhouse Branch
Johnsons Mill Run
Parkers Creek
Parkers Creek Lateral 1
Parkers Creek Lateral 2
Belvoir Hwy
Hooker Rd
13
264
258
264A



PC/JMR
Watershed Master Plan
Figure 1-2
Watershed Map
0 1,000 2,000 4,000 Feet
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
Find yourself in good company
CDM Smith
Legend
Primary System Culverts/Bridges
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Tributaries
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Parkers Creek Lateral 1
Parkers Creek
13
Pactolus Hwy
MARTIN LUMartin Luther King Jr Hwy
Johnsons Mill Run
N Memorial Dr
Harris Mill Run
Tar River
Schoolhouse Branch

- Primary System – Johnsons Mill Run
  - Old River Road Bridge
  - Belvoir Highway (NC 33) Bridge
  - Mount Pleasant Church Road (Staton House Road)

- Secondary Systems
  - Countryside/Oak Grove Estates Subdivision
  - Greenfield Terrace
  - Haw Drive, Trent Circle, and Catawba Street

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 and non-thoroughfare roads;
- 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.

Major and minor thoroughfare roadway crossings were identified based on the City's Thoroughfare Plan. **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	Desired Level of Service (Frequency Storm Event)	Project Area
Piped Collection Systems	10	▪ Countryside Estates and Oak Grove Subdivisions ▪ Greenfield Terrace ▪ Haw Drive and Catawba Street
Non-Thoroughfare Crossings	10	**Parkers Creek** ▪ Industrial Boulevard Bridge ▪ Farm Crossing Culverts (2 - private) **Johnsons Mill Run** ▪ Mount Pleasant Church Road (Staton House Road) Bridge **Parkers Creek Lateral 2** ▪ Private Crossing Bridge ▪ Greenfield Agricultural Field Culverts (2) ▪ Greenfield Park Entrance

Drainage Type	Desired Level of Service (Frequency Storm Event)	Project Area
Minor Thoroughfare Roadway Crossings	25	**Johnsons Mill Run** ▪ Old River Road Bridge **Parkers Creek** ▪ Old Creek Road Bridge
Major Thoroughfare Roadway Crossings (Freeways, Expressways, Boulevards)	50	**Parkers Creek** ▪ Mumford Road Culvert ▪ Pactolus Highway Culvert ▪ Staton Road Culvert ▪ Memorial Drive and Highway 264 Culvert ▪ Highway 264 Entrance Ramp Culvert **Parkers Creek Lateral 1** ▪ N Greene Street Culvert ▪ Memorial Drive Culverts **Parkers Creek Lateral 2** ▪ Memorial Drive Culverts **Johnsons Mill Run** ▪ Old River Road Bridge ▪ Belvoir Highway (NC 33) Bridge
Railroad Crossing	100	▪ Parkers Creek – Bridge ▪ Parkers Creek Lateral 1 - Bridge ▪ Parkers Creek Lateral 2 - Culverts

2.1 Citizen Input

The Master Plan included a citizen input component to solicit feedback and information regarding stormwater impacts and the future of stormwater management in the City. In 2014, the City mailed out approximately 3,600 questionnaires related to stormwater management to all property owners within the City. Approximately 6% (228) of the questionnaires were completed and returned to the City for consideration. Of the returned questionnaires, 16 were from residents within the PC/JMR Watershed. The questionnaire results were georeferenced according to the address of the questionnaire respondent (See **Figures 2-1 and 2-2**). Approximately 63 percent of the responses indicated some level of property flooding, with two property owners responding that they are experiencing living space flooding at least once per year. Twenty-five percent of the completed questionnaires for the watershed noted yard flooding and another 75 percent noted street flooding. Approximately 30 percent of the respondents reported that they were not experiencing any type of flooding. A total of six residents reported erosion threatening either streets, yards, garages, or fences. Of the six reports of erosion, four indicated yard erosion. See Figure 2-2 for locations of reported erosion. A sample questionnaire and the tabulated results are provided in Appendix D.

On November 12th, 2014 and November 17, 2015, the City provided another avenue for obtaining citizen input by holding public meetings at the Greenfield Community Center and at City Hall. An open house format allowed property owners to attend at their convenience, and speak to City Staff or representatives from CDM Smith. About 20 residents from the watershed attended the initial meeting and nearly a dozen attended the second meeting. Minutes from the November 2014 and November 2015 meetings are included in Appendix D.

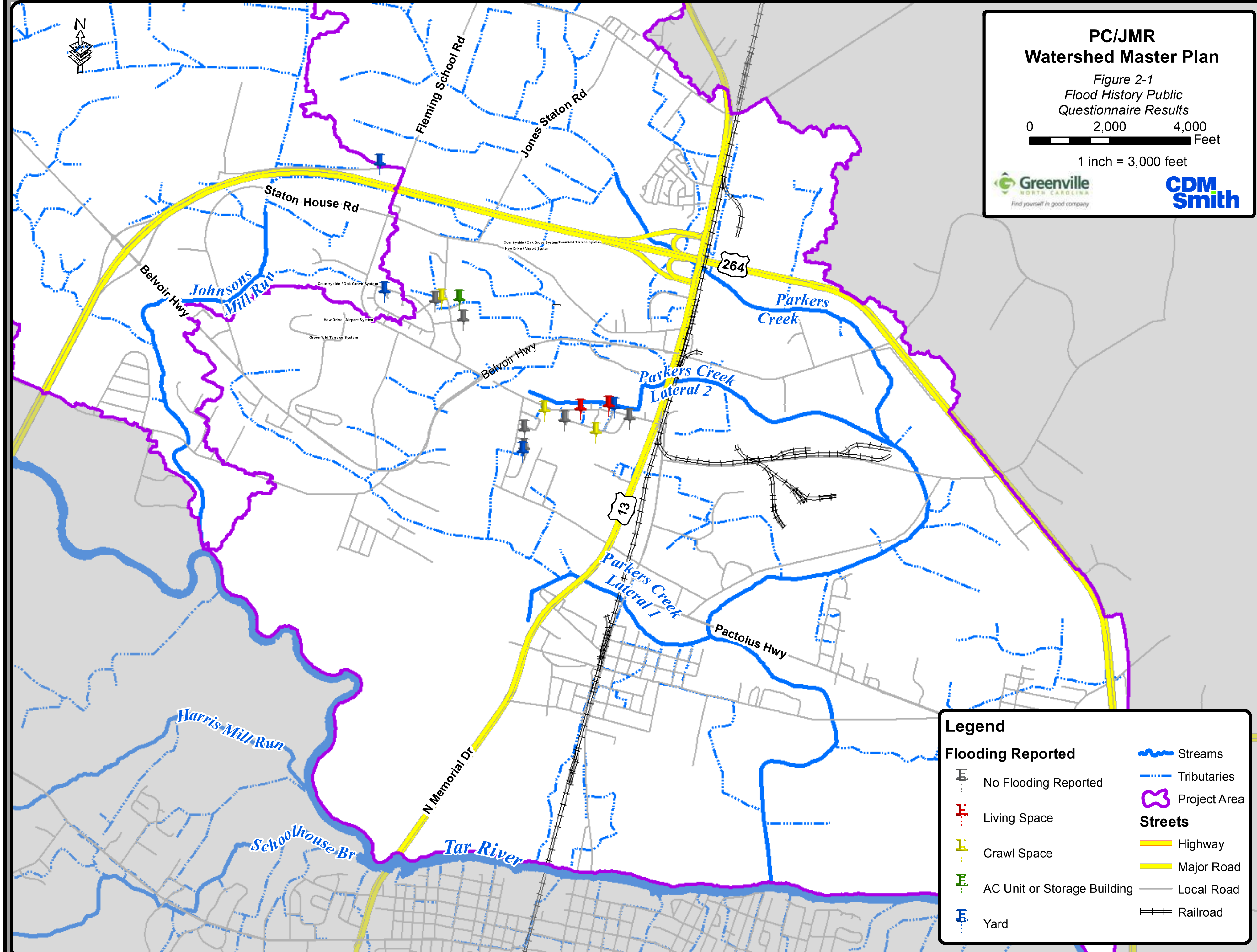
The results and comments from the citizen's input contributed to the identification and prioritization of problem areas, and the validation of model results.

2.2 Watershed Characteristics

The PC/JMR watershed study area is a combination of two watersheds each draining to the Tar River from north to south. From their headwaters north and west of the City limits the watersheds mostly drain areas outside the City limits including the industrial properties to the east of Memorial Drive. Johnsons Mill Run drains an expansive agricultural area to the north. Inside the City limits, the watershed includes distributed residential subdivisions and the Memorial Drive corridor. The PC/JMR watersheds are expected to experience considerable development in the foreseeable future, however not as rapid as other areas of Greenville. A significant portion of both watersheds is in the 100-year floodplain of the Tar River.

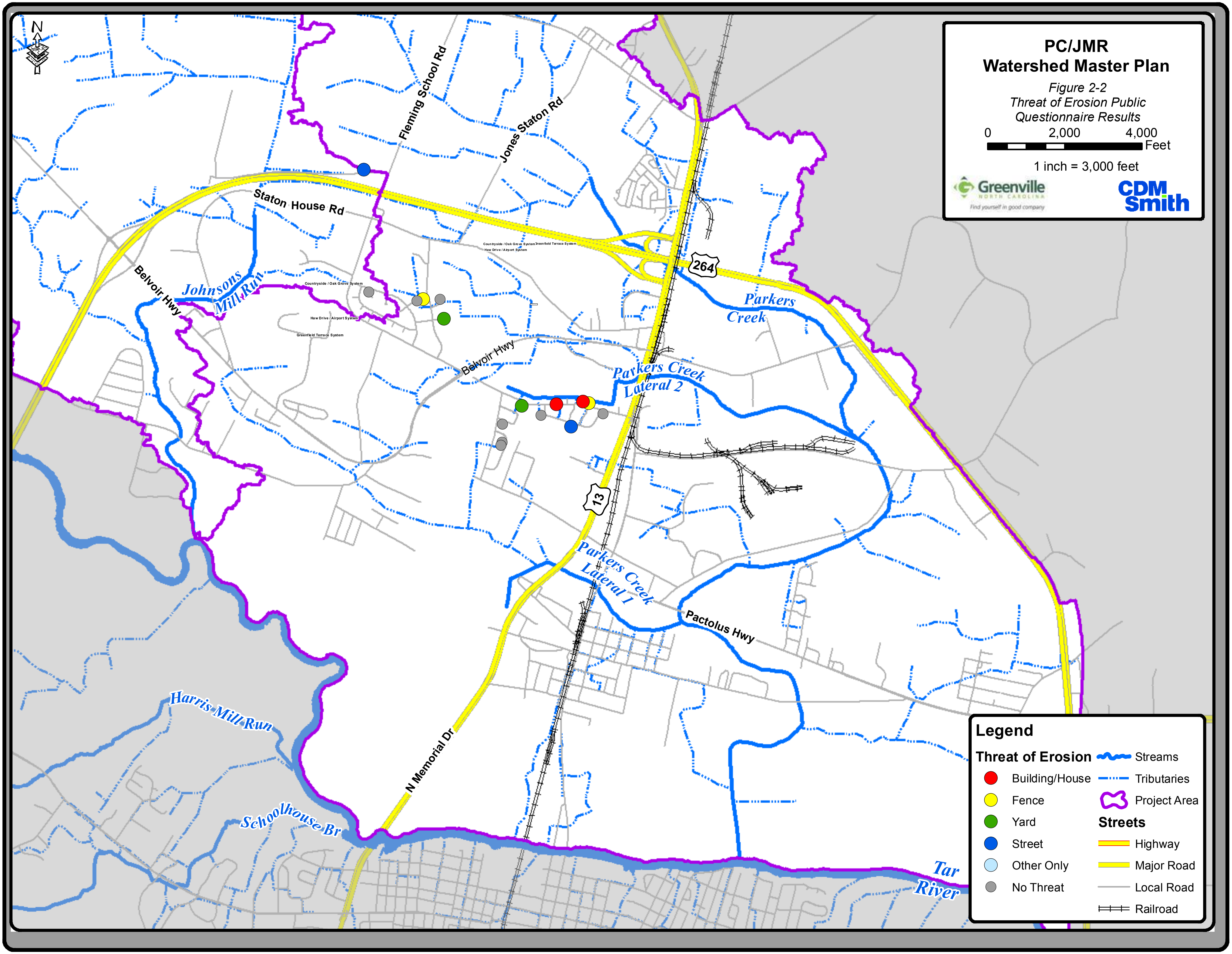
The PC/JMR project watersheds are approximately 40 square miles and are located in the northern portion of Greenville north of the Tar River. The PC watershed is generally bound by I-264 to the east and Allpine-Taylor Road to the north. PC and JMR watersheds share a common boundary near Fleming School Road running north to south and both creeks drain south into the Tar River. The JMR watershed covers a large undeveloped area to the north of the City extending towards Conetoe.

Parkers Creek and Johnsons Mill Run watersheds drain almost all of Greenville north of the Tar River. There are a few areas within the city limits to the east of highway 264 that are not



PC/JMR
Watershed Master Plan

Figure 2-1
Flood History Public Questionnaire Results



PC/JMR
Watershed Master Plan
Figure 2-2
Threat of Erosion Public
Questionnaire Results
0
2,000
4,000
Feet
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
Find yourself in good company
CDM Smith
N
Fleming School Rd
Jones Staton Rd
Staton House Rd
Belvoir Hwy
Johnsons Mill Run
Parkers Creek
Parkers Creek Lateral 2
Parkers Creek Lateral 1
264
13
Pactolus Hwy
N Memorial Dr
Harris Mill Run
Schoolhouse Br
Tar River
Legend
Threat of Erosion
Building/House
Fence
Yard
Street
Other Only
No Threat
Streams
Tributaries
Project Area
Streets
Highway
Major Road
Local Road
Railroad

within these watersheds. These areas were included in the stormwater inventory, but not in the watershed master plan. Almost all of Parkers Creek watershed is within the city's ETJ, while only a small portion of JMR watershed is within the ETJ. Approximately 87 percent of the PC watershed is in the ETJ while about 24% is within the current city limits. Roughly 357 of the roughly 16,877 acres (2%) of the JMR watershed are within the ETJ and out of that, only about 24 acres are within the city limits associated with the Countryside Estates subdivision.

Parkers Creek watershed is comprised mostly of open space with an industrial area and dispersed residential subdivisions. The Memorial Drive and N. Greene Street corridor splits the north side of the city with some commercial and institutional land uses. The Tar River floodplain accounts for much of the open space in the watershed especially since following the flooding of 1997 many residences in the flood buyout zone have been abandoned. To the north, small subdivisions such as Greenfield Terrace and Countryside Estates extend the city limits towards the northwest. The Moore Road area drains into the county towards the east and is not in the Parkers Creek watershed.

The topography of PC/JMR is very flat with the highest point within the City limits at an elevation of about 42 feet draining to the Tar River only a few feet above sea level. The vast majority of Parkers Creek and its tributaries are maintained trapezoidal channels because the flat conditions require regular drainage ditch maintenance to maintain conveyance. Channel conditions are generally stable since velocities are very low and therefore erosion is minimal.

2.2.1 Parkers Creek Watershed Characteristics

The Parkers Creek Watershed is approximately 11 square miles between its downstream boundary along the Tar River and its upstream boundary north of US Hwy 264 to the north. Land use in the watershed is mostly undeveloped as shown on the Existing Conditions Land Use Map included in Appendix C, and listed in **Tables 2-1A and B**. The future conditions land use is expected to be comprised of additional development with mostly residential and some commercial/institutional uses according to the zoning.

Table 2-1A: Parkers Creek Watershed Existing Land Use

Land Use Category	Area (acres)	Percent of Basin Area
Commercial	270	4.0%
Office/Institutional/Multifamily	325	4.8%
Industrial	987	14.5%
High Density Residential	33	0.5%
Medium Density Residential	322	4.7%
Low Density Residential	284	4.2%
Conservation/Open Space	3,090	45.5%
Agricultural/Cropland	908	13.4%
Right-of-Way	575	8.5%
TOTAL	6,794	100.0%

Table 2-1B Parkers Creek Watershed Future Land Use

Land Use Category	Area (acres)	Percent of Basin
Commercial	294	4%
High density residential	445	7%
Industrial	2697	40%
Low density residential	221	3%
Medium density residential	970	14%
Multi-family	496	7%
Open space	741	11%
Right-of-way	450	7%
Very low density residential	479	7%
TOTAL	6,793	100%

The soils within the watershed are predominately NRCS hydrologic soils group D (56%) followed by type A (39%), as shown on the Soils Map included in Appendix C. More detailed information about the land use and soils in the Parkers Creek Watershed is contained in Appendix A.

2.2.2 Johnsons Mill Run Watershed Characteristics

The Johnsons Mill Run Watershed is approximately 17,400 acres (27 square miles) between its downstream boundary along the Tar River and its upstream boundary in the vicinity of the Pitt County boundary near Conetoe, North Carolina. Land use in the watershed is over 85 percent undeveloped as shown on the Existing Conditions Land Use Map included in Appendix C. The existing land use in the watershed is split between the agricultural and other open space categories with only a very small percentage of residential in the south (See **Tables 2-2A and B**). In the foreseeable future, the land use is expected to transition towards more residential land uses but remain predominantly agriculture and open space as shown in Table 2-2B.

Table 2-2A: Johnsons Mill Run Watershed Existing Land Use

Land Use Category	Area (acres)	Percent of Basin Area
Medium Density Residential	30	0.2%
Low Density Residential	139	0.8%
Conservation/Open Space	764	4.5%
Agricultural/Cropland	3,275	19.4%
Barren land	65	0.4%
Deciduous forest/Evergreen	3,899	23.1%
Shrub/Grass/Pasture	4,485	26.6%
Woody wetlands	3,586	21.2%
Emergent herbaceous wetlands	381	2.3%
Right-of-Way	250	1.5%
TOTAL	16,877	100.0%

Table 2-2B: Johnsons Mill Run Watershed Future Land Use

Land Use Category	Area (acres)	Percent of Basin Area
Commercial	178	1.1%
Crops	9280	55%
High density residential	92	0.5%
Industrial	20	0.1%
Low density residential	188	1.1%
Medium density residential	3160	19%
Multi-family	211	1.2%
Open space	2914	17%
Right-of-way	388	2.3%
Very low density residential	439	2.6%
TOTAL	16,877	100%

The soils within the Johnsons Mill Run watershed are predominately NRCS hydrologic soils group D (82%) followed by type A (13%), as shown on the Soils Map included in Appendix C. More detailed information about the land use and soils in the Johnsons Mill Run Watershed is contained in Appendix A.

2.3 Existing Conditions Survey and Field Data Collection

For the PC/JMR Watershed Master Plan, stormwater infrastructure throughout the watershed was collected by CH Engineering personnel to compile a GIS stormwater inventory database for the City. This was accomplished by using Global Positioning Systems (GPS) as the primary means of data capture. CH Engineering employed survey grade GPS to locate the x, y, and z coordinates of each visible stormwater system structure and conventional surveying techniques to obtain other 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 1,073 closed system structures and 85,481 linear feet of pipe were collected as part of the city-wide inventory north of the Tar River. **Tables 2-3 and 2-4** summarize the inventory collected in the PC/JMR Watershed.

Table 2-3: Inventory Summary – Closed System Structures

Structure Type	Count Surveyed
Yard Inlet	77
Drop Inlet	55
Junction Box	96
Pipe End	496
Pond Structure	1
Slab Top	4
Catch Basin	273
Underground Pipe Junction	44
Total	1046

Table 2-4: Inventory Summary – Pipes

Size	Length (Linear Feet)
12″ Diameter	239
15″ Diameter	20,948
18″ Diameter	20,177
21″ Diameter	338
24″ Diameter	13,797
30″ Diameter	6,561
36″ Diameter	9,398
42″ Diameter	4,660
48″ Diameter	1,902
54″ Diameter	173
60″ Diameter	930
66″ Diameter	143
Total	79,266

Data was obtained for those open channels required to complete connectivity for modeling purposes. Attributes such as shape, lining type, bed type, flow, bottom width, top width, and bank heights were collected for 158 open channel sections totaling over 23.5 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 bank, bottom of bank, and channel centerline was obtained at 20 cross sections throughout the PC/JMR Watershed. Refer to the City of Greenville Storm Water System Inventory Standard Operating Procedures for additional details on the processes and details of the inventory database.

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 PC/JMR Watershed. The United States Army Corps of Engineers (USACE) HEC-HMS was selected to model the primary systems. HEC-HMS simulates the 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 surface 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 throughout each reach varying with the topography. Storage routing was modeled to account particularly for accessible storage volume in the areas upstream of crossings. 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

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)
Parkers Creek							
J_PC_2300	US Hwy 264 Entrance Ramp	XS-29594	175	382	549	705	874
J_PC_2000	Memorial Drive and US Hwy 264	XS-27742	231	469	661	825	1,012
J_PC_1800	Railroad Bridge	XS-26062	261	517	728	898	1,096
J_PC_1500	Staton Road	XS-21432	305	586	807	1,012	1,242
J_PC_1200	Industrial Boulevard	XS-17681	429	834	1,124	1,447	1,795
J_PC_1200	Old Creek Road	XS-17049	429	834	1,124	1,447	1,795
J_PC_1000	Farm Culvert 2	XS-16107	427	880	1,183	1,516	1,884
J_PC_1000	Farm Culvert 1	XS-15749	427	880	1,183	1,516	1,884
J_PC_800	Pactolus Highway	XS-10165	458	970	1,300	1,659	2,064
J_PC_400	Mumford Road	XS-5784	522	1,134	1,589	2,016	2,525
J_PC_200	D/S Limit of Parkers Creek	XS-5229	545	1,191	1,682	2,151	2,713
Parkers Creek Lateral 1							
J_PC_531	U/S Limit of Parkers Cr-Lateral 1	XS-5182	8	17	25	31	39
J_PC_530	Memorial Drive	XS-4219	55	148	235	315	404
J_PC_510	Railroad Bridge	XS-2910	73	189	299	394	500
J_PC_510	N. Greene Street	XS-2747	73	189	299	394	500
J_PC_L1	D/S Limit of Parkers Cr-Lateral 1	XS-962	90	230	361	476	603
Parkers Creek Lateral 2							
J_PC_1340	U/S Limit of Parkers Cr-Lateral 2	XS-9978	7	17	25	33	41
J_PC_1320	Memorial Drive	XS-6192	80	202	301	391	495
J_PC_1320	Railroad Culvert	XS-5987	80	202	301	391	495
J_PC_1320	Private crossing (bridge)	XS-5330	80	202	301	391	495
J_PC_1310	0.5 mile below Railroad	XS-2950	113	268	386	496	621
J_PC_L2	D/S Limit of Parkers Cr-Lateral 2	XS-816	128	304	438	560	699
Johnsons Mill Run							
J_JMR_9000	U/S Limit of Johnsons Mill Run	XS-11718	349	844	1,253	1,640	2,086
J_JMR_6000	Mount Pleasant Church Road	XS-9099	350	847	1,250	1,638	2,085
J_JMR_5000	Belvoir Highway (NC 33)	XS-7850	350	848	1,251	1,640	2,088
J_JMR_3000	0.4 mile below NC Hwy 43	XS-5427	562	1,276	1,850	2,393	3,052
J_JMR_2000	Old River Road	XS-3307	566	1,281	1,859	2,391	3,062
J_JMR_OUT	D/S Limit of Johnsons Mill Run	XS-271	566	1,283	1,860	2,393	3,061

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 with 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 PC/JMR 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.
- 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 CDM Smith surveyed cross sections. The channel cross sections were merged with North Carolina State LiDAR data (2007) to develop cross sections spanning the entire floodplain area. The starting water surface elevations for the HEC-RAS models were calculated using the slope-area method. They are as follows:

- 0.0004 feet/foot for Parkers Creek
- 0.0005 feet/foot for Parkers Creek Lateral 1
- 0.0005 feet/foot for Parkers Creek Lateral 2
- 0.0005 feet/foot for Johnsons Mill Run

3.1.2.1 Hydraulic Performance

Eighteen crossings were analyzed for flooding potential for the primary system. Ten were located along Parkers Creek, three were located along Johnsons Mill Run, three were located along Parkers Creek Lateral 1, while the remaining five were located along Parkers Creek Lateral 2. Descriptions of the existing primary system crossings analyzed are summarized in **Table 3-2**. Photographs 3-1 through 3-31 of this section provide visual images of the primary system crossings.

Table 3-2: Existing Condition of Primary System Crossings

Location	Size/Material	Condition
Parkers Creek		
Mumford Road Culvert	Triple 14' x 12' Box Culverts	Good*
Pactolus Highway/NC 33 Culvert	Twin 12' x 12' Box Culverts	Good*
Farm Culvert 1	96" CMP	Good
Farm Culvert 2	96" CMP	Good
Old Creek Road Bridge	3 span Girder Bridge	Fair*
Industrial Boulevard Bridge	3 span Girder Bridge	Fair*
Staton Road Culvert	Twin 84" RCPs	Fair*
Railroad Bridge	Trestle Bridge	Fair
Memorial Drive and Highway 264 Culvert	Triple 8' x 8' Box Culverts	Fair*
Highway 264 Entrance Ramp Culvert	Triple 8' x 8' Box Culverts	Good*
Parkers Creek Lateral 1		
N. Greene Street Culvert	7' x 5' Box Culverts	Good*
Railroad Bridge	2 span Bridge	Fair
Memorial Drive Culverts	Twin 7' x 7' Box Culverts	Fair
Parkers Creek Lateral 2		
Industrial Park Bridge	Single span bridge	Fair
Railroad Culvert	Triple 66" RCPs	Fair
Memorial Drive Culverts	Elliptical 8.5' x 5' RCP	Fair*
Greenfield Agricultural Field Culvert 1	48 " CMP	Fair
Greenfield Agricultural Field Culvert 2	48 " CMP	Fair
Greenfield Park Entrance	60" CMP	Fair
Johnsons Mill Run		
Old River Road Bridge	2 span Girder Bridge	Good*
Belvoir Highway (NC 33) Bridge	3 span Girder Bridge	Fair*
Mount Pleasant Church Road (Station House Road)	2 span Girder Bridge	-

*Conditions as classified in NCDOT Bridge Inspection Reports in Appendix L
All other condition assessments from inventory collection.

Photograph 3-1
Parkers Creek: Mumford Road – Upstream Culvert

Photograph 3-2
Parkers Creek: Mumford Road – Downstream Culvert

Photograph 3-3
Parkers Creek: NC 33

Photograph 3-4
Parkers Creek: Farm Culvert 1 – Upstream

Photograph 3-5
Parkers Creek: Farm Culvert 1 – Upstream

Photograph 3-6
Parkers Creek: Farm Culvert 2 – Upstream

Photograph 3-7
Parkers Creek: Farm Culvert 2-Downstream

Photograph 3-8
Parkers Creek: Old Creek Road Bridge – Upstream

Photograph 3-9
Parkers Creek: Old Creek Road Bridge – Downstream

Photograph 3-10
Parkers Creek: Industrial Boulevard Bridge

Photograph 3-11
Parkers Creek: Highway 264 Ramp Culvert – Downstream

Photograph 3-12
Railroad Bridge Upstream

Photograph 3-13
Railroad Bridge Downstream

Photograph 3-14
Parkers Creek: Highway Culvert – Upstream

Photograph 3-15
Parkers Creek: Highway 264 Culvert – Downstream

Photograph 3-16
Parkers Creek: Highway 264 Ramp Culvert – Upstream

Photograph 3-17
Parkers Creek: Highway 264 Ramp Culvert – Downstream

Photograph 3-18
Parkers Creek Lateral 1: N. Greene Street Culvert – Upstream

Photograph 3-19
Parkers Creek Lateral 1: Railroad Bridge – Upstream

Photograph 3-20
Parkers Creek Lateral 1: Railroad Bridge – Downstream

Photograph 3-21
Parkers Creek Lateral 1: Memorial Drive – Upstream

Photograph 3-22
Parkers Creek Lateral 2: Industrial Park Bridge – Upstream

Photograph 3-23
Parkers Creek Lateral 2: Industrial Park Bridge – Downstream

Photograph 3-24
Parkers Creek Lateral 2: Railroad Culverts – Upstream

Photograph 3-25
Parkers Creek Lateral 2: Railroad Culverts – Downstream

Photograph 3-26
Parkers Creek Lateral 2: Memorial Drive Culvert – Downstream

Photograph 3-27
Parkers Creek Lateral 2: Greenfield Culvert

Photograph 3-28
Parkers Creek Lateral 2: Greenfield Park Entrance – Upstream

Photograph 3-29
Parkers Creek Lateral 2: Greenfield Park Entrance – Downstream

Photograph 3-30
Johnsons Mill Run: Old River Road Bridge

Photograph 3-31
Johnsons Mill Run: NC 33 / Belvoir Highway Bridge

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 Parkers Creek, eight out of the ten crossings are meeting their designated LOS.

Along Johnsons Mill Run, all of the three crossings are meeting its desired LOS. Belvoir Highway and Old River Road bridges meet a 50-year LOS. Old River Road and Mount Pleasant Church roads both meet a 25-year LOS.

Along Parkers Creek Lateral 1, two out of the three crossings are meeting its desired LOS.

Along Parkers Creek Lateral 2, four out of the five crossings are meeting its desired LOS.

In addition to evaluating the roadway crossings, an evaluation was performed to determine the residences along Parkers Creek and Johnsons Mill Run that are at risk of flooding during the 25- and 100-year storm event. The existing 25- and 100- year floodplains for Parkers Creek and Johnsons Mill Run are shown in **Figures 3-1 through 3-5**. 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 individual property owners of the potential risk of flooding.

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

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

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired LOS	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
Parkers Creek							
US Hwy 264 Entrance Ramp	34.07	100-yr	24.91	26.70	27.67	28.48	29.77
Memorial Drive and US Hwy 264	34.00	100-yr	24.71	26.47	27.39	28.09	29.21
Railroad Bridge	28.67	100-yr	24.54	26.08	26.78	27.28	27.79
Staton Road	23.62	50-yr	21.22	**23.75**	**24.20**	**24.39**	**24.56**
Industrial Boulevard	20.63	10-yr	19.21	20.10	**21.01**	**21.34**	**21.66**
Old Creek Road	20.66	25-yr	18.86	19.68	20.29	**20.73**	**21.36**
Farm Culvert 2	16.90	-	**18.47**	**19.33**	**20.05**	**20.51**	**21.02**
Farm Culvert 1	17.59	-	**18.22**	**19.12**	**19.95**	**20.42**	**20.92**
Pactolus Highway	21.70	50-yr	11.33	13.18	14.22	15.15	16.18
Mumford Road	15.77	50-yr	7.37	9.01	9.93	10.62	11.40
Parkers Creek - Lateral 1 (south)							
Memorial Drive	23.71	50-yr	14.04	16.28	18.09	18.46	18.82
Railroad Bridge	22.28	100-yr	13.80	16.13	17.90	18.14	18.29
N. Greene Street	17.78	50-yr	13.78	16.10	**17.87**	**18.10**	**18.24**
Parkers Creek - Lateral 2 (north)							
Greenfield Park Access Road	25.20	10-yr	21.14	23.92	**26.10**	**26.77**	**26.98**
Greenfield Farm Culvert	24.97	10-yr	21.11	23.88	**26.09**	**26.77**	**26.98**
Memorial Drive	26.19	50-yr	21.07	23.77	26.06	**26.76**	**26.97**
Railroad Culvert	28.57	100-yr	20.88	22.90	24.08	25.00	26.00
Private crossing (bridge)	24.60	-	20.74	22.66	23.66	24.34	**24.99**
Johnsons Mill Run							
Mount Pleasant Church Road	27.90	25-yr	23.25	25.64	26.96	**28.16**	**29.01**
Belvoir Highway (NC 33)	28.06	50-yr	21.85	23.86	24.92	25.78	26.75
Old River Road	20.63	25-yr	15.58	17.05	18.70	20.48	**22.20**

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding. Red text indicates crossing not meeting designated LOS.

**Green shade indicates crossing meets desired LOS. Red shade indicates crossing does not meet desired LOS.

All stages are not considered backwater effects (BFE @ 25 for JMR and 22 for PC) from the Tar River.

Table 3-4A: Existing Conditions At-Risk Properties/Structures – Parkers Creek and Laterals 1 and 2

Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
100 ASHTON DR	MAIN	25.48	**26.09**	**26.98**
103 ASHTON DR	MAIN	25.93	**26.09**	**26.98**
104 ASHTON DR	MAIN	25.89	**26.09**	**26.98**
105 ASHTON DR	AUX	25.9	**26.09**	**26.98**
105 ASHTON DR	MAIN	25.85	**26.09**	**26.98**
106 ASHTON DR	MAIN	25.82	**26.09**	**26.98**
106 ASHTON DR	AUX	25.91	**26.09**	**26.98**
107 ASHTON DR	MAIN	25.77	**26.09**	**26.98**
107 ASHTON DR	AUX	25.83	**26.09**	**26.98**
108 ASHTON DR	MAIN	25.76	**26.09**	**26.98**
101 BEACHWOOD DR	MAIN	25.62	**26.09**	**26.98**
102 BEACHWOOD DR	AUX	25.96	**26.1**	**26.98**
102 BEACHWOOD DR	AUX	25.98	**26.1**	**26.98**
102 BEACHWOOD DR	MAIN	25.97	**26.1**	**26.98**
103 BEACHWOOD DR	MAIN	25.91	**26.09**	**26.98**
107 BEACHWOOD DR	AUX	25.87	**26.09**	**26.98**
107 BEACHWOOD DR	MAIN	25.87	**26.09**	**26.98**
711 BUBBA BV*	MAIN	29.33	27.86	**29.86**
711 BUBBA BV*	MAIN	28.69	27.9	**29.87**
711 BUBBA BV*	MAIN	29.41	27.91	**29.87**
711 BUBBA BV*	MAIN	28.55	27.94	**29.88**
711 BUBBA BV*	MAIN	28.3	28.03	**29.88**
711 BUBBA BV*	MAIN	28.53	28.06	**29.89**
711 BUBBA BV*	MAIN	29.52	27.95	**29.88**
711 BUBBA BV*	AUX	28.35	28.08	**29.89**
711 BUBBA BV*	MAIN	28.4	28.08	**29.89**
711 BUBBA BV*	MAIN	28.48	28.1	**29.89**
711 BUBBA BV*	MAIN	29.06	28.09	**29.89**
711 BUBBA BV*	MAIN	28.46	28.14	**29.89**
711 BUBBA BV*	MAIN	29.35	28.18	**29.89**
2230 CAROLINA LEAF RD	AUX	23.89	23.5	**24.87**
407 CHURCH ST	AUX	13.53	12.67	**13.6**
100 FIRESIDE RD	MAIN	25.75	**26.1**	**26.99**
101 FIRESIDE RD	MAIN	25.9	**26.1**	**26.99**
104 FIRESIDE RD	AUX	26	**26.1**	**26.99**
104 FIRESIDE RD	MAIN	26	**26.1**	**26.99**
0 N GREENE ST	MAIN	17.84	**17.9**	**18.3**
1630 N GREENE ST**	AUX	17.43	**17.92**	**18.33**
1630 N GREENE ST**	AUX	16.75	**17.92**	**18.33**
1630 N GREENE ST**	MAIN	15.34	**17.92**	**18.34**
0 GREENFIELD BV	AUX	24.29	**26.09**	**26.98**
102 GREENFIELD BV	MAIN	26	**26.09**	**26.98**

Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
103 GREENFIELD BV	AUX	26	**26.09**	**26.98**
103 GREENFIELD BV	MAIN	26	**26.09**	**26.98**
104 GREENFIELD BV	MAIN	26	**26.09**	**26.98**
105 GREENFIELD BV	MAIN	26	**26.09**	**26.98**
105 GREENFIELD BV	AUX	26	**26.09**	**26.98**
106 GREENFIELD BV	MAIN	25.98	**26.09**	**26.98**
107 GREENFIELD BV	MAIN	26	**26.09**	**26.98**
108 GREENFIELD BV	MAIN	25.83	**26.09**	**26.98**
109 GREENFIELD BV	MAIN	26	**26.09**	**26.98**
110 GREENFIELD BV	MAIN	25.65	**26.09**	**26.98**
112 GREENFIELD BV	MAIN	25.39	**26.09**	**26.98**
112 GREENFIELD BV	AUX	25.18	**26.09**	**26.98**
113 GREENFIELD BV	AUX	26	**26.09**	**26.98**
113 GREENFIELD BV	MAIN	26	**26.09**	**26.98**
200 GREENFIELD BV	MAIN	25.19	**26.09**	**26.98**
200 GREENFIELD BV	AUX	24.99	**26.09**	**26.98**
201 GREENFIELD BV	MAIN	25.84	**26.09**	**26.98**
202 GREENFIELD BV	MAIN	25.03	**26.09**	**26.98**
202 GREENFIELD BV	AUX	24.78	**26.09**	**26.98**
203 GREENFIELD BV	MAIN	25.78	**26.09**	**26.98**
204 GREENFIELD BV	MAIN	24.87	**26.09**	**26.98**
205 GREENFIELD BV	MAIN	25.73	**26.09**	**26.98**
206 GREENFIELD BV	MAIN	24.68	**26.09**	**26.98**
206 GREENFIELD BV	AUX	24.5	**26.09**	**26.98**
300 GREENFIELD BV	MAIN	24.51	**26.09**	**26.98**
303 GREENFIELD BV	MAIN	25.53	**26.09**	**26.98**
306 GREENFIELD BV	MAIN	24.74	**26.09**	**26.98**
308 GREENFIELD BV	MAIN	25.57	**26.09**	**26.98**
310 GREENFIELD BV	MAIN	25.75	**26.09**	**26.98**
401 GREENFIELD BV	MAIN	25.91	**26.09**	**26.98**
403 GREENFIELD BV	AUX	25.94	**26.1**	**26.98**
403 GREENFIELD BV	MAIN	25.77	**26.1**	**26.98**
404 GREENFIELD BV	MAIN	25.35	**26.1**	**26.98**
407 GREENFIELD BV	MAIN	25.67	**26.1**	**26.98**
409 GREENFIELD BV	MAIN	25.7	**26.1**	**26.98**
411 GREENFIELD BV	MAIN	25.79	**26.1**	**26.98**
412 GREENFIELD BV	MAIN	25.86	**26.1**	**26.99**
502 GREENFIELD BV	MAIN	25.33	**26.1**	**26.99**
503 GREENFIELD BV	AUX	25.91	**26.1**	**26.99**
503 GREENFIELD BV	MAIN	25.61	**26.1**	**26.99**
504 GREENFIELD BV	MAIN	25.08	**26.1**	**26.99**
505 GREENFIELD BV	MAIN	25.61	**26.1**	**26.99**
506 GREENFIELD BV	MAIN	25.15	**26.1**	**26.99**
509 GREENFIELD BV	MAIN	25.84	**26.1**	**26.99**

Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
510 GREENFIELD BV	MAIN	25.28	**26.1**	**26.99**
512 GREENFIELD BV	MAIN	25.61	**26.1**	**26.99**
513 GREENFIELD BV	AUX	26.32	26.1	**26.99**
513 GREENFIELD BV	MAIN	26.19	26.1	**26.99**
518 GREENFIELD BV	MAIN	26.12	26.1	**26.99**
519 GREENFIELD BV	MAIN	26.48	26.1	**26.99**
520 GREENFIELD BV	MAIN	26.2	26.1	**26.99**
521 GREENFIELD BV	MAIN	26.61	26.1	**26.99**
0 INDUSTRIAL BV*	AUX	20.87	**21.2**	**21.88**
405 INDUSTRIAL BV*	MAIN	20.28	**21.6**	**22.88**
1201 INDUSTRIAL BV*	AUX	21.32	21.3	**22.01**
1201 INDUSTRIAL BV*	MAIN	21.79	21.43	**22.19**
1201 INDUSTRIAL BV*	AUX	21.24	**21.43**	**22.19**
0 MARTIN LUTHER KIN HW*	AUX	19.67	**19.96**	**20.93**
0 MARTIN LUTHER KIN HW*	AUX	19.38	**19.96**	**20.93**
5121 MARTIN LUTHER KIN HW*	AUX	22.15	**22.43**	**23.24**
5121 MARTIN LUTHER KIN HW*	AUX	22.45	22.44	**23.25**
5121 MARTIN LUTHER KIN HW*	MAIN	23.22	22.43	**23.24**
5605 MARTIN LUTHER KIN HW*	MAIN	24.96	24.68	**25.39**
1501 N MEMORIAL DR**	MAIN	18.94	18.2	**18.98**
1935 N MEMORIAL DR	MAIN	26.57	26.09	**26.98**
2201 N MEMORIAL DR	MAIN	26.01	**26.09**	**26.98**
2201 N MEMORIAL DR	AUX	26.02	**26.09**	**26.98**
2201 N MEMORIAL DR	AUX	26.03	**26.09**	**26.98**
2201 N MEMORIAL DR	MAIN	26.03	**26.09**	**26.98**
2201 N MEMORIAL DR	AUX	26.04	**26.09**	**26.98**
2201 N MEMORIAL DR	MAIN	26.05	**26.09**	**26.98**
2201 N MEMORIAL DR	MAIN	26.01	**26.09**	**26.98**
2201 N MEMORIAL DR	MAIN	25.91	**26.09**	**26.98**
2201 N MEMORIAL DR	AUX	26.03	**26.09**	**26.98**
2399 N MEMORIAL DR	AUX	24.43	**26.07**	**26.98**
2399 N MEMORIAL DR	MAIN	24.97	**26.07**	**26.98**
1000 MUMFORD RD*	MAIN	6.57	**7.81**	**8.72**
1400 OLD CREEK RD*	MAIN	19.33	**20.24**	**21.18**
1410 OLD CREEK RD*	AUX	20.08	**20.26**	**21.22**
1410 OLD CREEK RD*	MAIN	19.7	**20.29**	**21.36**
531 PACTOLUS HW*	MAIN	13.79	**14.51**	**16.51**
120 PARK ACCESS RD	AUX	26.22	26.1	**26.98**
107 STATON CT*	MAIN	20.7	**21.39**	**22.69**
310 STATON RD*	MAIN	22.92	**23.4**	**24.79**

Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
801 STATON RD*	MAIN	25.82	25.3	**26.24**
803 STATON RD*	MAIN	23.71	**25.47**	**26.38**
901 STATON RD*	MAIN	24.69	**25.17**	**25.93**
901 STATON RD*	AUX	23.7	**24.64**	**25.33**
901 STATON RD*	MAIN	24.41	**24.9**	**25.56**
271 STATON HOUSE RD*	MAIN	25.5	**26.11**	**27.01**
271 STATON HOUSE RD*	MAIN	26	**26.2**	**27.15**
271 STATON HOUSE RD*	MAIN	26.44	26.17	**27.11**
271 STATON HOUSE RD*	MAIN	26.67	26.22	**27.18**
530 STATON HOUSE RD*	AUX	28.01	27.16	**28.63**
580 STATON HOUSE RD*	AUX	27.64	27.2	**28.69**
580 STATON HOUSE RD*	AUX	27.49	27.22	**28.71**
610 STATON HOUSE RD*	AUX	27.74	27.3	**28.81**
101 TIPTON DR	MAIN	26.02	**26.09**	**26.98**
109 TRENT CI	MAIN	26.76	26.1	**26.99**
111 TRENT CI	MAIN	26.44	26.1	**26.99**
113 TRENT CI	MAIN	26.51	26.1	**26.99**
115 TRENT CI	AUX	26.63	26.1	**26.99**
115 TRENT CI	MAIN	26.83	26.1	**26.99**
0 WOODSIDE RD	AUX	25.99	25.95	**26.83**
0 WOODSIDE RD	MAIN	25.86	**26.09**	**26.98**
104 WOODSIDE RD	MAIN	25.95	**26.09**	**26.98**
107 WOODSIDE RD	MAIN	26	**26.09**	**26.98**
108 WOODSIDE RD	MAIN	25.83	**26.09**	**26.98**
108 WOODSIDE RD	AUX	25.84	**26.09**	**26.98**
109 WOODSIDE RD	MAIN	26	**26.09**	**26.98**
110 WOODSIDE RD	MAIN	25.74	**26.09**	**26.98**
111 WOODSIDE RD	MAIN	26.06	26.09	**26.98**
112 WOODSIDE RD	MAIN	25.7	**26.09**	**26.98**
113 WOODSIDE RD	MAIN	26.16	26.09	**26.98**
115 WOODSIDE RD	MAIN	26.24	26.09	**26.98**
117 WOODSIDE RD	MAIN	26.23	26.09	**26.98**
119 WOODSIDE RD	MAIN	26.17	26.07	**26.96**
121 WOODSIDE RD	MAIN	26.08	26.05	**26.94**
201 WOODSIDE RD	MAIN	26.02	26.01	**26.9**
203 WOODSIDE RD	MAIN	25.93	**26.04**	**26.93**
205 WOODSIDE RD	AUX	26.12	25.89	**26.78**
205 WOODSIDE RD	MAIN	25.86	**26.08**	**26.96**
300 WOODSIDE RD	MAIN	25.92	**26.1**	**26.98**
302 WOODSIDE RD	MAIN	25.97	**26.1**	**26.98**
306 WOODSIDE RD	MAIN	26	**26.1**	**26.98**
306 WOODSIDE RD	AUX	26	**26.1**	**26.98**
307 WOODSIDE RD	MAIN	25.97	**26.1**	**26.98**
307 WOODSIDE RD	AUX	26	**26.01**	**26.9**

Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
308 WOODSIDE RD	MAIN	26	**26.1**	**26.98**
311 WOODSIDE RD	MAIN	26	**26.1**	**26.98**
315 WOODSIDE RD	AUX	26	**26.1**	**26.98**
315 WOODSIDE RD	MAIN	26	**26.1**	**26.98**

Bold text indicates LAG flooding.
* Structure associated with Parkers Creek main stem.
** Structure associated with Parkers Creek Lateral 1.
All others associated with Parkers Creek Lateral 2.

As shown in Table 3-4A, 174 structures along Parkers Creek and its two laterals were identified for being at risk of flooding in the 100-year storm event. Among these, 125 are also in the modeled 25-year floodplain and 49 are auxiliary structures as opposed to main buildings. The majority of these potentially floodprone buildings are in the Greenfield Terrace subdivision at the end of Parkers Creek Lateral 2.

At the upstream end of Parkers Creek, 13 trailer type structures are located in or partially in the 100-year floodplain on the Bubba Boulevard property. Downstream of Highway 264 nine main buildings potentially affected by Parkers Creek flooding are located on Staton Road and MLK Highway. None of these main buildings are entirely surrounded by the modeled 100-year floodplain.

Along Lateral 2 east of Memorial Drive there are three properties with buildings in the modeled floodplains on Industrial Boulevard and Staton Road. Three of these are surrounded by the modeled floodplain at 1101 Industrial Boulevard. West of Memorial Drive there are over 121 residential structures identified in the modeled floodplain. These structures are mostly on Greenfield Boulevard, Woodside Road, Fireside Road, Ashton Road, and Trent Circle.

Several of the Greenfield Terrace residences submitted questionnaires indicating that they have experienced yard flooding.

Table 3-4B: Existing Conditions At-Risk Properties/Structures – Johnsons Mill Run

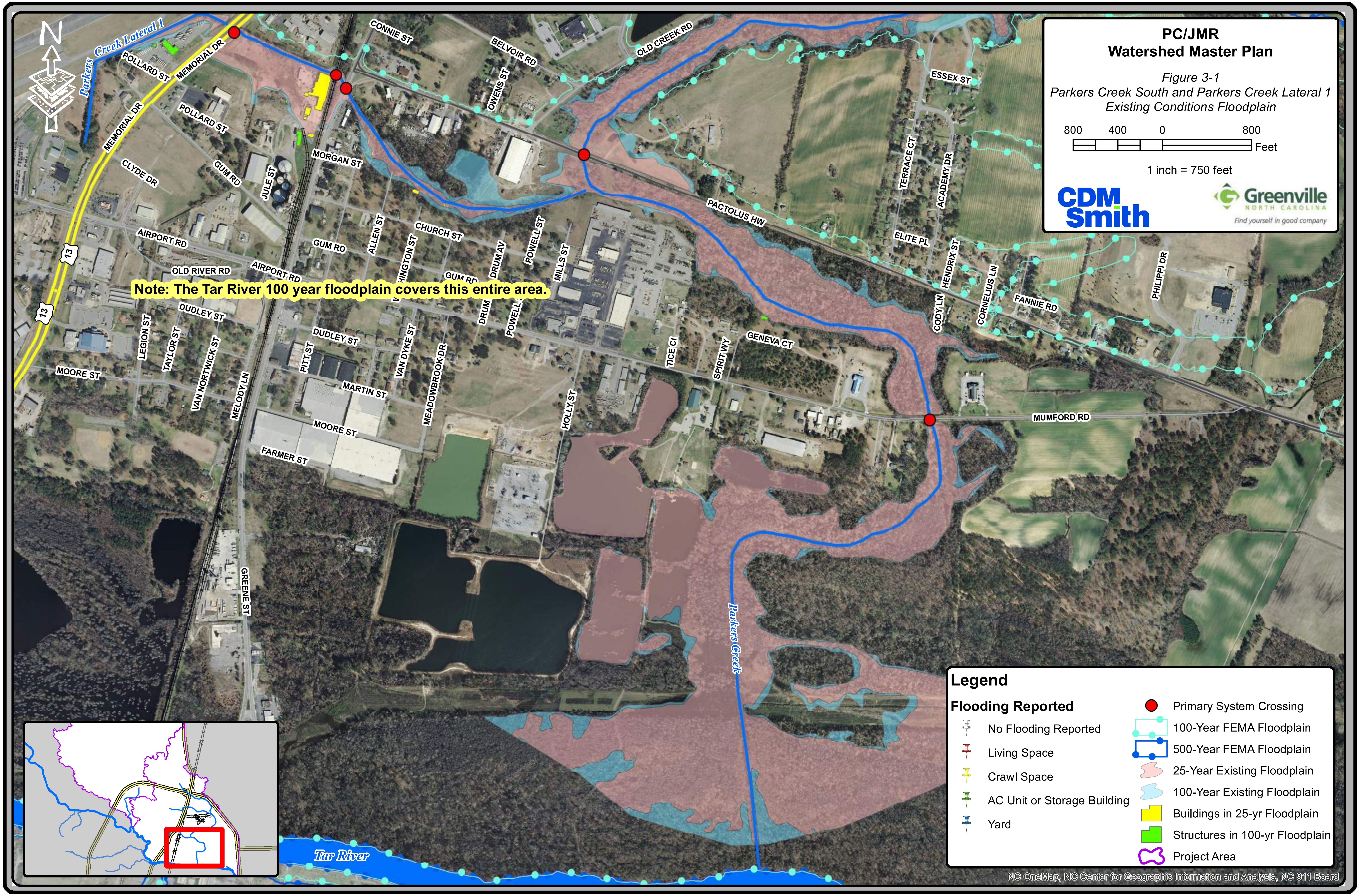
Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
944 BENJAMAN DR	MAIN	24.54	20.71	**25.06**
952 BENJAMAN DR	MAIN	24.49	20.75	**25.07**
962 BENJAMAN DR	MAIN	24.71	20.85	**25.11**
970 BENJAMAN DR	AUX	23.97	20.88	**25.12**
990 BENJAMAN DR	MAIN	24.09	21.19	**25.24**
1000 BENJAMAN DR	MAIN	23.28	21.3	**25.3**
1016 BENJAMAN DR	AUX	21.93	21.55	**25.39**
1026 BENJAMAN DR	MAIN	22.75	21.67	**25.44**
1032 BENJAMAN DR	MAIN	22.13	21.72	**25.46**
1040 BENJAMAN DR	MAIN	21.84	21.77	**25.49**
1048 BENJAMAN DR	MAIN	21.42	**21.82**	**25.51**
1063 BENJAMAN DR	MAIN	24.6	21.7	**25.5**
1068 BENJAMAN DR	AUX	20.14	**21.7**	**25.5**
1077 BENJAMAN DR	MAIN	24.47	21.7	**25.5**
1078 BENJAMAN DR	MAIN	23.75	21.7	**25.5**
1084 BENJAMAN DR	MAIN	24.25	21.7	**25.5**
1092 BENJAMAN DR	MAIN	24.21	21.7	**25.5**
1100 BENJAMAN DR	MAIN	24.74	21.7	**25.5**
1201 DUCE DR	MAIN	29.64	29	**31**
1202 DUCE DR	MAIN	29.85	29	**31**
1202 DUCE DR	MAIN	29.94	29	**31**
1205 DUCE DR	MAIN	30	29	**31**
1207 DUCE DR	MAIN	30	29	**31**
1209 DUCE DR	MAIN	29.87	29	**31**
1213 DUCE DR	MAIN	28.83	28.74	**30.72**
1214 DUCE DR	MAIN	30.32	29.34	**31.35**
1215 DUCE DR	MAIN	28.51	**28.94**	**30.98**
1216 DUCE DR	MAIN	29.31	**29.33**	**31.35**
1217 DUCE DR	MAIN	28.26	**29.09**	**31.18**
1218 DUCE DR	MAIN	28.84	**29.3**	**31.33**
1302 DUCE DR	MAIN	28.49	**29.07**	**31.19**
1303 DUCE DR	MAIN	28.14	**28.95**	**31.08**
1304 DUCE DR	MAIN	28.54	**28.96**	**31.11**
1649 DUCE DR	MAIN	28.02	**29.04**	**31.14**
1667 DUCE DR	MAIN	28.57	**28.83**	**31.01**
708 DUSK CT	MAIN	28.61	**29.29**	**31.33**
725 DUSK CT	MAIN	28.54	**29.3**	**31.34**
726 DUSK CT	MAIN	28.97	**29.5**	**31.45**
1306 DUSK CT	MAIN	29.39	**29.53**	**31.46**
1341 FLEMING SCHOOL RD	MAIN	30	29	**31**
1361 FLEMING SCHOOL RD	MAIN	30	29	**31**
1361 FLEMING SCHOOL RD	AUX	30	29	**31**

Address	Main or Auxiliary Building	LAG	Calculated Water Surface Elevation (feet NAVD)	
			25-year flood	100-year flood
1381 FLEMING SCHOOL RD	MAIN	30	29	**31**
1381 FLEMING SCHOOL RD	AUX	30	29	**31**
1441 FLEMING SCHOOL RD	MAIN	30.19	29.5	**31.5**
1451 FLEMING SCHOOL RD	MAIN	30.33	29.5	**31.5**
1461 FLEMING SCHOOL RD	MAIN	30.44	29.5	**31.5**
1461 FLEMING SCHOOL RD	MAIN	30.71	29.5	**31.5**
1462 FLEMING SCHOOL RD	MAIN	30.68	29.5	**31.5**
916 SLAUTER ST	MAIN	25.05	20.8	**25.1**
926 SLAUTER ST	MAIN	24.76	20.8	**25.1**
936 SLAUTER ST	MAIN	24.57	20.8	**25.1**
0 STATON HOUSE RD	MAIN	30.79	29.5	**31.5**
1201 STATON HOUSE RD	AUX	30.87	29.5	**31.5**
1201 STATON HOUSE RD	MAIN	30.99	29.5	**31.5**
1211 STATON HOUSE RD	AUX	30.89	29.5	**31.5**
1211 STATON HOUSE RD	MAIN	30.93	29.5	**31.5**
1221 STATON HOUSE RD	MAIN	30.69	29.5	**31.5**
1794 STATON HOUSE RD	AUX	27.01	26.44	**28.8**
1794 STATON HOUSE RD	AUX	26.68	26.46	**28.82**
1794 STATON HOUSE RD	MAIN	27.43	26.48	**28.83**
908 THOMAS ST	MAIN	25.07	21.3	25.3
908 THOMAS ST	AUX	25.13	21.3	25.3

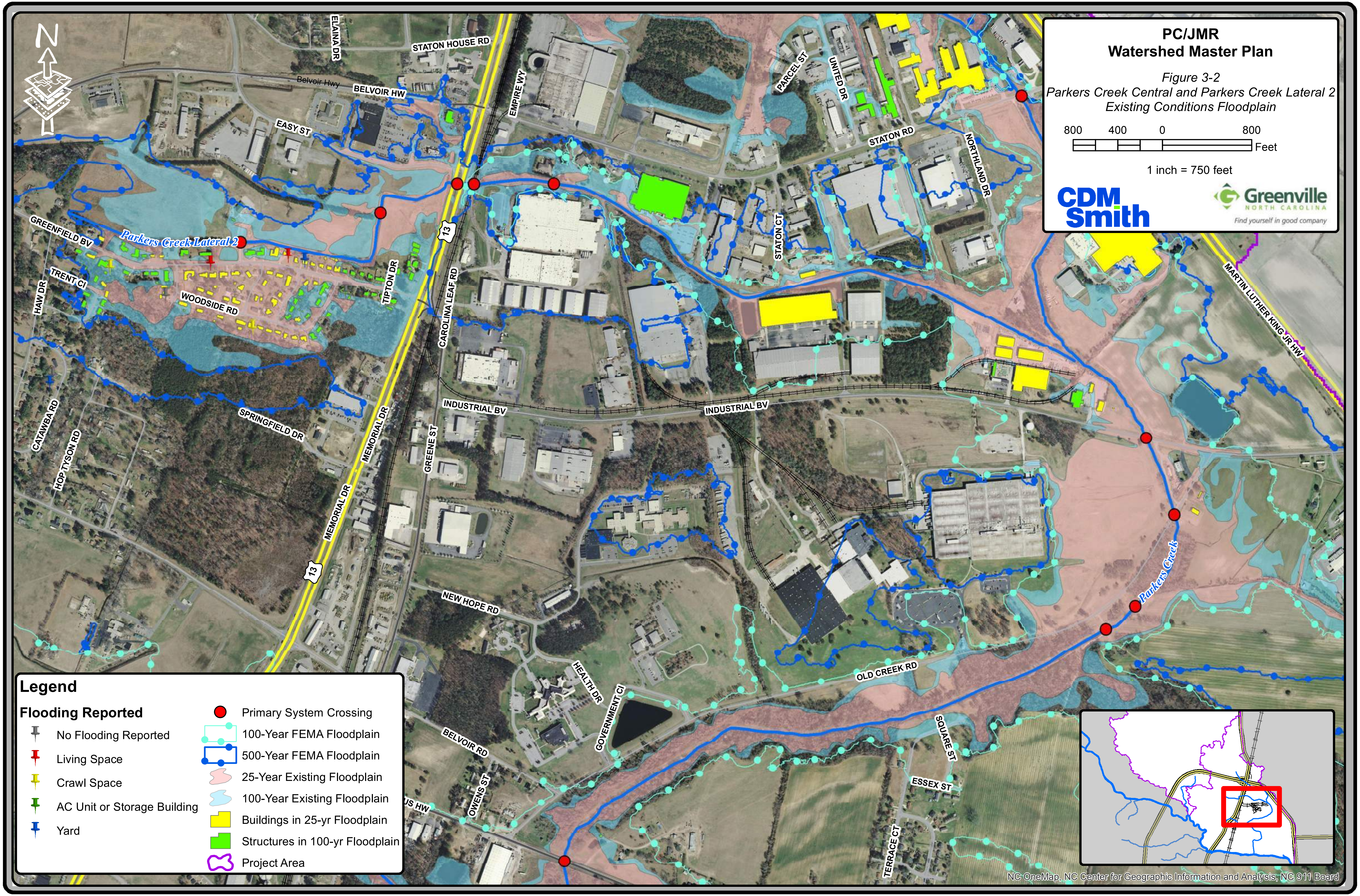
* Bold text indicates LAG flooding.

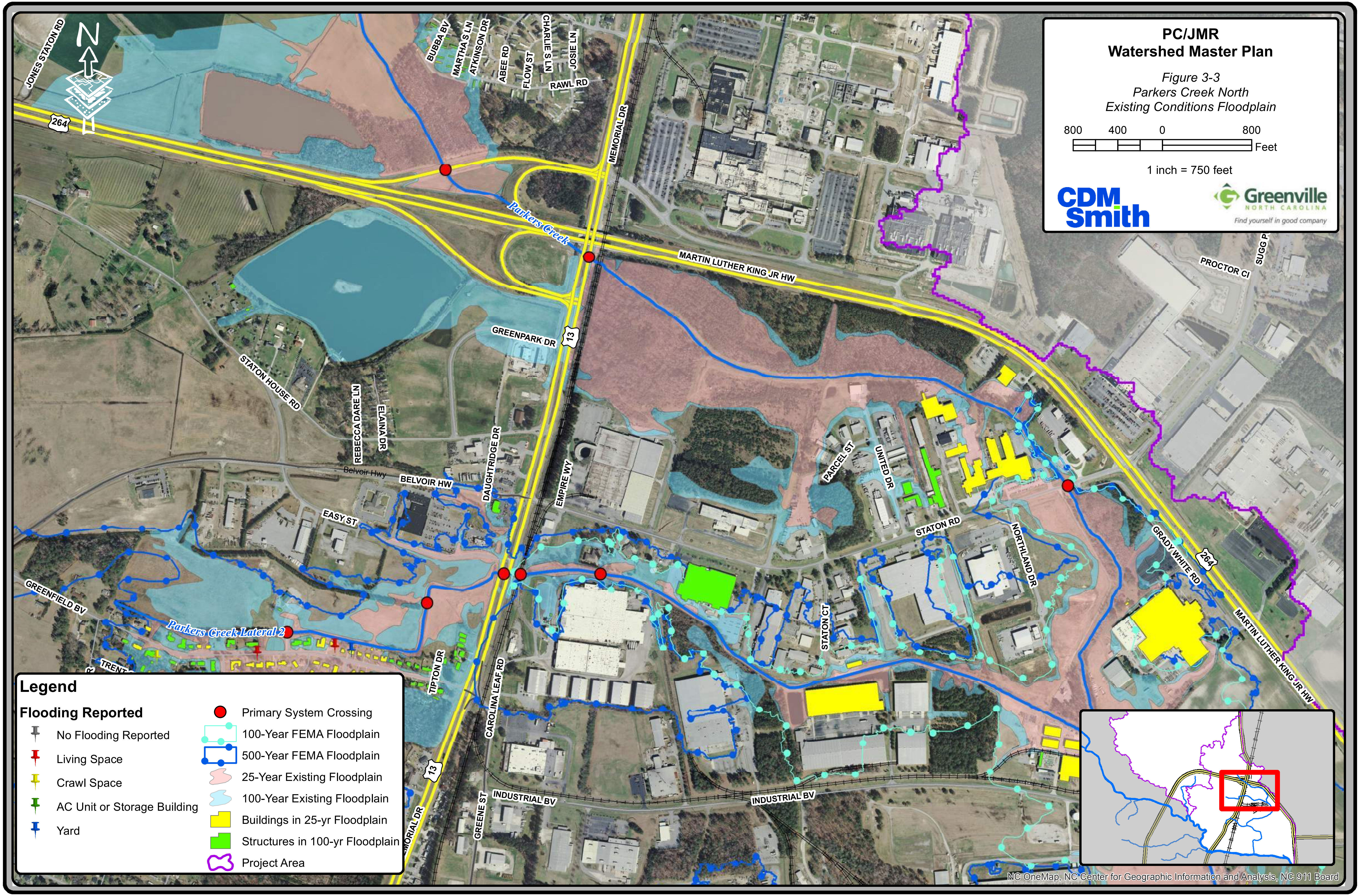
As shown in Table 3-4B, sixty-three structures along Johnsons Mill Run were identified for being at risk of flooding in the 100-year storm event. Of these, 15 are also within the modeled 25-year floodplain. The majority of these are residences located along Duce Drive, and Benjamin Drive, both outside of the City limits. None of the residences along Johnsons Mill Run submitted questionnaires indicating that they have experienced structural or yard flooding.

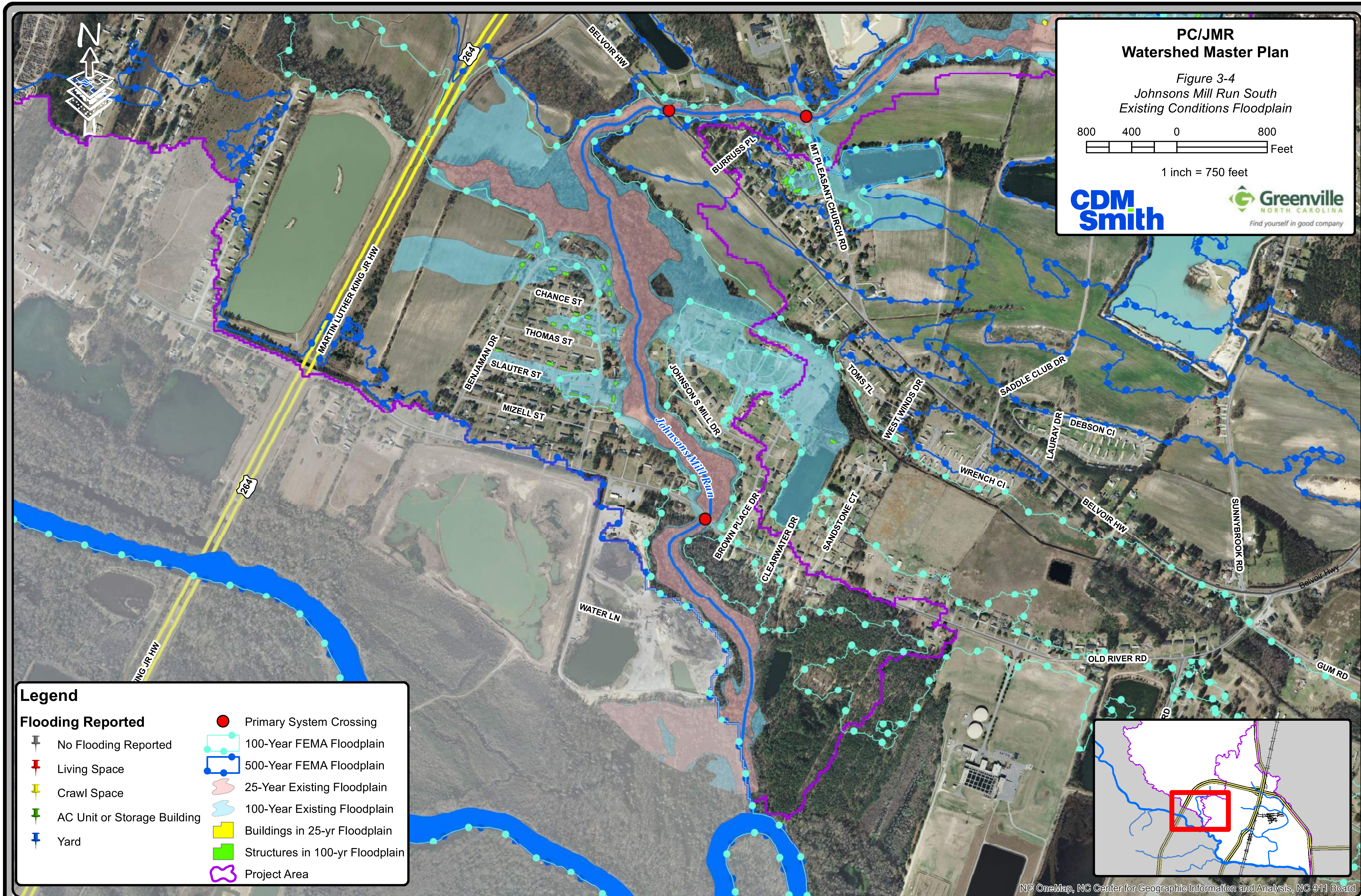
As noted above, the LAG elevations shown in the table are not surveyed and are estimated based on the State of North Carolina's LiDAR data. LAG flooding shown below may not result in actual LAG or finished floor flooding, but it is indicative of structures being at risk of flooding.



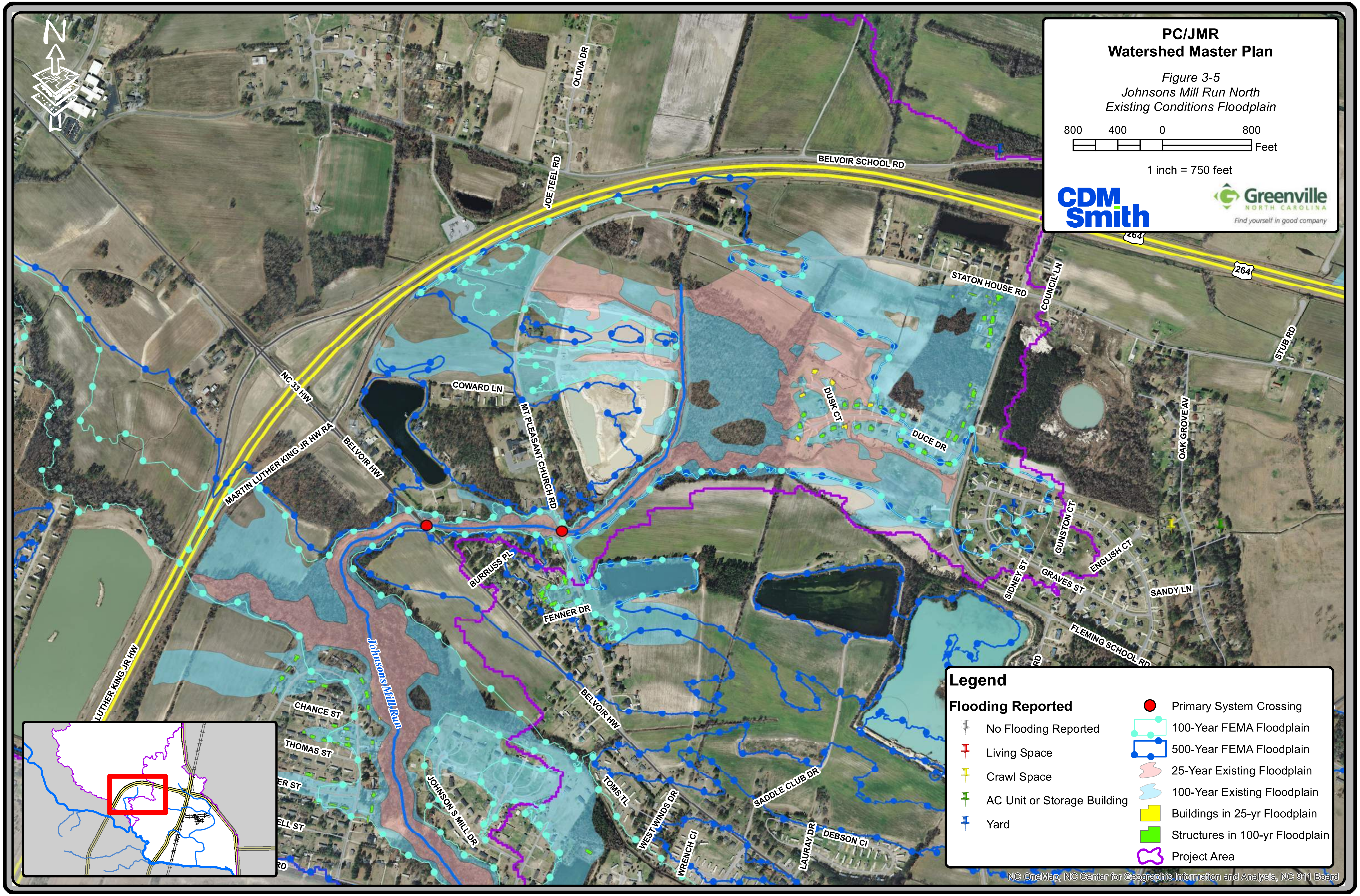
PC/JMR
Watershed Master Plan
Figure 3-1
Parkers Creek South and Parkers Creek Lateral 1
Existing Conditions Floodplain
800 400 0 800
Feet
1 inch = 750 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
Note: The Tar River 100 year floodplain covers this entire area.
Parkers Creek Lateral 1
Parkers Creek
Tar River
CONNIE ST
BELVOIR RD
OLD CREEK RD
ESSEX ST
MEMORIAL DR
POLLARD ST
OWENS ST
MORGAN ST
CLYDE DR
GUM RD
JULE ST
PACTOLUS HW
TERRACE CT
ACADEMY DR
ELITE PL
AIRPORT RD
OLD RIVER RD
CHURCH ST
ALLEN ST
POWELL ST
MILLS ST
DRUM AV
HENDRIX ST
CORNELIUS LN
CODY LN
FANNIE RD
PHILIPPI DR
DUDLEY ST
GENEVA CT
TICE CI
SPIRIT WY
LEGION ST
TAYLOR ST
VAN NORTWICK ST
MELODY LN
PITT ST
VAN DYKE ST
MEADOWBROOK DR
MARTIN ST
MOORE ST
FARMER ST
HOLLY ST
MUMFORD RD
GREENE ST
13
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Primary System Crossing
100-Year FEMA Floodplain
500-Year FEMA Floodplain
25-Year Existing Floodplain
100-Year Existing Floodplain
Buildings in 25-yr Floodplain
Structures in 100-yr Floodplain
Project Area
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board


PC/JMR
Watershed Master Plan
Figure 3-2
Parkers Creek Central and Parkers Creek Lateral 2
Existing Conditions Floodplain
800 400 0 800
Feet
1 inch = 750 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
N
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Primary System Crossing
100-Year FEMA Floodplain
500-Year FEMA Floodplain
25-Year Existing Floodplain
100-Year Existing Floodplain
Buildings in 25-yr Floodplain
Structures in 100-yr Floodplain
Project Area
Parkers Creek Lateral 2
Parkers Creek
STATON HOUSE RD
ELAINA DR
Belvoir Hwy
BELVOIR HW
EASY ST
EMPIRE WY
PARCEL ST
UNITED DR
STATON RD
NORTHLAND DR
STATON CT
GREENFIELD BV
TRENT CI
HAW DR
WOODSIDE RD
TIPTON DR
CAROLINA LEAF RD
13
INDUSTRIAL BV
MARTIN LUTHER KING JR HW
SPRINGFIELD DR
CATAWBA RD
HOP TYSON RD
MEMORIAL DR
GREENE ST
NEW HOPE RD
HEALTH DR
GOVERNMENT CI
OLD CREEK RD
BELVOIR RD
OWENS ST
US HW
SQUARE ST
ESSEX ST
TERRACE CT
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board


PC/JMR
Watershed Master Plan
Figure 3-3
Parkers Creek North
Existing Conditions Floodplain
800 400 0 800
Feet
1 inch = 750 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Primary System Crossing
100-Year FEMA Floodplain
500-Year FEMA Floodplain
25-Year Existing Floodplain
100-Year Existing Floodplain
Buildings in 25-yr Floodplain
Structures in 100-yr Floodplain
Project Area
N
JONES STATON RD
264
BUBBA BV
MARTHA S LN
ATKINSON DR
ABEE RD
FLOW ST
CHARLIE S LN
JOSIE LN
RAWL RD
MEMORIAL DR
Parkers Creek
MARTIN LUTHER KING JR HW
PROCTOR CI
SUGG P
GREENPARK DR
13
STATON HOUSE RD
REBECCA DARE LN
ELAINA DR
DAUGHTRIDGE DR
Belvoir Hwy
BELVOIR HW
EMPIRE WY
EASY ST
PARCEL ST
UNITED DR
STATON RD
NORTHLAND DR
GRADY WHITE RD
GREENFIELD BV
Parkers Creek Lateral 2
TIPTON DR
CAROLINA LEAF RD
STATON CT
INDUSTRIAL BV
GREENE ST
MORIAL DR
TRENT
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board



PC/JMR
Watershed Master Plan
Figure 3-4
Johnsons Mill Run South
Existing Conditions Floodplain
800 400 0 800
Feet
1 inch = 750 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
N
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Primary System Crossing
100-Year FEMA Floodplain
500-Year FEMA Floodplain
25-Year Existing Floodplain
100-Year Existing Floodplain
Buildings in 25-yr Floodplain
Structures in 100-yr Floodplain
Project Area
BELVOIR HW
BURRUSS PL
MT PLEASANT CHURCH RD
MARTIN LUTHER KING JR HW
264
CHANCE ST
THOMAS ST
SLAUTER ST
MIZELL ST
BENJAMAN DR
JOHNSON S MILL DR
Johnsons Mill Run
TOMS TL
WEST WINDS DR
SADDLE CLUB DR
LAURAY DR
DEBSON CI
WRENCH CI
BELVOIR HW
SUNNYBROOK RD
Belvoir Hwy
BROWN PLACE DR
CLEARWATER DR
SANDSTONE CT
WATER LN
OLD RIVER RD
GUM RD
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board



PC/JMR
Watershed Master Plan
Figure 3-5
Johnsons Mill Run North
Existing Conditions Floodplain
800 400 0 800
Feet
1 inch = 750 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
BELVOIR SCHOOL RD
OLIVIA DR
JOE TEEL RD
STATON HOUSE RD
COUNCIL LN
STUB RD
264
COWARD LN
NC 33 HW
MT PLEASANT CHURCH RD
DUSK CT
DUCE DR
OAK GROVE AV
MARTIN LUTHER KING JR HW RA
BELVOIR HW
GUNSTON CT
ENGLISH CT
SIDNEY ST
GRAVES ST
SANDY LN
BURRUSS PL
FENNER DR
FLEMING SCHOOL RD
Johnsons Mill Run
LUTHER KING JR HW
CHANCE ST
THOMAS ST
JOHNSON S MILL DR
TOMS TL
WEST WINDS DR
WRENCH CI
SADDLE CLUB DR
LAURAY DR
DEBSON CI
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Primary System Crossing
100-Year FEMA Floodplain
500-Year FEMA Floodplain
25-Year Existing Floodplain
100-Year Existing Floodplain
Buildings in 25-yr Floodplain
Structures in 100-yr Floodplain
Project Area
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

3.2 Secondary System Hydrologic and Hydraulic Analyses

While Parkers Creek and Johnsons Mill Run 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, three secondary systems were identified for further evaluation as shown in Figure 1-2. The secondary systems evaluated are as follows:

- Countryside/Oak Grove Estates Subdivision
- Greenfield Terrace System
- Haw Drive – E. Catawba Street System

3.2.1 Hydrology

EPA SWMM was used in the evaluation of the secondary systems. A detailed description about the hydrologic modeling methodology is included in Appendix A.

3.2.2 Hydraulics

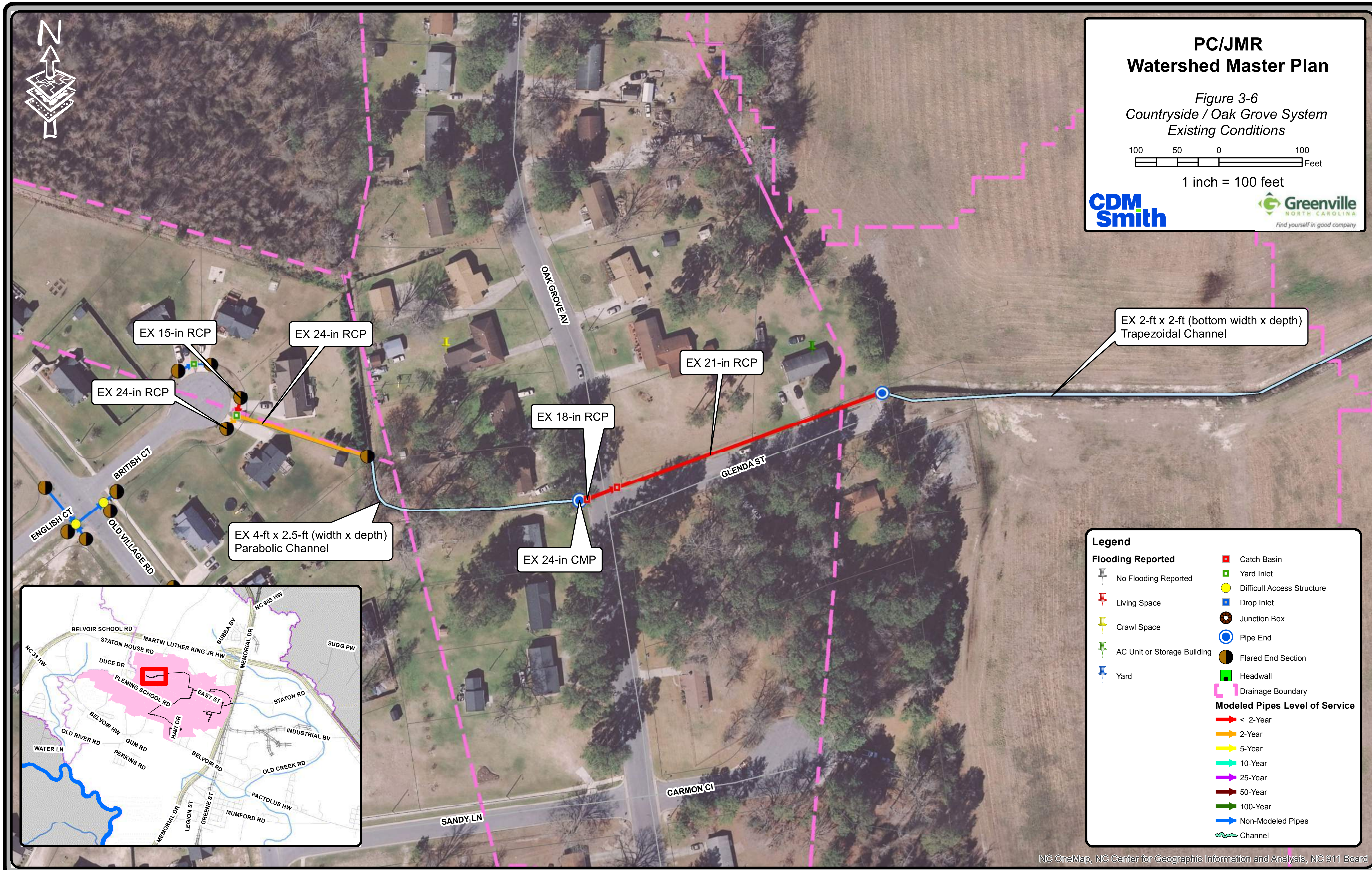
3.2.2.1 Countryside/Oak Grove Estates System

The Countryside/Oak Grove Estates System collects drainage from approximately 92 acres in the Countryside Estates subdivision and discharges via a drainage channel to Parkers Creek Lateral 2. There are an additional 30 acres collected in the Countryside / Oak Grove Estates System that discharges to Johnsons Mill Run. The conveyance system is comprised of a combination of RCP and corrugated metal pipe CMP ranging from 15- to 24-inches in diameter as well as a 4-foot deep trapezoidal channel. The pipes were determined to be in good condition based on data collected during the inventory. There are two reports of flooding in this area. The two residential flooding issues shown in **Figure 3-6** include a resident at the end of Glenda Street who experiences yard flooding and flooding of a storage space as well as another report of yard flooding up to the crawl space. Both of these residents reported general street flooding along Glenda Street and Oak Grove Avenue as well as flooding from the Countryside drainage ditch at the west end of Glenda Street.

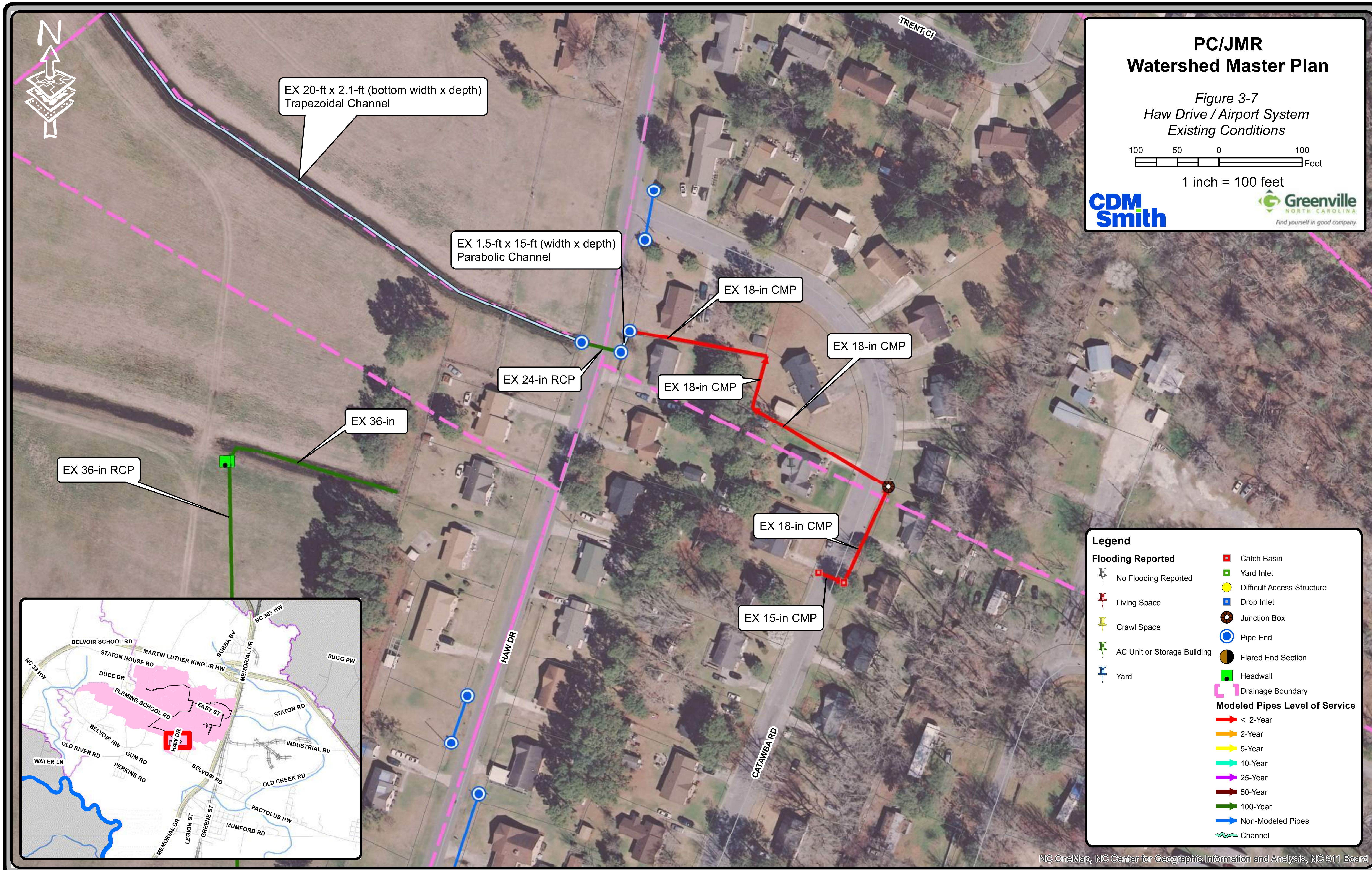
Figure 3-6 also shows the LOS being provided by the existing drainage system. Model results show that the majority of the system operates at or below a 2-year LOS. Backwater from the Countryside drainage ditch coupled with the long, flat sections of pipe contribute to this system not performing at its desired 10-year LOS.

3.2.2.2 Haw Drive/Airport System

The Haw Drive/Airport System collects drainage from approximately 75 acres along Catawba Road north of the airport. The conveyance system is comprised of a combination of RCP and CMP ranging from 15- to 24-inches in diameter and trapezoidal drainage channels. The pipes are predominantly in good condition based on data collected during the inventory. **Figure 3-7** shows the LOS being provided by the existing drainage system. Model results show that the majority of the system operates below a 2-year LOS.



PC/JMR
Watershed Master Plan
Figure 3-6
Countryside / Oak Grove System
Existing Conditions
100 50 0 100
Feet
1 inch = 100 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
N
EX 15-in RCP
EX 24-in RCP
EX 24-in RCP
EX 21-in RCP
EX 18-in RCP
EX 2-ft x 2-ft (bottom width x depth)
Trapezoidal Channel
EX 4-ft x 2.5-ft (width x depth)
Parabolic Channel
EX 24-in CMP
OAK GROVE AV
GLENDA ST
BRITISH CT
ENGLISH CT
OLD VILLAGE RD
CARMON CI
SANDY LN
BELVOIR SCHOOL RD
STATON HOUSE RD
MARTIN LUTHER KING JR HW
NC 903 HW
BUBBA BV
MEMORIAL DR
SUGG PW
NC 33 HW
DUCE DR
FLEMING SCHOOL RD
EASY ST
STATON RD
BELVOIR HW
HAW DR
INDUSTRIAL BV
OLD RIVER RD
GUM RD
WATER LN
PERKINS RD
BELVOIR RD
OLD CREEK RD
PACTOLUS HW
MEMORIAL DR
LEGION ST
GREENE ST
MUMFORD RD
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Drainage Boundary
Modeled Pipes Level of Service
< 2-Year
2-Year
5-Year
10-Year
25-Year
50-Year
100-Year
Non-Modeled Pipes
Channel
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board


PC/JMR
Watershed Master Plan
Figure 3-7
Haw Drive / Airport System
Existing Conditions
100 50 0 100
Feet
1 inch = 100 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
EX 20-ft x 2.1-ft (bottom width x depth)
Trapezoidal Channel
EX 1.5-ft x 15-ft (width x depth)
Parabolic Channel
EX 18-in CMP
EX 18-in CMP
EX 18-in CMP
EX 24-in RCP
EX 36-in
EX 36-in RCP
EX 18-in CMP
EX 15-in CMP
TRENT CI
HAW DR
CATAWBA RD
BELVOIR SCHOOL RD
MARTIN LUTHER KING JR HW
STATON HOUSE RD
NC 903 HW
BUBBA BV
MEMORIAL DR
SUGG PW
NC 33 HW
DUCE DR
FLEMING SCHOOL RD
EASY ST
STATON RD
BELVOIR HW
HAW DR
INDUSTRIAL BV
OLD RIVER RD
GUM RD
WATER LN
PERKINS RD
BELVOIR RD
OLD CREEK RD
PACTOLUS HW
MEMORIAL DR
LEGION ST
GREENE ST
MUMFORD RD
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Drainage Boundary
Modeled Pipes Level of Service
< 2-Year
2-Year
5-Year
10-Year
25-Year
50-Year
100-Year
Non-Modeled Pipes
Channel
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

Persistent roadway flooding has been reported by residents of Haw Drive and Catawba Street. The source of flooding has been identified as a lack of capacity of the downstream ditch system which crossed the airport towards the west before draining back to the east. A short closed pipe system of mostly 18-inch diameter drains these roadways to the airport channel beginning at Haw Drive. Recent drainage additions at the airport associated with runway extension were expected to correct these issues by connecting to the southern drainage flow path. The improvements may have reduced the extent of flooding at Haw Street, but did not alleviate the flooding issues for the northern area of the neighborhood, particularly Catawba Street.

Under the new drainage configuration, the northern area drains across the airport and back towards the north eventually connecting to Parkers Creek Lateral 2. The southern area drains directly to the south connecting to Parkers Creek Lateral 1 via a new 36-inch double barrel culvert. The recent additions added new channels and pipes and widened existing channels. While the channel improvements have opened up drainage across the airport, they disconnected the north area from the drainage path to the south. The flow path on the north side appears to be limited by grade with the invert on the west side of the airport at the same elevation as on the east. Therefore, a lack of drainage path is creating backwater into the neighborhood. The connection to the south appears to have ample grade to drain without backup. A recommended improvement option may be to connect the north drainage to the southern ditch via another ditch.

3.2.2.3 Greenfield Terrace System

The Greenfield Terrace System collects drainage from approximately 162 acres in the Greenfield Terrace subdivision and discharges directly to Parkers Creek Lateral 2 upstream of Memorial Drive. The conveyance system is comprised of a combination of RCP and CMP ranging from 15 to 24 inches in diameter in good condition based on data collected during the inventory. There are several reports of flooding in this area. The five residential flooding issues shown in Figure 3-6 include street flooding, yard flooding, yard erosion, as well as two reports of flooding in areas up to living spaces.

Figure 3-8 also shows the LOS being provided by the existing closed system. Model results show that the majority of the system operates below a 2-year LOS. Several stormwater inlets were observed to be obstructed with yard debris in addition to the general contribution of backwater in the system due to long, flat sections of pipe.

PC/JMR
Watershed Master Plan
Figure 3-8
Greenfield Terrace System
Existing Conditions
100 50 0 100
Feet
1 inch = 100 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
EX 60-in CMP
EX 60-in CMP
EX 12-ft x 7.5 (bottom width x depth)
Trapezoidal Channel
Parkers Creek Lateral 2
EX 15-in RCP
EX 15-in RCP
EX 15-in RCP
EX 15-in RCP
EX 15-in RCP
EX 15-in RCP
PARK ACCESS RD
GREENFIELD BV
FIRESIDE RD
BEACHWOOD DR
ASHTON DR
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Drainage Boundary
Modeled Pipes Level of Service
< 2-Year
2-Year
5-Year
10-Year
25-Year
50-Year
100-Year
Non-Modeled Pipes
Channel
BELVOIR SCHOOL RD
STATON HOUSE RD
MARTIN LUTHER KING JR HW
NC 903 HW
BUBBA BV
MEMORIAL DR
SUGG PW
NC 33 HW
DUCE DR
FLEMING SCHOOL RD
EASY ST
STATON RD
BELVOIR HW
HAW DR
INDUSTRIAL BV
OLD RIVER RD
GUM RD
WATER LN
PERKINS RD
BELVOIR RD
OLD CREEK RD
PACTOLUS HW
MEMORIAL DR
LEGION ST
GREENE ST
MUMFORD RD
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

3.3 Stream Stability Field Assessments

There are 44 miles of stream and ditches located in the PC/JMR Watershed. Within the watershed, 7.3 miles of stream, including Parkers Creek and Johnsons Mill Run, are classified for secondary recreation and aquatic wildlife survival and propagation (Class C) by NCDWR. These two streams are also classified as nutrient sensitive waters (NSW) by NCDWR, indicating they are subject to excessive growth of microscopic or macroscopic vegetation, or they contribute to downstream nutrient loading (NCDWR 2010). 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 PC/JMR 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, 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 5 to 50, with a score of 50 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.

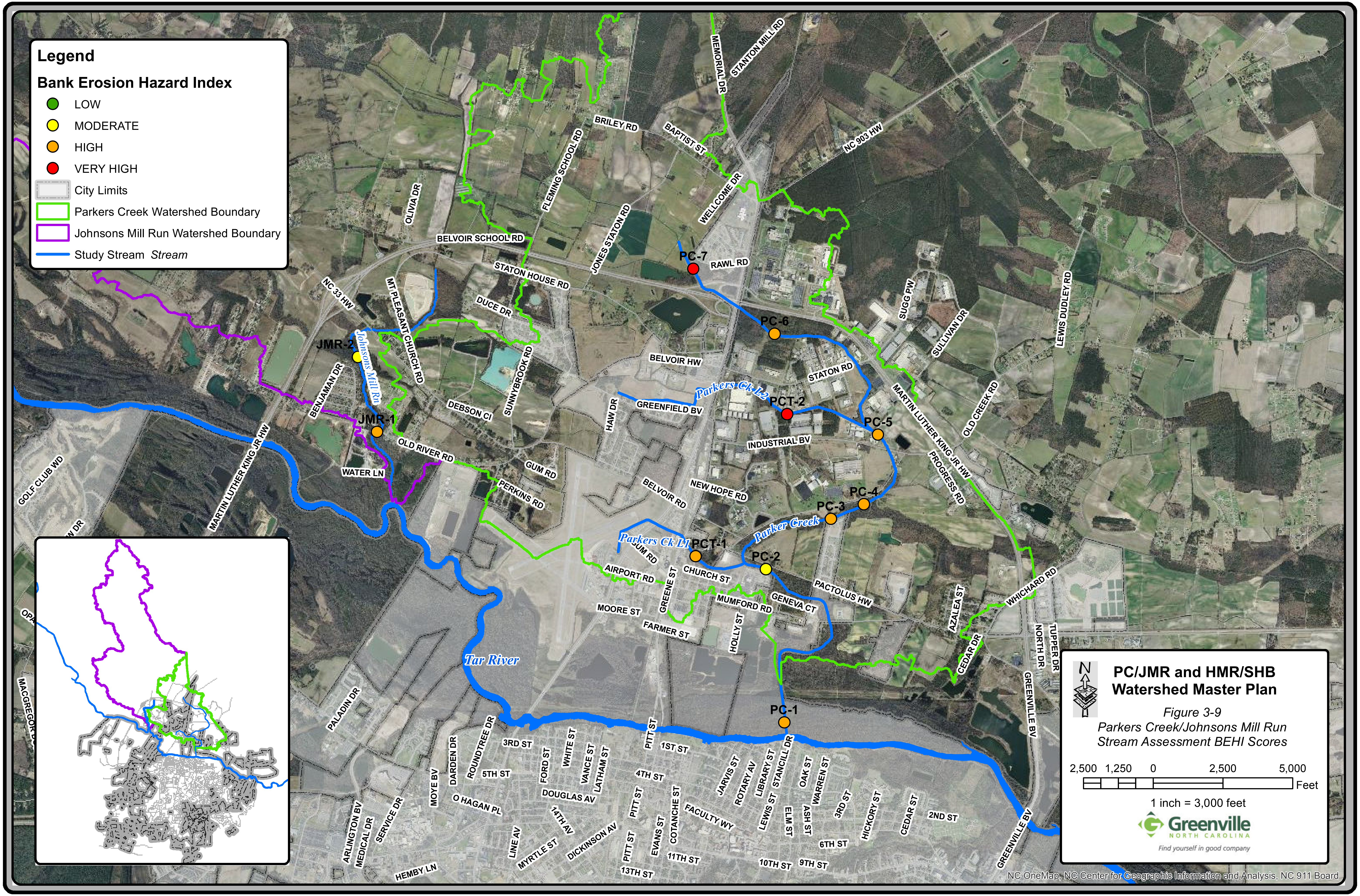
There are four main drainage features within the PC/JMR Watershed (see Figure 3-9). The largest of these is Parkers Creek. Johnsons Mill Run and its tributaries lie in the southwest portion of the watershed and constitute the second drainage feature. The remaining two drainage features are Parkers Creek Lateral 1 and Parkers Creek Lateral 2 (north). BEHI scores for each of these drainage areas are discussed below.

Nine BEHI assessments were performed along Parkers Creek and its laterals. Of these assessments on Parkers Creek, two had a BEHI rating of very high, one had a rating of moderate, and all other sample locations had a rating of high. The assessments showed that Parkers Creek is primarily a sand channel with generally high ratings for root density, bank height/bankfull height ratios mostly in the moderate to high range. Most of the sampling points had good surface protection and low to moderate bank angles. Due to the low gradient conditions and vegetative cover on the banks of most of Parkers Creek and its tributary Laterals 1 and 2, the banks are not experiencing destabilizing erosion.

Two BEHI assessments were performed on Johnsons Mill Run. These assessments scored in the moderate and high range. These are primarily sand bed channels with moderate to high bank height/bankfull height ratios, moderate to high bank angles, and low to moderate amounts of surface protection. Despite BEHI scores on the high side, excessive bank erosion was not observed on JMR warranting streambank stabilization and the stream is buffered with forest for almost the entire length assessed.

One BEHI assessment was performed on Parkers Creek Lateral 1. This assessment scored in the moderate range. Parkers Creek Lateral 1 is primarily a sand bottom channel with very high ratings for root density and high ratings for surface protection. This stream had moderate bank height/bankfull height ratios, and low bank angles.

One BEHI assessment was performed on Parkers Creek Lateral 2. This assessment scored in the very high range indicating a high potential for erosion. However, this reach is relatively low gradient and erosion is not a problem despite tall, steep banks. Parkers Creek Lateral 2 is a sand bed channel with low root density scores and very low surface protection scores. Bank height/bankfull height ratios were high, and root depth/bank height ratios were very high, but no significant erosion was observed This reach is surrounded by industrial development encroaching on the banks of the creek. Due to the very limited room for bank stabilization measures, the large number of different property owners, and the lack of active erosion this reach is not a candidate for bank stabilization.


Legend
Bank Erosion Hazard Index
LOW
MODERATE
HIGH
VERY HIGH
City Limits
Parkers Creek Watershed Boundary
Johnsons Mill Run Watershed Boundary
Study Stream Stream
PC/JMR and HMR/SHB Watershed Master Plan
Figure 3-9
Parkers Creek/Johnsons Mill Run Stream Assessment BEHI Scores
2,500 1,250 0 2,500 5,000
Feet
1 inch = 3,000 feet
N
Greenville
NORTH CAROLINA
Find yourself in good company
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board
PC-1
PC-2
PC-3
PC-4
PC-5
PC-6
PC-7
PCT-1
PCT-2
JMR-1
JMR-2
Tar River
Parker Creek
Parkers Ck L1
Parkers Ck L2
Johnsons Mill Rn
MEMORIAL DR
STANTON MILL RD
BRILEY RD
BAPTIST ST
NC 903 HW
FLEMING SCHOOL RD
WELLCOME DR
OLIVIA DR
JONES STATON RD
BELVOIR SCHOOL RD
RAWL RD
STATON HOUSE RD
NC 33 HW
MT PLEASANT CHURCH RD
DUCE DR
SUGG PW
SULLIVAN DR
LEWIS DUDLEY RD
BELVOIR HW
SUNNYBROOK RD
STATON RD
GREENFIELD BV
HAW DR
DEBSON CI
BENJAMAN DR
INDUSTRIAL BV
MARTIN LUTHER KING JR HW
OLD CREEK RD
OLD RIVER RD
WATER LN
GUM RD
PERKINS RD
BELVOIR RD
NEW HOPE RD
PROGRESS RD
GOLF CLUB WD
AIRPORT RD
CHURCH ST
GREENE ST
PACTOLUS HW
MUMFORD RD
GENEVA CT
MOORE ST
FARMER ST
HOLLY ST
AZALEA ST
WHICHARD RD
CEDAR DR
NORTH DR
TUPPER DR
GREENVILLE BV
PALADIN DR
MACGREGOR DS
ROUNDTREE DR
3RD ST
1ST ST
PITT ST
STANCILL DR
FORD ST
WHITE ST
VANCE ST
LATHAM ST
4TH ST
5TH ST
DARDEN DR
MOYE BV
JARVIS ST
ROTARY AV
LIBRARY ST
OAK ST
WARREN ST
O HAGAN PL
DOUGLAS AV
14TH AV
FACULTY WY
LEWIS ST
ELM ST
ASH ST
HICKORY ST
CEDAR ST
2ND ST
6TH ST
9TH ST
10TH ST
11TH ST
13TH ST
COTANCHE ST
EVANS ST
DICKINSON AV
MYRTLE ST
LINE AV
HEMBY LN
ARLINGTON BV
MEDICAL DR
SERVICE DR

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 encroachment, 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 and were based on future land use conditions. 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.

Peak flows for the primary systems under future conditions were developed for the 2-, 10-, 25-, 50-, and 100-year storm events, the same scenarios as for the existing conditions. The future conditions land use was determined based on projected future use of the project area using the available zoning GIS information provided by the City. Based on this information, the hydrologic parameters, such as curve numbers, time of concentration, and land cover, were updated to reflect the future conditions. Appendix A provides additional information on the hydrologic modeling.

The proposed conditions flows were developed taking into account attenuation for the proposed culvert sizes. The proposed peak flows used for sizing the proposed culverts for the various alternatives are summarized in tables. The flows assume all proposed improvements within the watershed are completed based on the alternative selected. If individual projects are implemented or combined with projects from another alternative, the peak flows should be updated to make sure downstream impacts are sufficiently analyzed. A hard copy of the HEC-HMS output is included as Appendix H. The CD found in Appendix J contains this digital information.

The hydraulic analysis for the proposed conditions was similar to the analysis completed for the existing and future conditions. The model was updated to reflect the proposed culvert improvements. The starting water surface elevations were the same for existing, future, and proposed conditions models. Appendix B provides additional information on the hydraulic modeling. A hard copy of the HEC-RAS output is included as Appendix H.

4.1.1 Parkers Creek

Parkers Creek and its two laterals (major tributaries) intersect the Memorial Drive corridor at three locations. Parkers Creek flows from the northwest under Highway 264, through the northeast industrial park mostly outside the City limits, crossing multiple roads. The two laterals drain areas to the west of Memorial Drive toward the main stem Parkers Creek to the east, each intersecting the roadway and railroad at Memorial Drive. Parkers Creek is dominated by backwater effects during high flows and therefore multiple roadways and crossings that are not meeting their designated LOS, including Staton Road and Industrial Boulevard.

US Highway 264 and Memorial Drive

At the interchange of Memorial Drive and US Highway 264 multiple roadways and a railroad cross Parkers Creek. From upstream to downstream, Parkers Creek first crosses under the US Hwy 264 entrance ramp to the northwest and then under Highway 264, both in triple 8′ x 8′ box culverts. The second set of 2,000-foot long concrete box culverts discharge on the east side of Memorial Drive where the creek flows beneath a railroad trestle bridge. As determined by the existing conditions analysis, each of these crossings exceed the 100-year LOS without any overtopping. According to the NCDOT Bridge Inspection Reports (Appendix L) the structures are in good or fair condition. The railroad trestle appears to be in fair condition. Since no overtopping is expected for the designated LOS and potential nearby dwelling structural flooding is not attributed to the crossings, no improvement alternatives were evaluated for the crossings at this location.

Staton Road

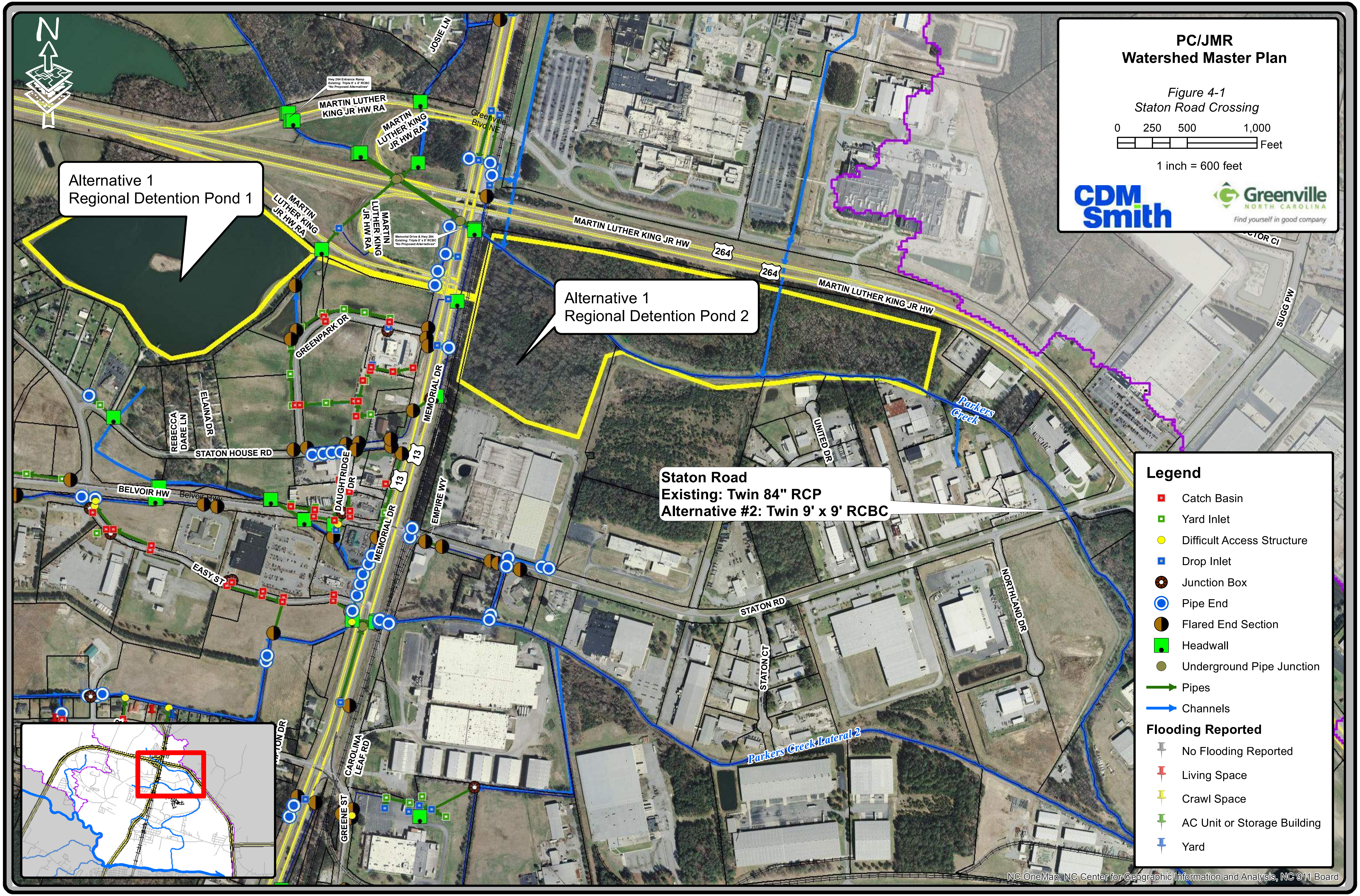
The existing twin 84" CMP and concrete culverts at Staton Road do not meet the desired 50-year LOS (see **Figure 4-1**). The culverts appear to be in fair condition with some degradation of the CMP bottom.

Alternative 1 – To reduce flooding along Parkers Creek, upstream regional detention was evaluated. As shown on Figure 4-1, two cascading regional detention ponds, one 100-acre and a second 60-acre regional detention facility were evaluated to reduce peak flows in Parkers Creek enough to reduce crossing overtoppings to meet the desired LOS at Staton Road, Industrial Boulevard, and Old Creek Road. This alternative would cost roughly $20 Million and would also reduce the extent of potential structural flooding along Parkers Creek. These projects and the crossings/areas which would have improved LOS are not within City limits and therefore they are not included in the project prioritization.

Alternative 2 – Without installation of an upstream regional detention facility as described in Alternative 1, improving the LOS at Staton Road is possible with a twin 9'x9' RCBC. However, this upgrade at Staton Road would only serve to increase the LOS from 2-yr to 25-yr, although the LOS for Staton Road is 50-yr as a designated thoroughfare. This improvement would cost an estimated $639,000. Additionally, this improvement at Staton Road would increase flood stages slightly at the downstream Old River Road bridge crossing under Alternative 2 without mitigating flood bench or upstream detention. Since these crossings and the roadways are themselves in the floodplain, the only other alternative to achieve the LOS for this site is a long span bridge which would go over and across the floodplain. This Alternative 2 project and the crossings/areas which would have improved LOS are not within City limits and therefore they are not included in the project prioritization .

Industrial Boulevard

The existing 3-girder wooden bridge crossing Parkers Creek at Industrial Boulevard is level with the floodplain but meets the required 10-year LOS. The existing bridge is wooden and has posted weight limits, but otherwise is in fair condition according to the NCDOT Bridge Inspection Report.


PC/JMR
Watershed Master Plan
Figure 4-1
Staton Road Crossing
0 250 500 1,000
Feet
1 inch = 600 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
Alternative 1
Regional Detention Pond 1
Alternative 1
Regional Detention Pond 2
Staton Road
Existing: Twin 84" RCP
Alternative #2: Twin 9' x 9' RCBC
MARTIN LUTHER KING JR HW RA
MARTIN LUTHER KING JR HW
MARTIN LUTHER KING JR HW
264
MEMORIAL DR
STATON HOUSE RD
BELVOIR HW
EASY ST
GREENPARK DR
DAUGHTRIDGE DR
EMPIRE WY
UNITED DR
STATON RD
STATON CT
NORTHLAND DR
SUGG PW
JOSIE LN
ELAINA DR
REBECCA DARE LN
CAROLINA LEAF RD
GREENE ST
13
Parkers Creek
Parkers Creek Lateral 2
Legend
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

The regional detention ponds proposed in Alternative 1 are intended to reduce peak flows before they reach the Industrial Boulevard crossing and effectively improve the crossing LOS.

Old Creek Road

As determined by the existing conditions analysis, the existing 3-girder wooden bridge at Old Creek Road is level with the floodplain and does meet the required 25-year LOS for minor thoroughfares without overtopping. While the bridge provides a 25- year LOS, the connecting roadway floods during the 25-year storm.

Farm Culverts

A pair of 96″ farm culverts in series parallel to Old Creek Road provide private access to agricultural property. These culverts are expected to flood more frequently than the 2-yr design storm. Since these are private culverts, no LOS is assigned and no improvements are recommended.

Pactolus Highway and Mumford Road

The existing twin 12′ x 12′ reinforced concrete box culverts at Mumford Road and the triple 14′ x 12′ Pactolus Highway (Route 33) meet the desired 50-year LOS. The culverts are all in good condition according to the latest NCDOT Bridge Inspection Reports, included in Appendix L. No improvements are proposed at these two locations (See Figure 4-1).

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

As noted in Table 3-4A a total of 27 structures along Parkers Creek are located at least partially within the existing conditions 100-year floodplain as modeled for this study and 11 structures along Parkers Creek are located at least partially within the 25-year floodplain. As a result of Alternative 1, two structures will be removed from the 25-year floodplain and five structures will be removed from the 100-year floodplain. Water surface elevations for the 25-year and 100-year event will be lower for 26 of the 27 floodprone structures along Parkers Creek resulting in a reduction in the frequency, severity, and duration of flooding.

As a result of Alternative 2, 3 structures will be removed from the 25-year floodplain and 12 structures will be removed from the 100-year floodplain. Water surface elevations for the 25-year and 100-year event will be lower for 26 of the 27 floodprone structures along Parkers Creek resulting in a reduction in the frequency, severity, and duration of flooding.

Table 4-1: Hydraulic Performance for Alternative 1 – Parkers Creek

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired LOS	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
US Hwy 264 Entrance Ramp (Existing Triple 8'x8' RCBC)	34.07	100-yr	24.74	26.45	27.43	28.26	29.28
Memorial Drive and US Hwy 264 (Existing Triple 8'x8' RCBC)	34.00	100-yr	24.51	26.18	27.11	27.82	28.66
Railroad Bridge (Existing Bridge)	28.67	100-yr	24.31	25.74	26.44	26.93	27.43
Staton Road (Existing Twin 7' RCP)	23.62	50-yr	18.72	21.23	22.26	23.31	**24.00**
Industrial Boulevard (Existing Bridge)	20.63	10-yr	17.56	19.93	20.28	**20.67**	**21.09**
Old Creek Road (Existing Bridge)	20.66	25-yr	17.15	19.77	19.96	20.15	20.40
Farm Culvert 2 (Existing 8' CMP)	16.90	-	16.77	**19.68**	**19.77**	**19.84**	**19.90**
Farm Culvert 1 (Existing 8' CMP)	17.59	-	16.06	**19.66**	**19.50**	**19.37**	**19.80**
Pactolus Highway (Existing Twin 12'x12' Box Culvert)	21.70	50-yr	10.19	12.00	13.00	13.88	14.73
Mumford Road (Existing Triple 14'x12' Box Culvert)	15.77	50-yr	6.57	8.14	9.06	9.82	10.51

* Bold text indicates the existing water surface has exceeded the rim elevation at the road thereby causing flooding.
** Green shade indicates crossing meets desired LOS. Red shade indicates crossing does not meet desired LOS.

Table 4-2: Hydraulic Performance for Alternative 2 – Parkers Creek

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired LOS	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
US Hwy 264 Entrance Ramp (Existing Triple 8'x8' RCBC)	34.07	100-yr	24.91	26.63	27.64	28.49	29.80
Memorial Drive and US Hwy 264 (Existing Triple 8'x8' RCBC)	34.00	100-yr	24.71	26.39	27.34	28.06	29.20
Railroad Bridge (Existing Bridge)	28.67	100-yr	24.53	25.99	26.73	27.25	27.78
Staton Road (Proposed Twin 9'x9' RCBC)	23.62	50-yr	21.12	22.62	23.30	**24.02**	**24.28**
Industrial Boulevard (Existing Bridge)	20.63	10-yr	19.96	**20.79**	**21.33**	**21.54**	**21.66**
Old Creek Road (Existing Bridge)	20.66	25-yr	19.79	20.20	**20.73**	**20.81**	**21.36**
Farm Culvert 2 (Existing 8' CMP)	16.90	-	**19.69**	**19.85**	**20.06**	**20.52**	**21.02**
Farm Culvert 1 (Existing 8' CMP)	17.59	-	**19.58**	**19.36**	**19.96**	**20.44**	**20.92**
Pactolus Highway (Existing Twin 12'x12' Box Culvert)	21.70	50-yr	11.33	13.18	14.22	15.15	16.18
Mumford Road (Existing Triple 14'x12' Box Culvert)	15.77	50-yr	7.37	9.01	9.93	10.62	11.40

*Bold text indicates the existing water surface has exceeded the rim elevation at the road thereby causing flooding.
**Green shade indicates crossing meets desired LOS. Red shade indicates crossing does not meet desired LOS.

4.1.2 Parkers Creek Lateral 1

Memorial Drive

The Memorial Drive crossing of Parkers Creek Lateral 1 has twin 7′ x 7′ box culverts in good condition and able to pass the 50-year designated LOS. Therefore, no improvements are proposed at this location (See **Figure 4-2**).

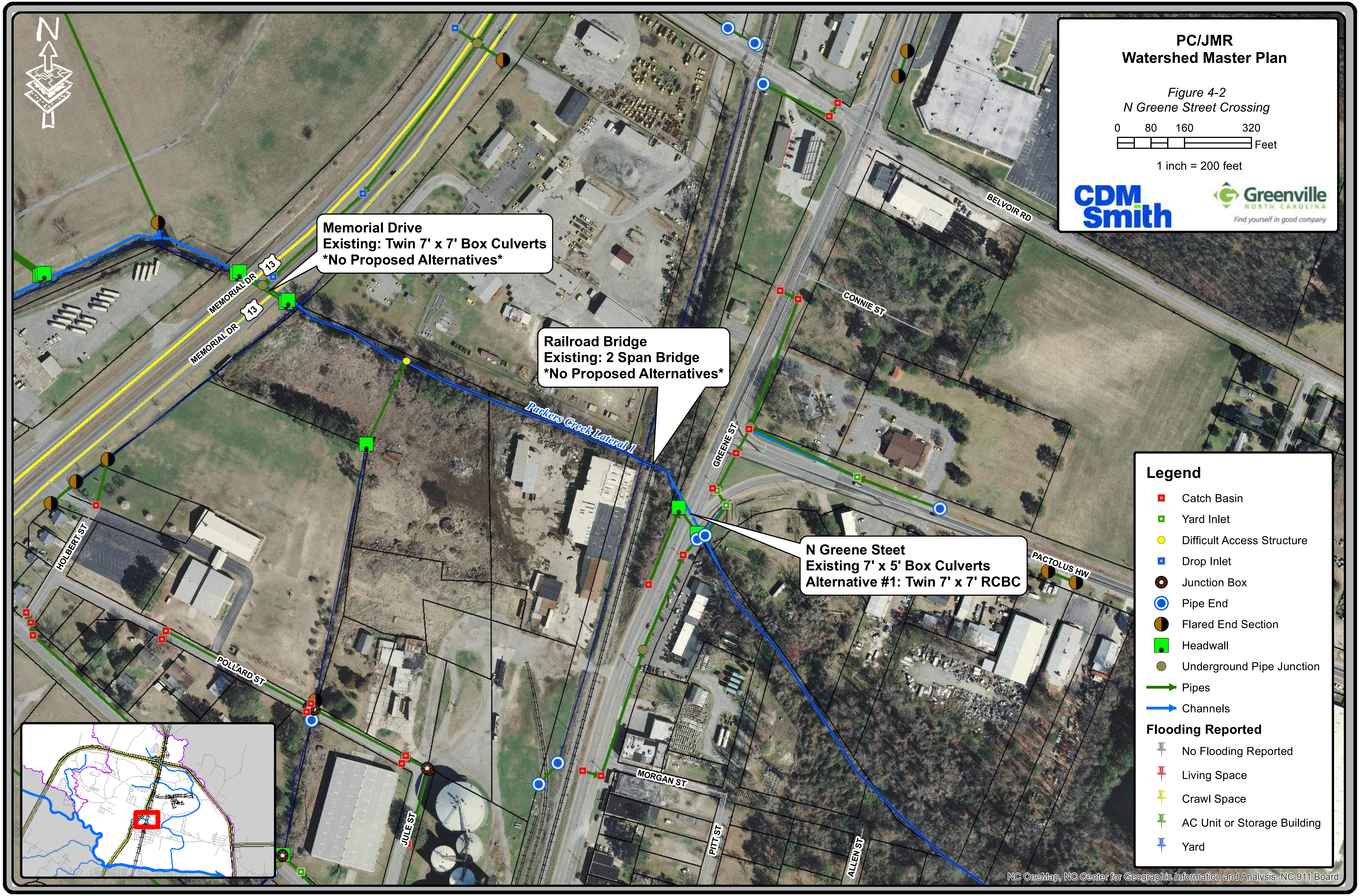
Railroad Bridge

The concrete Railroad Bridge crossing of Parkers Creek Lateral 1 is in fair condition and able to pass the 100-year designated LOS. Therefore, no improvements are proposed at this location.

N. Greene Street

The Greene Street crossing of Parkers Creek Lateral 1 has a single 7′ x 5′ RCBC only meeting a 25-year LOS. Proposed upgrade to the culvert is a twin 7′ x 7′ RCBC to meet the 50-year designated LOS. Since the crossing appears to be in good condition and overtops only about 1/10 of a foot for the designated design storm, no other alternatives are presented.

A summary of the hydraulic performance for the improvements proposed is included in **Table 4-3** below. The water surface elevations shown assume all proposed



PC/JMR
Watershed Master Plan
Figure 4-2
N Greene Street Crossing
0 80 160 320
Feet
1 inch = 200 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
Memorial Drive
Existing: Twin 7' x 7' Box Culverts
No Proposed Alternatives
Railroad Bridge
Existing: 2 Span Bridge
No Proposed Alternatives
N Greene Steet
Existing 7' x 5' Box Culverts
Alternative #1: Twin 7' x 7' RCBC
Parkers Creek Lateral 1
MEMORIAL DR
13
GREENE ST
CONNIE ST
BELVOIR RD
PACTOLUS HW
HOLBERT ST
POLLARD ST
MORGAN ST
JULE ST
PITT ST
ALLEN ST
Legend
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

primary system improvements for Parkers Creek Lateral 1 are constructed. The total estimated cost for this project is $650,000. (See Figure 4-1).

Table 4-3: Hydraulic Performance for Parkers Creek - Lateral 1 (south) Improvements

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired LOS	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
Memorial Drive (Existing Twin 7'x7' RCBC)	23.71	50-yr	13.57	15.00	15.97	16.65	17.44
Railroad Bridge (Existing Bridge)	22.28	100-yr	12.82	14.29	15.28	15.96	16.65
N. Greene Street (Proposed Twin 7'x7' RCBC)	17.78	50-yr	12.71	14.20	15.17	15.83	16.50

* Bold text indicates the existing water surface has exceeded the rim elevation at the road thereby causing flooding.
** Green shade indicates crossing meets desired LOS. Red shade indicates crossing does not meet desired LOS.

As a result of improvements on Parkers Creek Lateral 1, three structures will be removed from the 25-year floodplain at 1630 N Greene Street and three structures will be removed from the 100-year floodplain at 1501 N. Memorial Drive and N. Greene Street.

4.1.3 Parkers Creek Lateral 2

Parkers Creek Lateral 2 drains the area west of Memorial Drive including the north end of the airport property, Greenfield Park, and the east side of Countryside Estates. Flows converge at the Memorial Drive crossing and then flow through the industrial park to the east without additional crossings except for one elevated private bridge crossing before confluence with Parkers Creek.

Memorial Drive and Railroad Crossing

The Memorial Drive and Railroad crossing of Parkers Creek Lateral 2 is a reported flow constriction. Until last year, the railroad crossing had only 1- 66" RCP to convey flows. Currently the railroad has 3-66" RCP culverts. The existing open culvert under Memorial Drive is a single elliptical 8.5' x 5' RCP. A second elliptical 8.5' x 5' RCP at this location is sealed closed, reportedly to manage flows without causing damage to the immediate downstream railroad crossing.

Alternative 1 – To improve the LOS and reduce flooding upstream of Memorial Drive, re-opening of the sealed culvert barrel is proposed. This alternative would improve the LOS of the crossing to the designated 50-year storm for existing conditions and lower the flood stages upstream by 1.5 feet for the 25-yr and 1.3 feet for the 100-year design storms. A reduction in the number of structures within the floodplain upstream of Memorial Drive by an estimated 99 structures for the 25-year storm, would result. The total estimated cost for the project is $5,000 to remove the concrete seal. (see **Figure 4-3**). Since this alternative does not achieve the designated LOS, it is not the recommended alternative and is not included in the project prioritization.


PC/JMR
Watershed Master Plan
Figure 4-3
Memorial Drive and Railroad Culvert Crossings
0 250 500 1,000 Feet
1 inch = 400 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
Greenfield Farm Culvert
Existing: 48" CMP
No Proposed Alternatives
Railroad Bridge
Existing: Triple 66" RCP
Alternative #2: Quadruple 66" RCP
Private Crossing
Existing: Bridge
No Proposed Alternatives
Greenfield Park Access Road
Existing: 60" CMP
No Proposed Alternatives
Memorial Drive
Existing: Eliptical 8.5' x 5' RCP
Alternative #1: Unsealed Second Arch Culvert
Alternative #2: Quadruple 66" RCP
Legend
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
STATON HOUSE RD
REBECCA DARE LN
ELAINA DR
GREENPARK DR
DAUGHTRIDGE DR
EMPIRE WY
BELVOIR HW
Belvoir Hwy
EASY ST
STATON RD
Parkers Creek Lateral 2
GREENFIELD BV
FIRESIDE RD
HAW DR
TRENT CI
WOODSIDE RD
MEMORIAL DR
CAROLINA LEAF RD
GREENE ST
INDUSTRIAL BV
SPRINGFIELD DR
13
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

Alternative 2 – To improve the LOS and reduce flooding upstream of Memorial Drive, upgrade of the Memorial Drive culverts to quadruple 66" RCP is proposed. Additionally, installation of a fourth culvert barrel under the railroad is required to match the capacity of the upgrade at Memorial Drive to meet the designated LOS. This alternative would reduce the number of structures within the floodplain upstream of Memorial Drive by an estimated 104 structures for the 25-year storm. The total estimated cost for this project is $1,170,000. (see Figure 4-3).

Now that the railroad crossing has increased capacity with three rather than one culvert barrel, it is proposed to open the sealed elliptical culvert under Memorial Drive. Alternative 1 will improve the crossing LOS to the 50-year under existing conditions, but only the 25-year under future conditions. To achieve the 50-year LOS under future conditions, Alternative 2 is recommended.

Private Bridge Crossing

A private bridge crossing of Parkers Creek Lateral 2 is elevated above the floodplain and does not restrict flows. This private crossing is approximately 600 feet downstream of Memorial Drive on an industrial property.

Summary of Hydraulic Performance Parkers Creek

A summary of the hydraulic performance for the improvements proposed for Alternatives 1 and 2 are included in **Tables 4-4 and 4-5**, respectively. The water surface elevations shown assume all proposed primary system improvements for Parkers Creek Lateral 2 are constructed. The LOS will be reduced if all projects are not implemented.

As noted in Table 3-4A a total of 174 structures along Parkers Creek Lateral 1 are located at least partially within the existing conditions 100-year floodplain as modeled for this study and 125 structures along Parkers Creek Lateral 1 are located at least partially within the 25-year floodplain. As a result of Alternative 1 on Lateral 2, 99 structures will be removed from the 25-year floodplain and 4 structures will be removed from the 100-year floodplain. Water surface elevations for the 25- year and 100-year event will be lower for 26 of the 27 floodprone structures along Parkers Creek Lateral 1 resulting in a reduction in the frequency, severity, and duration of flooding.

As a result of Alternative 2 on Lateral 2, 104 structures will be removed from the 25-year floodplain and eight structures will be removed from the 100-year floodplain. Water surface elevations for the 25-year and 100-year event will be lower for floodprone structures along Parkers Creek Lateral 2 upstream of Memorial Drive resulting in a reduction in the frequency, severity, and duration of flooding.

Table 4-4: Hydraulic Performance for Alternative 1 – Parkers Creek - Lateral 2 (north)

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired LOS	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
Greenfield Park Access Road (Existing 60" CMP)	25.20	10-yr	21.60	23.93	**25.40**	**26.61**	**27.03**
Greenfield Farm Culvert (Existing 48" CMP)	24.97	10-yr	21.57	23.89	**25.36**	**26.61**	**27.03**
Memorial Drive (Proposed Unsealed Second Arch Culvert)	26.19	50-yr	21.53	23.77	25.31	**26.60**	**27.02**
Railroad Culvert (Existing Triple 66" RCP)	28.57	100-yr	21.47	23.46	24.66	25.63	26.71
Private crossing (Existing Bridge)	24.60	-	21.32	23.11	24.04	**24.68**	**25.29**

*Bold text indicates the existing water surface has exceeded the rim elevation at the road thereby causing flooding. Red text indicates the overtopping does not meet the designated LOS.

**Green shade indicates crossing meets desired LOS. Red shade indicates crossing does not meet desired LOS.

Table 4-5: Hydraulic Performance for Alternative 2 – Parkers Creek - Lateral 2 (north)

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired LOS	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
Greenfield Park Access Road (Existing 60" CMP)	25.20	10-yr	20.98	23.11	24.50	**25.40**	**26.52**
Greenfield Farm Culvert (Existing 48" CMP)	24.97	10-yr	20.93	23.06	24.43	**25.32**	**26.51**
Memorial Drive (Proposed Quadruple 66" RCP)	26.19	50-yr	20.89	22.95	24.22	25.25	**26.50**
Railroad Culvert (Proposed Quadruple 66" RCP)	28.57	100-yr	20.87	22.83	23.93	24.75	25.60
Private crossing (Existing Bridge)	24.60	-	20.74	22.66	23.66	24.34	**24.99**

*Bold text indicates the existing water surface has exceeded the rim elevation at the road thereby causing flooding.

**Green shade indicates crossing meets desired LOS. Red shade indicates crossing does not meet desired LOS.

4.1.4 Johnsons Mill Run

The three most downstream crossings of Johnsons Mill Run within the hydraulic study area all meet the desired LOS for crossing overtopping. Flooding which potentially impacts structures to the west of Countryside Estates is not influenced by the crossings for the modeled 25-year or 100-year floodplain. The two downstream NCDOT bridges at Belvoir Highway (NC 33) and Old River Road were recently rebuilt and are in fair or good condition.

The Mount Pleasant Church Road crossing was not evaluated for condition. No improvements are proposed for any structures on Johnsons Mill Run. **Tables 4-6 and 4-7** are below.

Table 4-6: Proposed Conditions Flows from HEC-HMS (Alternative 1)

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)
Parkers Creek							
J_PC_2300	US Hwy 264 Entrance Ramp	XS-29594	5	13	20	27	36
J_PC_2000	Memorial Drive and US Hwy 264	XS-27742	67	148	209	263	326
J_PC_1800	Railroad Bridge	XS-26062	113	241	334	414	505
J_PC_1500	Staton Road	XS-21432	184	368	488	595	715
J_PC_1200	Industrial Boulevard	XS-17681	287	620	847	1,035	1,245
J_PC_1200	Old Creek Road	XS-17049	287	620	847	1,035	1,245
J_PC_1000	Farm Culvert 2	XS-16107	284	649	914	1,126	1,355
J_PC_1000	Farm Culvert 1	XS-15749	284	649	914	1,126	1,355
J_PC_800	Pactolus Highway	XS-10165	326	739	1,067	1,335	1,619
J_PC_400	Mumford Road	XS-5784	401	908	1,340	1,710	2,120
J_PC_200	D/S Limit of Parkers Creek	XS-5229	426	969	1,440	1,858	2,325
Parkers Creek - Lateral 1 (south)							
J_PC_531	U/S Limit of Parkers Cr-Lateral 1	XS-5182	8	17	25	31	39
J_PC_530	Memorial Drive	XS-4219	55	148	235	315	404
J_PC_510	Railroad Bridge	XS-2910	73	189	299	394	500
J_PC_510	N. Greene Street	XS-2747	73	189	299	394	500
J_PC_L1	D/S Limit of Parkers Cr-Lateral 1	XS-962	90	230	361	476	603
Parkers Creek - Lateral 2 (north)							
J_PC_1340	U/S Limit of Parkers Cr-Lateral 2	XS-9978	7	17	25	33	41
J_PC_1320	Memorial Drive	XS-6192	56	135	196	251	314
J_PC_1320	Railroad Culvert	XS-5987	56	135	196	251	314
J_PC_1320	Private crossing (bridge)	XS-5330	56	135	196	251	314
J_PC_1310	0.5 mile below Railroad	XS-2950	88	201	286	362	447
J_PC_L2	D/S Limit of Parkers Cr-Lateral 2	XS-816	103	230	337	428	528

Table 4-7: Proposed Conditions Flows from HEC-HMS (Alternative 2)

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)
Parkers Creek							
J_PC_2300	US Hwy 264 Entrance Ramp	XS-29594	175	382	549	705	874
J_PC_2000	Memorial Drive and US Hwy 264	XS-27742	231	469	661	825	1,012
J_PC_1800	Railroad Bridge	XS-26062	261	517	728	898	1,096
J_PC_1500	Staton Road	XS-21432	124	273	394	512	643
J_PC_1200	Industrial Boulevard	XS-17681	180	416	600	769	961
J_PC_1200	Old Creek Road	XS-17049	180	416	600	769	961
J_PC_1000	Farm Culvert 2	XS-16107	192	435	654	860	1,085
J_PC_1000	Farm Culvert 1	XS-15749	192	435	654	860	1,085
J_PC_800	Pactolus Highway	XS-10165	238	542	814	1,083	1,376
J_PC_400	Mumford Road	XS-5784	323	753	1,124	1,486	1,887
J_PC_200	D/S Limit of Parkers Creek	XS-5229	349	815	1,226	1,637	2,096
Parkers Creek - Lateral 1 (south)							
J_PC_531	U/S Limit of Parkers Cr-Lateral 1	XS-5182	8	17	25	31	39
J_PC_530	Memorial Drive	XS-4219	55	148	235	315	404
J_PC_510	Railroad Bridge	XS-2910	73	189	299	394	500
J_PC_510	N. Greene Street	XS-2747	73	189	299	394	500
J_PC_L1	D/S Limit of Parkers Cr-Lateral 1	XS-962	90	230	361	476	603
Parkers Creek - Lateral 2 (north)							
J_PC_1340	U/S Limit of Parkers Cr-Lateral 2	XS-9978	7	17	25	33	41
J_PC_1320	Memorial Drive	XS-6192	80	202	301	391	495
J_PC_1320	Railroad Culvert	XS-5987	80	202	301	391	495
J_PC_1320	Private crossing (bridge)	XS-5330	80	202	301	391	495
J_PC_1310	0.5 mile below Railroad	XS-2950	113	268	386	496	621
J_PC_L2	D/S Limit of Parkers Cr-Lateral 2	XS-816	128	304	438	560	699

4.2 Secondary Systems

Developing flood control alternatives for the secondary systems typically included increases 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 the secondary system are oftentimes constrained by private property as space is typically limited between houses or other structures. Utility conflicts are another constraint typical for secondary system improvements. Secondary system improvements also 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.

Countryside – Oak Grove Avenue System

Drainage issues including standing water in the road and ditches along residential yards have been reported in this area. The Countryside subdivision drains to the west through a culvert under Fleming School Rd and to the east beneath Oak Grove Avenue and Glenda Street. Neither the east or west culverts in conjunction with the respective downstream ditches are capable of conveying the 2-yr design storm, let alone the 10-year designated LOS. However, the more immediate issues are associated with standing water occurring with smaller, frequent rain events. At the end of Old Village Road, standing water is attributed to blockage of the downstream ditch in the County Drainage District jurisdiction. On both the east and west of the area the downstream ditches are maintained by the County Drainage District.

On the west side of Countryside Estates drains flow to the culvert under Fleming School Road to the ditch in Pitt County Drainage District 12484. Flooding at the cul-de-sac end of Old Village Road is attributed to blockage of the downstream ditch. Low flows are not moving unimpeded through the ditch on private property and are backing up water to Old Village Road during small rain events. Modeling in SWMM indicates the piping system including the 24" RCP at the end of Old Village Road and the 36" CMP under Fleming School Road have sufficient capacity to convey flows from the approximately 32-acre drainage area on the east side of Fleming School Road including the 10-yr designated LOS flows when the downstream ditch is maintained clear. The west end of the 36" CMP culvert under Fleming School Road is slightly damaged, but this does not appear to be affecting capacity for smaller events. Besides end repair or replacement of the CMP culvert under Fleming School Road, no infrastructure improvements are recommended for the west side of Countryside Estates. Coordination with the Pitt County Drainage District is recommended to implement clearing of the downstream ditch and restore drainage to the west end of Countryside Estates.

Flooding of Oak Grove Avenue is expected during any sizeable storm as the system is only able to convey less than the 2-year storm without overtopping the roadway. The closed drainage system under Glenda Street receives drainage from approximately 94 acres of undeveloped and medium density residential land uses at the intersection with Oak Grove Avenue. The most frequent and visible issue is poor roadway drainage with standing water in the roadway caused by damaged, uneven, and uncrested pavement associated with original construction and installation of a sewer line beneath the road.

Currently this drainage system, on the east side of the Countryside Estates, does not meet a 2-year LOS and is attributed to roadway and structural flooding. Modeling results from the Countryside – Oak Grove Avenue System suggest that with the drainage areas currently entering the system and the grade-related limitations of the possible improvements, the 10-year LOS will be met through significant infrastructure improvements to the existing system. The system receives drainage from over 90 acres, and improvements to manage the lateral stormwater runoff are limited due to physical constraints such as the low depth of cover available for pipe upsizing, and the low gradient of the drainage system. Besides drainage system improvements meeting the desired 10-year LOS, roadway improvements along Oak Grove Avenue are recommended to address the recurring issue of standing water by improving drainage along this roadway and more effectively directing runoff to the existing drainage system. CDM Smith recommends the following improvement options for the Countryside – Oak Grove Avenue System to achieve the designated LOS (see **Figure 4-4**):

- Replace 165 linear feet of 24" RCP with 27" RCP at 2308 British Court;
- Replace 10 linear feet of 24" CMP, 39 linear feet of 18-inch RCP, and 338 linear feet of 21" RCP with double 4'x2' RCBC barrels across Oak Grove Avenue and the length of Glenda Street;
- Widen 1,700 linear feet of the existing drainage ditch from a 4' bottom width to a 8' bottom width;
- Pavement replacement and regrading to drain;
- Install 1 yard inlet;
- Install 2 catch basins; and
- Install headwalls on both ends of RCBC.

Results from the model for the Countryside System suggest that upsizing of conduit will achieve the designated LOS despite low depth of cover and high groundwater table. The Total estimated cost for the recommended alternative is $580,000. A portion of the proposed improvements will cause significant impacts to private property. There will be impacts to the driveways, landscaping, and/or fencing at the following private properties:

- 2308 British Court
- 303 Oak Grove Avenue
- 301 Oak Grove Avenue

There is curb and gutter located along Glenda Street that will need to be removed and replaced as part of this project. Gas lines, water mains, and sanitary sewer lines were also identified as potential site restrictions and utility conflicts in the project area.

Two residents reported flooding in this system. The resident at 305 Oak Grove Avenue reported flooding up to their crawl space, while the resident at 103 Glenda Street reported flooding to up to their storage space. It is suspected that the flooding in this system is largely due to a high backwater in the Countryside ditch between the subdivisions as well as low sloping grades in the area. Therefore, the recommended improvements for the Countryside – Oak Grove Avenue system are expected to have little impact on the yard flooding.

The drainage system serving the west side of Countryside Estates was also evaluated to remedy the persistent flooding at the end of Old Village Road. On the west side, flooding is attributed to blockage of the downstream ditch in Pitt County Drainage District 12484. Low flows are not moving through the ditch and are backing up water all the way to Old Village Road. The culvert beneath Fleming School Road has sufficient capacity to convey runoff from Countryside Estates to the ditch in the Drainage District, but clearing maintenance of the ditch is required.

Flooding of Oak Grove Avenue is expected during any sizeable storm as the system is only

PC/JMR
Watershed Master Plan
Figure 4-4
Countryside / Oak Grove System
Proposed Conditions
100 50 0 100
Feet
1 inch = 100 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
N
Widen 1,700 LF of existing
6-feet wide ditch to 9-feet wide
Replace 165 LF of
24-inch RCP with 30-inch RCP
Replace 338 LF of 21-inch RCP
with double elliptical 24-inch by 38-inch RCP
Replace 10 LF of 24-inch CMP
with double elliptical 24-inch by 38-inch RCP
Replace 39 LF of 18-inch RCP
with double elliptical 24-inch by 38-inch RCP
OAK GROVE AV
GLENDA ST
BRITISH CT
ENGLISH CT
CARMON CI
SANDY LN
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Proposed Pipe Improvements
Proposed Channel Improvements
Non-Modeled Pipes
Proposed Pipe to be Abandoned
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

able to convey less than the 2-year storm without overtopping the roadway. However, the most frequent and visible issue is poor roadway drainage with standing water in the roadway caused by damaged, uneven, and uncrested pavement associated with original construction and installation of a sewer line beneath the road.

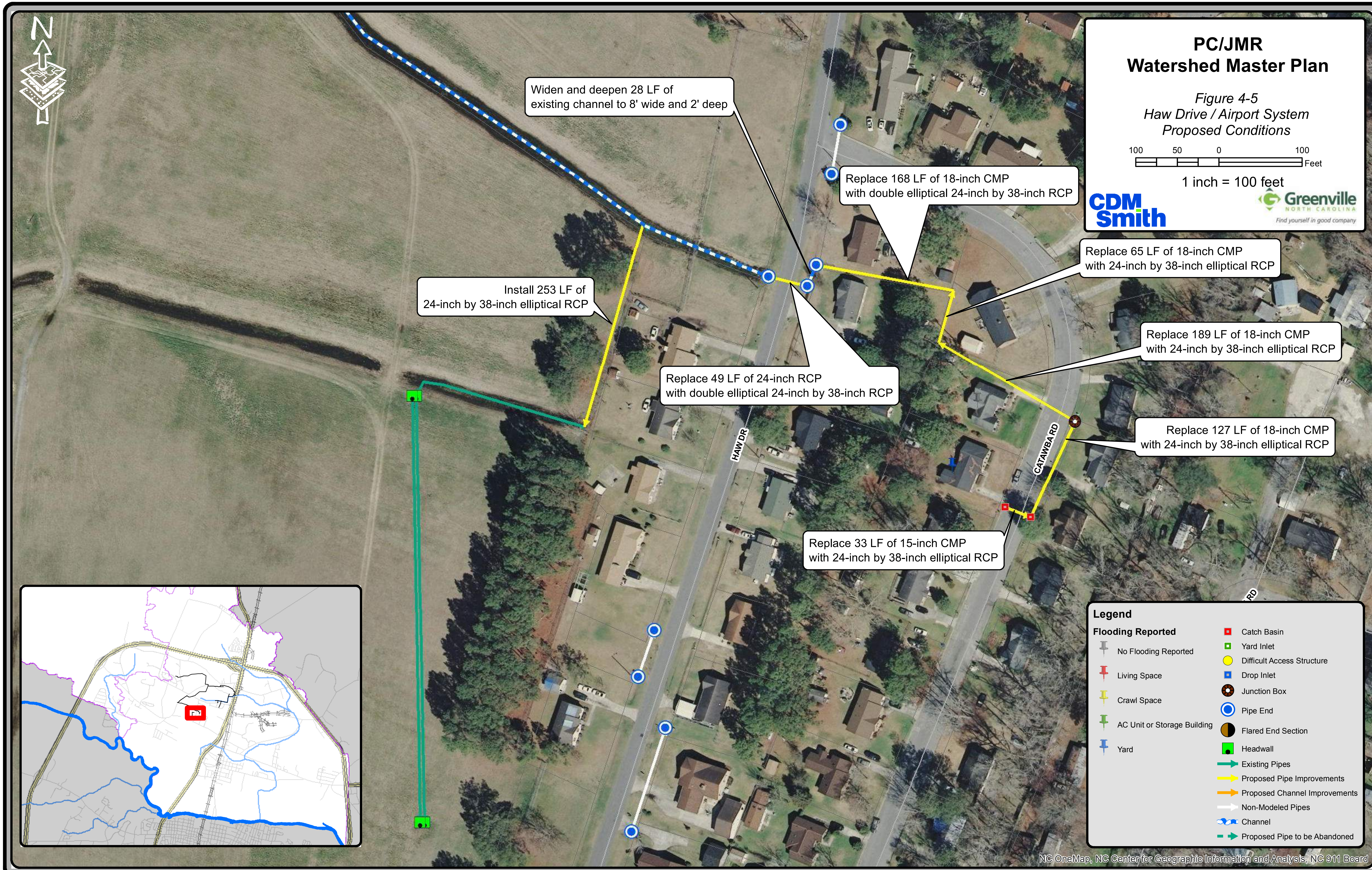
Modeling results of the Countryside – Oak Grove Avenue System indicate that meeting the 10-year LOS is feasible through extensive infrastructure improvements to the existing system. To address regular standing water, roadway improvements along Oak Grove Avenue are recommended to improve drainage along this roadway and direct runoff to the existing drainage system and avoid standing water. Due to the flatness of the area, elliptical pipes are required to attain capacity to convey the runoff from the neighborhood for the 10-year LOS storm with a minimum of 1 foot of ground cover over the pipes. Additionally, widening of the downstream channel is required to alleviate overtopping flooding conditions for the 10-year LOS storm. The cost for improvements to the Countryside/Oak Grove stormwater system is estimated at $580,000.

Haw Drive – Airport System

Currently this drainage system does not meet a 2-year LOS but does not cause structural flooding or prevent roadway access. The proposed improvements to meet the designated 10-yr LOS include new pipes and inlets along E Catawba Road to direct runoff to a conveyance system within the City right-of-way which will more easily facilitate future maintenance of the system and improve the LOS. Proposed pipe improvements range in size from 18” RCP to 24” RCP. In some locations with limited cover, twin elliptical RCP’s are proposed. While the proposed improvements will not meet the desired LOS, they will alleviate some of the more frequent flooding conditions. Addition of a connecting drainage feature on the airport property to allow drainage to the south is also recommended. The secondary system flooding that will remain for events below the 10-year LOS does not appear to cause structural damage or prevent emergency access on roadways.

CDM Smith recommends the following improvements for the Haw Drive – Airport System as shown in **Figure 4-5**:

- Replace 33 linear feet of 15” CMP with 24” RCP across E Catawba Road near 106 E Catawba Road;
- Replace 127 linear feet of 18” CMP with 24” RCP along E Catawba Road;
- Replace 189 linear feet of 18” CMP with 3.3’x2’ Elliptical RCP across E Catawba Road through the property at 104 E Catawba Road;
- Replace 65 linear feet of 18” CMP with 3.3’x2’ Elliptical RCP along the rear boundary of the parcel at 102 E Catawba Road;
- Replace 168 linear feet of 18” CMP with 3.3’x2’ Elliptical RCP along the boundary of the parcel at 218 Haw Drive;
- Enlarge the channel along Haw Drive from 18” deep and 18” wide to 24” deep and 4’ wide;
- Replace 49 linear feet of 24” RCP with 3.3’x2’ Elliptical RCP across Haw Drive;
- Add 256 linear feet of new 24” RCP behind 211 Haw Drive to connect the two ditches from north to south;
- Install 2 catch basins;
- Install 1 junction box; and install 2 pipe end headwalls.



PC/JMR
Watershed Master Plan
Figure 4-5
Haw Drive / Airport System
Proposed Conditions
100 50 0 100
Feet
1 inch = 100 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
Widen and deepen 28 LF of existing channel to 8' wide and 2' deep
Replace 168 LF of 18-inch CMP with double elliptical 24-inch by 38-inch RCP
Replace 65 LF of 18-inch CMP with 24-inch by 38-inch elliptical RCP
Install 253 LF of 24-inch by 38-inch elliptical RCP
Replace 189 LF of 18-inch CMP with 24-inch by 38-inch elliptical RCP
Replace 49 LF of 24-inch RCP with double elliptical 24-inch by 38-inch RCP
Replace 127 LF of 18-inch CMP with 24-inch by 38-inch elliptical RCP
Replace 33 LF of 15-inch CMP with 24-inch by 38-inch elliptical RCP
HAW DR
CATAWBA RD
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Existing Pipes
Proposed Pipe Improvements
Proposed Channel Improvements
Non-Modeled Pipes
Channel
Proposed Pipe to be Abandoned
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

The proposed improvements will provide a 10-year LOS for the Haw Drive System. The total estimated cost for the recommended alternative is $330,000. Small segments of the project are located in the E Catawba Road right-of-way and the Haw Drive right-of-way. The curb and gutter along E Catawba Road will need to be removed and replaced. Gas lines, underground electric, sanitary sewer lines, and water lines were also identified as a potential site restrictions and utility conflicts in the project area.

Some of the proposed improvements will cause significant impacts to private property. There will be impacts to the driveways, landscaping, and/or fencing at the following private properties:

- 104 E Catawba Road
- 102 E Catawba Road
- 218 Haw Drive

Greenfield Terrace System

Currently this drainage system does not meet a 2-year LOS but does not cause structural flooding or prevent roadway access. CDM Smith recommends the following improvements for the Greenfield Terrace System as shown in **Figure 4-6** to improve the LOS to the 10-yr design storm:

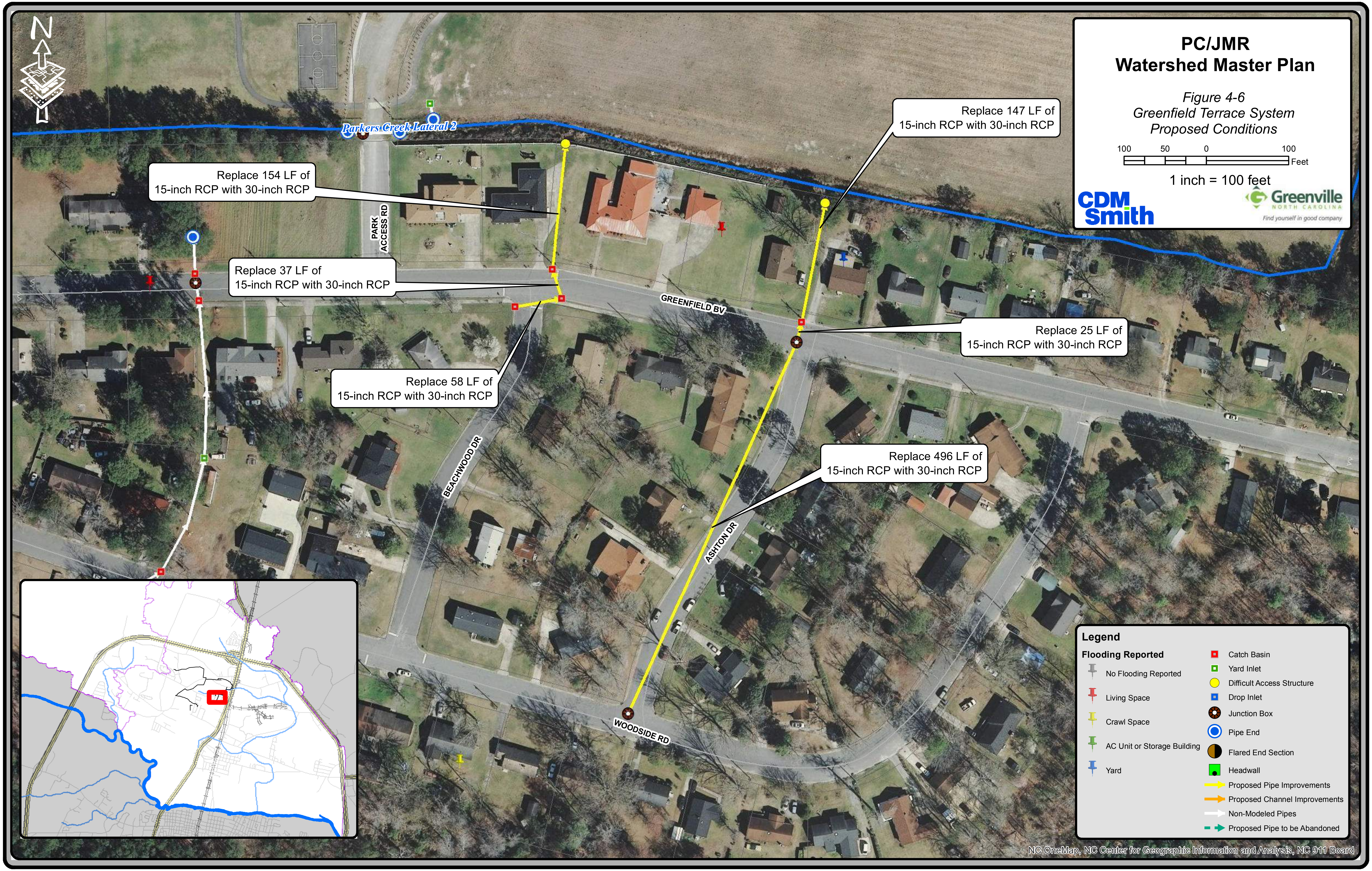
- Replace 154 linear feet of 15″ RCP with 30″ RCP at 306 Greenfield Boulevard;
- Replace 37 linear feet of 15″ RCP with 30″ RCP across Greenfield Boulevard;
- Replace 58 linear feet of 15″ RCP with 30″ RCP across Beachwood Drive;
- Replace 147 linear feet of 15″ RCP with 30″ RCP at 206 Greenfield Boulevard;
- Replace 25 linear feet of 15″ RCP with 30″ RCP across Greenfield Boulevard;
- Replace 496 linear feet of 15″ RCP with 30″ RCP along Ashton Drive;
- Replace 2 junction boxes;
- Replace 4 catch basins; and
- Install 2 pipe end headwalls.

The proposed improvements alone will eliminate flooding and surcharging for the 2-year event, however, flooding will still remain for the 10-year unless the Primary system improvements at Memorial Drive and off-line stormwater detention are implemented at Greenfield Terrace Park.

A 13-acre pond would provide 566,000 cubic feet of storage which would reduce the flood stage for the 10-yr storm by nearly 0.5 feet. The pond will alleviate flooding by reducing the peak stage just enough to keep it below the surface of the drainage system on Greenfield Boulevard, but cannot prevent surcharging of the system due to high backwater conditions. Due to the high cost of a detention pond to reduce nuisance flooding on Greenfield Boulevard, which does not cause any property damage or make roadway access impassible for emergency vehicles, this project is not considered cost effective.

The total estimated cost for the recommended drainage system improvements alone is $450,000. The total estimated cost for the detention wetland is $4.9 million dollars. Significant cost reduction could be realized if soils were removed for nearby road projects. Some of the proposed improvements will cause significant impacts to private property. There will be impacts to the driveways, landscaping, and/or fencing at the following private properties:

- 206 Greenfield Boulevard
- 300 Greenfield Boulevard
- 306 Greenfield Boulevard
- 308 Greenfield Boulevard
- 100 Ashton Drive


PC/JMR
Watershed Master Plan
Figure 4-6
Greenfield Terrace System
Proposed Conditions
100 50 0 100
Feet
1 inch = 100 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
N
Parkers Creek Lateral 2
PARK ACCESS RD
GREENFIELD BV
BEACHWOOD DR
ASHTON DR
WOODSIDE RD
Replace 154 LF of
15-inch RCP with 30-inch RCP
Replace 37 LF of
15-inch RCP with 30-inch RCP
Replace 58 LF of
15-inch RCP with 30-inch RCP
Replace 147 LF of
15-inch RCP with 30-inch RCP
Replace 25 LF of
15-inch RCP with 30-inch RCP
Replace 496 LF of
15-inch RCP with 30-inch RCP
Legend
Flooding Reported
No Flooding Reported
Living Space
Crawl Space
AC Unit or Storage Building
Yard
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Proposed Pipe Improvements
Proposed Channel Improvements
Non-Modeled Pipes
Proposed Pipe to be Abandoned
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

4.3 High Risk Areas for 25-year Detention

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 Parkers Creek/Johnsons Mill Run (PC/JMR) Watershed 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 models 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 10-year detention requirements would result in little to no increase in peak flows for the design event. Typically, this would include most secondary systems, although secondary systems with significant documented water quantity problems that also includes infrastructure requiring a level of service greater than a 10-year event may be evaluated for the 25-year detention requirement.

4.3.1 Evaluation

As noted in Section 3.1 crossings at N. Greene Road and Memorial on Parkers Creek laterals do not meet the required level of service (LOS) based on model results. Another crossing on

Parkers Creek outside the City limits at Staton Road also does not currently meet the LOS. However, based on interviews with City staff and resident feedback these crossings are not considered well-documented water quantity problems as a history of overtopping at these crossings has not been observed. The future 25-year flows within the primary streams are a maximum of 17% higher than existing flows just upstream of the Memorial Drive crossing. However, since the N. Greene Road and Memorial Drive culvert improvements are required to provide a 50-year level of service, it is assumed that 25-year detention upstream of the culvert would not result in substantial cost savings when designing to a 50-year level of service. These crossings on Parkers Creek and its laterals are already subject to flooding for less than the design storm, requiring 25-year detention upstream of the project area is not recommended.

It is recommended that the City carefully consider any re-zoning applications and/or annexation requests in the ETJ draining to Parkers Creek to determine if a change from the projected zoning would change the projected future flows and thereby possibly necessitate detention for the 25-year storm event.

4.3.2 Results

In summary, based on an analysis of the PC/JMR watershed evaluating feedback from the public, City staff, model results, and anticipated future development, there are no recommendations for requiring 25-year detention for future development in the PC/JMR watershed.

Traditional stormwater management has typically been designed to reduce flooding, but at times has neglected water quality by collecting runoff directly from impervious surfaces and discharging directly into a stream causing erosion and deterioration of water quality. 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. High flows in streams cause bank erosion adding additional sediment into the riparian habitat. 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.

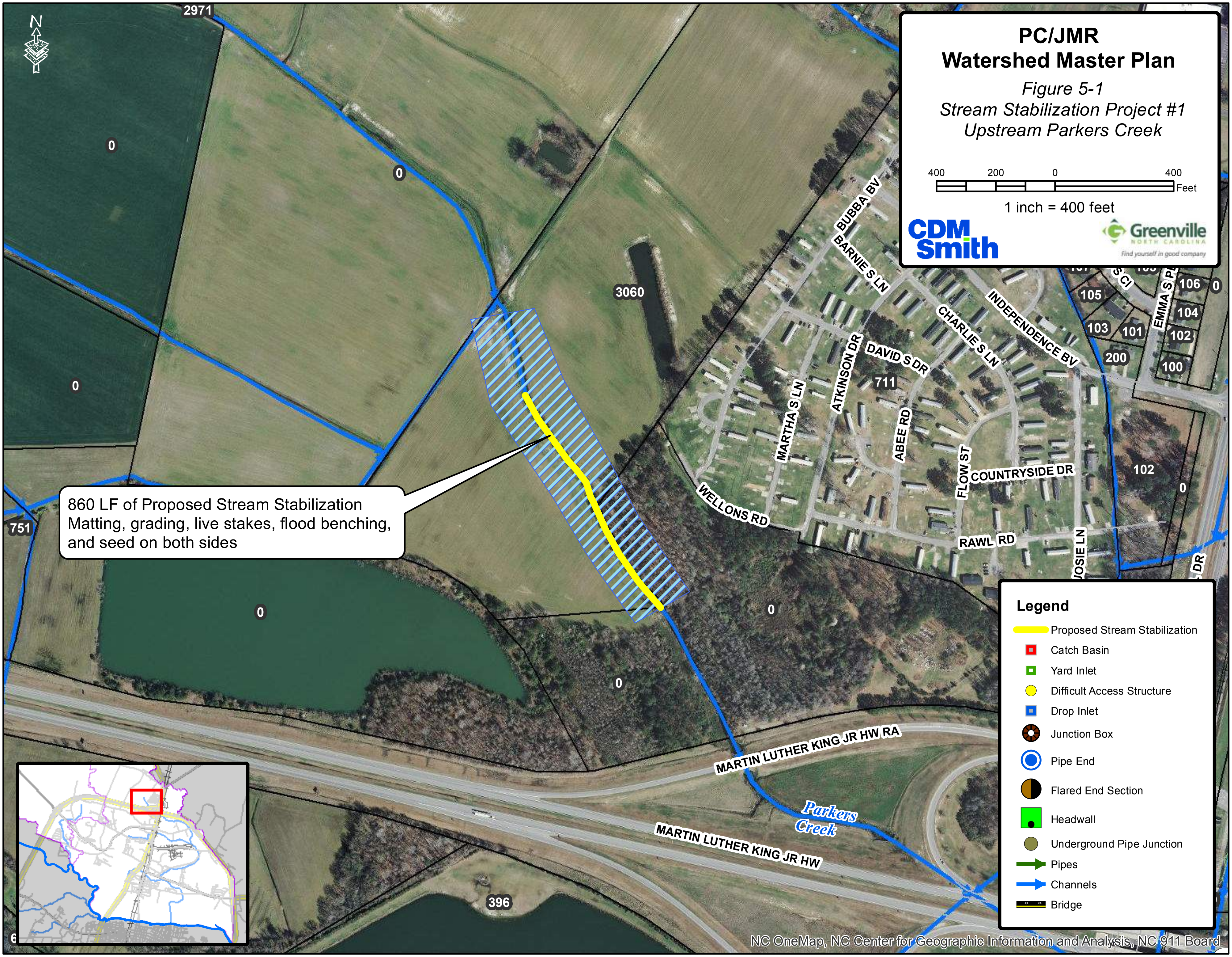
Stream stabilization projects can be constructed to reduce instream sediment loads and to protect private property from further erosion. Best management practices (BMPs) can be constructed to treat runoff prior to being discharged to the stormwater conveyance system and ultimately the receiving waters of the system. Retrofitting BMPs can be difficult due to limited space and other constraints. Stream stabilization projects and BMP retrofits identified in the PC/JMR Watershed are described below.

5.1 Stream Stabilization Projects

Based on the basin wide stream assessment completed as described in Section 3.3, six stream stabilization projects were identified to help reduce instream erosion or improve channel conditions. 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 PC/JMR, 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:

5.1.1 Streambank Stabilization Project 1 – Upstream Parkers Creek Bank Stabilization

The Upstream Parkers Creek Bank Stabilization project begins on Parkers Creek north of the crossing of US-264 and the associated entrance ramp, near Bubba Boulevard. As shown on **Figure 5-1**, the project begins approximately 150 feet upstream (east) of the access ramp, and consists of approximately 1,100 feet of significant erosion on both banks of Parkers Creek. The significant erosion is caused by unstable bank angles and a lack of stabilizing vegetation, resulting in bank failure.


PC/JMR
Watershed Master Plan
Figure 5-1
Stream Stabilization Project #1
Upstream Parkers Creek
400 200 0 400
Feet
1 inch = 400 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
860 LF of Proposed Stream Stabilization
Matting, grading, live stakes, flood benching,
and seed on both sides
Legend
Proposed Stream Stabilization
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
Bridge
2971
751
396
3060
711
MARTIN LUTHER KING JR HW RA
MARTIN LUTHER KING JR HW
Parkers Creek
WELLONS RD
MARTHA S LN
ATKINSON DR
DAVID S DR
ABEE RD
FLOW ST
COUNTRYSIDE DR
RAWL RD
JOSIE LN
CHARLIE S LN
INDEPENDENCE BV
BARNIE S LN
BUBBA BV
EMMA S PL
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

The channel is on private agricultural land along and outside the City limits and within the ETJ (confirm). The upstream Parkers Creek Bank Stabilization project is located on a third order perennial section of main stem Parkers Creek. The project reach, consisting of about 1,100 feet of bank failure, has a drainage area of approximately 1,650 acres. Land use surrounding this project consists mainly of agriculture and vacant land. The bottom width (streambed) is approximately 12 feet wide with sand bars due to the bank failures. Within the project reach, both the left and right banks are nearly 8 feet tall and are nearly vertical. The average top channel width is approximately 45 feet wide. Bank conditions are moderately unstable and are actively eroding due to the combination of high flows and highly-erodible, loamy-sand soils.

Photograph 5-1.
Parkers Creek Bank Erosion Near Bubba Boulevard

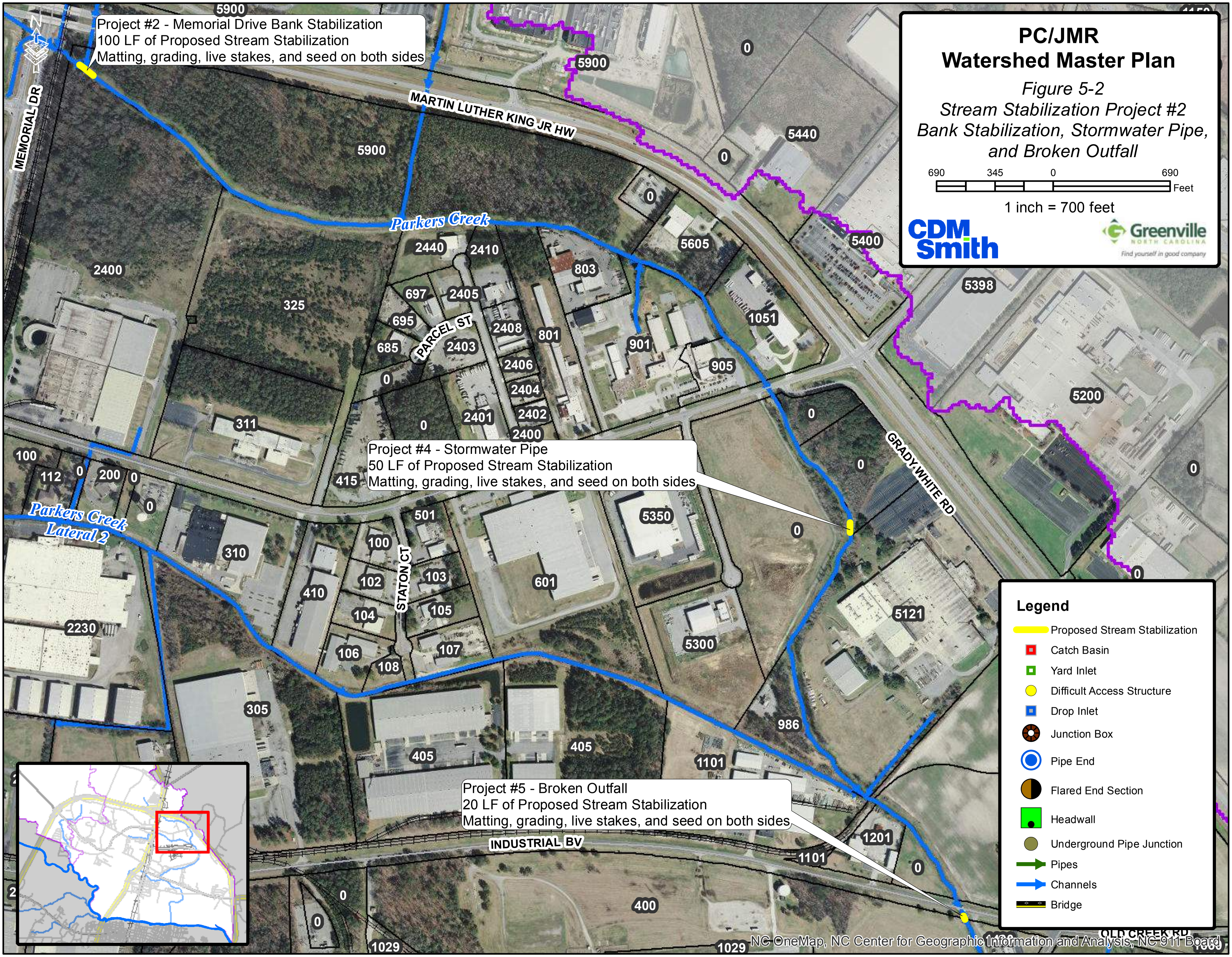
The proposed project reach has opportunities for bank stabilization to prevent bank erosion and sediment loading to Parkers Creek. Accessibility is not readily available but can be attained across agricultural fields. Initially, site conditions should be evaluated further to assess bank stability, rate of active erosion, and potential corrective measures. Grading the affected banks to a stable dimension and implementing protection by seeding/planting native vegetation are recommended. The estimated cost for the upper Parkers Creek Bank Channel Stabilization project is $270,000.

5.1.1 Streambank Stabilization Project 2 – Parkers Creek Memorial Drive Bank Stabilization

The Parkers Creek Memorial Drive Bank Stabilization project begins on Parkers Creek near the intersection of N Memorial Drive and US-264. As shown on **Figure 5-2**, the project begins approximately 150 feet downstream (east) of the railroad bridge, and consists of approximately 100 feet of significant erosion on the right bank of Parkers Creek. The significant erosion is caused by high-velocity flows that come out of a large stormwater pipe on the opposite bank, resulting in bank failure. This stormwater pipe is the end point of a stormwater channel that drains a large, impervious area to the north of

PC/JMR Watershed Master Plan

Figure 5-2
Stream Stabilization Project #2
Bank Stabilization, Stormwater Pipe, and Broken Outfall



Parkers Creek, including the DSM Pharmaceuticals complex. In addition to bank stabilization measures on Parkers Creek, conditions should be evaluated further to determine potential stormwater BMPs that can be implemented upstream on private property and outside the City limits to reduce high-velocity flows at the end of pipe.

Photograph 5-2.
Parkers Creek stormwater outfall plunge pool

The Parkers Creek Memorial Drive Bank Stabilization project is located on a third order perennial section of Parkers Creek. The project reach, consisting of about 100 feet of bank failure, has a drainage area of approximately 2,400 acres. Land use surrounding this project consists mainly of agriculture and vacant land, with fragmented woodlots, commercial and industrial facilities, and small residential neighborhoods also present. The proposed project reach flows largely northwest to southeast and possess a wooded riparian buffer approximately 1,200 feet wide, with 1,000 feet of buffer located on the south bank. A 25-foot wide, maintained utility easement parallels the stream at the top of the north bank. The bottom width (streambed) is approximately 30 feet wide due to the bank failure. Streambed widths downstream of the bank failure are approximately 10 feet wide. Within the project reach, both the left and right banks are nearly 8 feet tall and are nearly vertical. The average top channel width is approximately 45 feet wide, but is much narrower (30 feet wide) downstream of the bank failure. Bank conditions are moderately unstable and are actively eroding due to the impact of high-velocity flows coming out end-of-pipe, and highly-erodible, loamy-sand soils.

The proposed project reach has opportunities for bank stabilization to prevent bank erosion and sediment loading to Parkers Creek. Relatively good accessibility is provided by the maintained utility easement to the north, which can be accessed by Staton Road to the south, N Memorial Drive to the west, and US-264 to the north. However, the area around the 20-foot easement is wooded and could impede the movement of heavy machinery. Initially, site conditions should be evaluated further to determine bank stability, rate of active erosion, and potential corrective measures. Grading the affected bank to a stable dimension and implementing bank armoring are potential corrective actions. In areas not directly impacted by high-velocity forces (i.e. downstream), banks should be protected by seeding/planting native vegetation.

The estimated cost for the Parkers Creek Memorial Drive Bank Stabilization project, not including potential BMPs to the upstream stormwater channel, is $39,000. While the proposed project itself is located away from structures and facilities, construction staging areas may have to be located on private industrial properties to the southeast, necessitating access agreements with landowners.

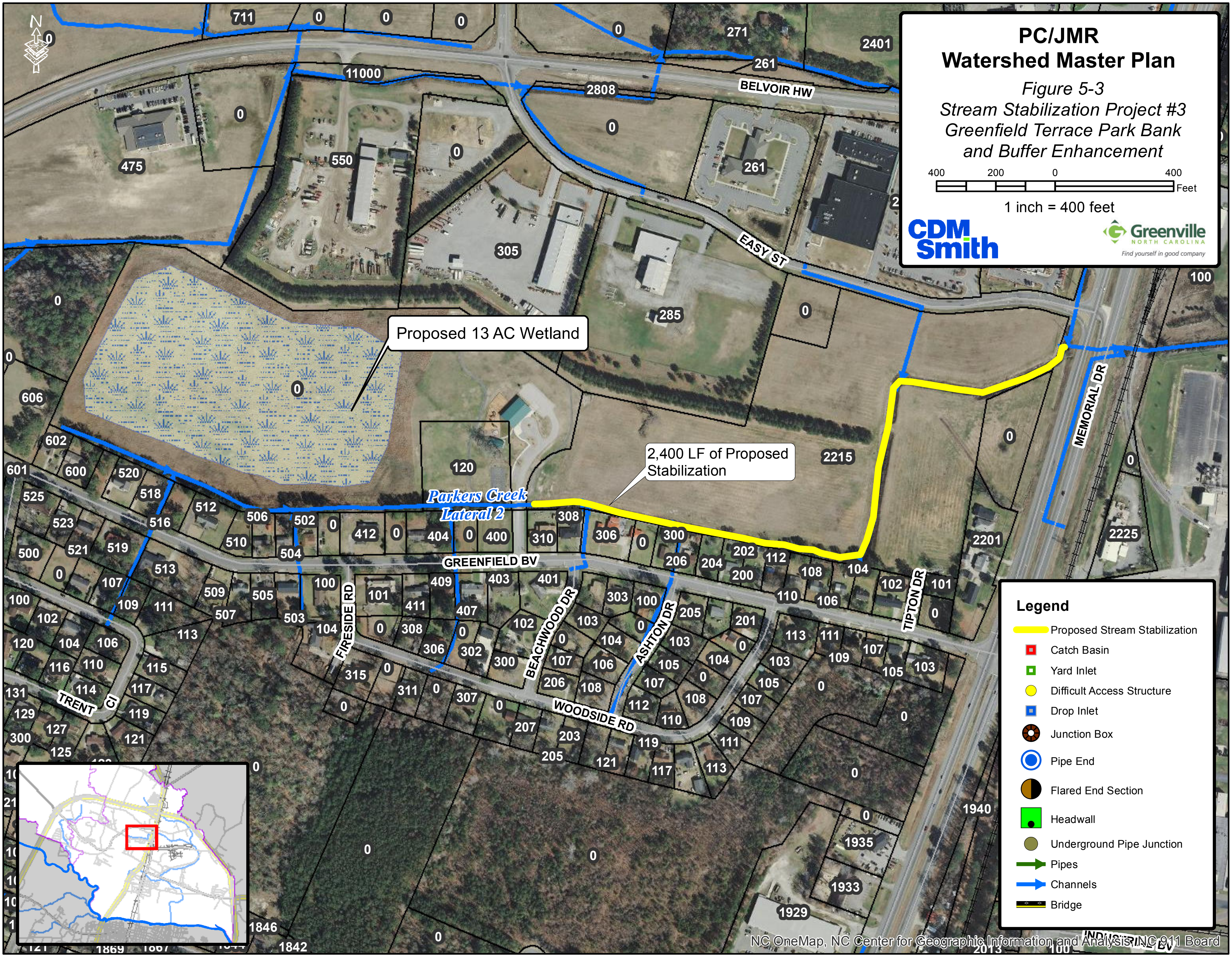
5.1.2 Stream Channel Enhancement Project 3 – Parkers Creek Lateral 2 – Greenfield Terrace Park

The Potential Reach Restoration in Greenfield Terrace Park project is located on Parkers Creek Lateral 2 in Greenfield Terrace Park west of N. Memorial Drive and north of Greenfield Boulevard. As shown on **Figure 5-3**, the project includes the entire modified channel within Greenfield Terrace Park, beginning at the N. Memorial Drive crossing and continuing upstream approximately 4,000 feet to the southwest Park boundary. The project reach consists of a modified (i.e. dredged and straightened), incised channel.

Photograph 5-3. Greenfield Terrace Park Existing Channel Facing Memorial Drive

Photograph 5-4. Greenfield Terrace Park Existing Channel from Park facing east

The Potential Reach Restoration in Greenfield Terrace Park project is located on a first order perennial section of Parkers Creek Lateral 2. The project reach, consisting of approximately 4,000 feet of straightened channel and steep banks, has a drainage area of approximately 200 acres. Land use surrounding this project consists of open parklands and vacant lands, fragmented woodlots, agricultural fields, residential neighborhoods, and commercial and industrial properties. Beginning upstream, the proposed project reach flows largely west to east for the first 2,800 feet, before sharply turning north for the next 600 feet. The channel then sharply turns to the east and continues for 600 feet before crossing N. Memorial Drive. For most of its route, the channel is buffered by maintained herbaceous vegetation and small shrubs. A narrow tree-line exists along the south bank, separating the channel from residential properties. The bottom channel width (streambed) is approximately 6 to 10 feet wide. Within the project reach, both the left and right banks are 5 to 8 feet tall with bank angles of 75°. The top channel width is approximately 25 to 40 feet wide. Bank conditions within the project reach are relatively stable due to herbaceous cover; however, the channel is maintained clear for drainage purposes and exhibits limited habitat value.



PC/JMR
Watershed Master Plan
Figure 5-3
Stream Stabilization Project #3
Greenfield Terrace Park Bank and Buffer Enhancement
400 200 0 400 Feet
1 inch = 400 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
Proposed 13 AC Wetland
2,400 LF of Proposed Stabilization
Parkers Creek Lateral 2
BELVOIR HW
EASY ST
MEMORIAL DR
GREENFIELD BV
FIRESIDE RD
BEACHWOOD DR
ASHTON DR
TIPTON DR
WOODSIDE RD
TRENT CI
Legend
Proposed Stream Stabilization
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
Bridge
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

The proposed project reach has opportunities for channel improvements. Located partially in a City-owned park, channel improvements would benefit residents by improving water quality, reducing flood risk to property, and enhancing wildlife habitat and recreational opportunities. Relatively good accessibility is provided by the Greenfield Terrace Park entrance road. The park property as owned by the City contains the first about 1,200 feet of the channel. Another 2,200 feet of channel extend across an agricultural field to Memorial Drive which is in the County Drainage District. To improve site conditions, developing a floodplain wetland bench to provide flood storage and habitat value is recommended. Additionally, or integrally, an off-line water quality wetland or a 13-acre off-line detention pond is recommended as part of improvements to the park to consist of an excavated area adjacent to the channel with a hydrologic connection to the stream channel and is discussed as a BMP in Section 5.3.2 and flood mitigation in Section 4. Where possible, banks should be protected by seeding/planting native vegetation.

The estimated cost for the Potential Reach Restoration in Greenfield Terrace Park project (i.e. flood bench) combined with offline wetland, is $150,000. Significant cost savings may be realized through coordination with NCDOT to utilize soil material for borrow on nearby roadway projects since the majority of the project cost is in excavation. While proposed construction activities will not affect existing park structures, the channel's proximity to nearby residential properties may require landowner coordination. Construction activities may also involve using park areas for staging and minor vegetation removal, which could temporarily close portions of the park to visitors.

5.1.3 Streambank Stabilization Project 4 – Parkers Creek Stormwater Pipe

The Parkers Creek Stormwater Pipe project begins on Parkers Creek south of the intersection of Staton Road and Grady White Road at the northwest corner of the Grady-White Boats primary parking lot. As shown on **Figure 5-2**, the project begins approximately 900 feet downstream (southeast) of the Staton Road crossing, and consists of approximately 50 feet of significant erosion and sediment deposition on the west bank of Parkers Creek. The significant erosion is caused by high-velocity flows that come out of a large stormwater pipe on the opposite bank, resulting in scouring and downstream sediment deposition. This stormwater pipe is the end point of a large, 15-foot wide stormwater channel that drains impervious industrial areas to the east of Parkers Creek.

Photograph 5-5.
Parkers Creek Outfall Bank Erosion Right Bank

In addition to bank stabilization measures on Parkers Creek, conditions should be evaluated further to determine potential stormwater BMPs that can be implemented upstream to reduce high-velocity flows at the end of pipe.

The Parkers Creek Stormwater Pipe project is located on a third order perennial section of Parkers Creek. The project reach, consisting of 50 feet of bank failure, has a drainage area of approximately 4,000 acres. Land use surrounding this project consists mainly of vacant land, fragmented woodlots, and industrial facilities. The proposed project reach flows largely north to south, before taking a turn to the southwest downstream of the stormwater outfall. A narrow riparian buffer approximately 175 feet wide exists within the project reach, but the top of bank is largely herbaceous vegetation and the channel downstream is largely unbuffered. The bottom width (streambed) is approximately 5 to 8 feet wide, with widths extending to 12 feet where stormwater impacts the bank directly. Within the project reach, both the left and right banks are 3 to 8 feet tall with a bank angle of approximately 75°. The average top channel width is approximately 20 feet wide. Bank conditions are unstable and are actively eroding due to the impact of high-velocity flows coming out end-of-pipe, and highly-erodible, loamy-sand soils.

The proposed project reach has opportunities for bank stabilization to prevent bank erosion and sediment loading to Parkers Creek. Relatively good accessibility is provided by City of Greenville's utility station access road to the west, which can be accessed via Staton Road to the north. Access is also provided by the Grady-White Boats primary parking lot to the east. Initially, site conditions should be evaluated further to determine bank stability, rate of active erosion, and potential corrective measures. Grading the affected bank to a stable dimension is possible on the west bank but would be infeasible on the east bank due to the proximity of the Grady-White Boats parking lot. Implementing bank armoring, particularly on the west bank, is another potential corrective action. In areas not directly impacted by high-velocity forces (i.e. downstream), banks should be protected by seeding/planting native vegetation. In addition to bank stabilization measures within the project reach, conditions should be evaluated to determine potential stormwater BMPs that can be implemented upstream to reduce high-velocity flows at the end of pipe. BMPs that increase infiltration and retention time (e.g. bioretention) are recommended.

5.1.4 Streambank Stabilization Project 5 – Parkers Creek Broken Outfall

The Parkers Creek Broken Outfall project begins on Parkers Creek at the Industrial Boulevard crossing. As shown on **Figure 5-2**, the project begins approximately 15 feet downstream of the Industrial Boulevard crossing on the east bank of Parkers Creek. The project reach consists of 20 feet of eroded bank surrounding a broken, metal stormwater pipe. The final five feet of stormwater pipe has been sheared off and now rests at the toe of slope. The bank sloughing surrounding the broken pipe is caused by stormwater entering at top of bank rather than directly into the channel, as designed. Unlike other Greenville bank stabilization projects discussed previously in which high-volume, high-velocity stormwater inputs are an issue, the stormwater inputs at this site appear small judging from the dry, turfed swale located upstream. The bank stabilization issues are directly related to the failure at the end of pipe.

Photograph 5-6.
Broken stormwater outfall and bank sloughing on Parkers Creek left bank

The Parkers Creek Broken Outfall project is located on a third order perennial section of Parkers Creek. The project reach, consisting of 20 feet of bank sloughing, has a drainage area of approximately 4,400 acres. Land use surrounding this project consists mainly of agricultural and vacant land, with fragmented woodlots and industrial facilities also present. The proposed project reach is at a large, gradual meander bend and flows largely north to south. The stream is largely un-buffered; although a narrow 20-foot strip on either side of the channel remains un-mowed. The bottom width (streambed) is approximately 7 feet wide. Within the project reach, both the left and right banks are 5 to 8 feet tall with a bank angle of approximately 70°. The average top channel width is approximately 25 feet wide. Bank conditions around the broken outfall are unstable and are actively eroding due to stormwater flows discharging at the top of bank, and highly-erodible, loamy-sand soils.

The proposed project reach has opportunities for bank stabilization to prevent bank erosion and sediment loading to Parkers Creek. Relatively good accessibility is provided by maintained vacant lands on either side of the creek, which can be accessed via Industrial Boulevard to the north. However, these lands are private and would require landowner approval. Initially, site conditions should be evaluated further to determine bank stability, rate of active erosion, and potential corrective measures. Grading the affected bank to a stable dimension is possible, but would require coordination with adjacent landowners. Implementing bank armoring, particularly on the east bank, where the bank failure is occurring, is another potential corrective action. These measures should be implemented in conjunction with replacing the broken stormwater outfall. Where possible, banks should be protected by seeding/planting native vegetation.

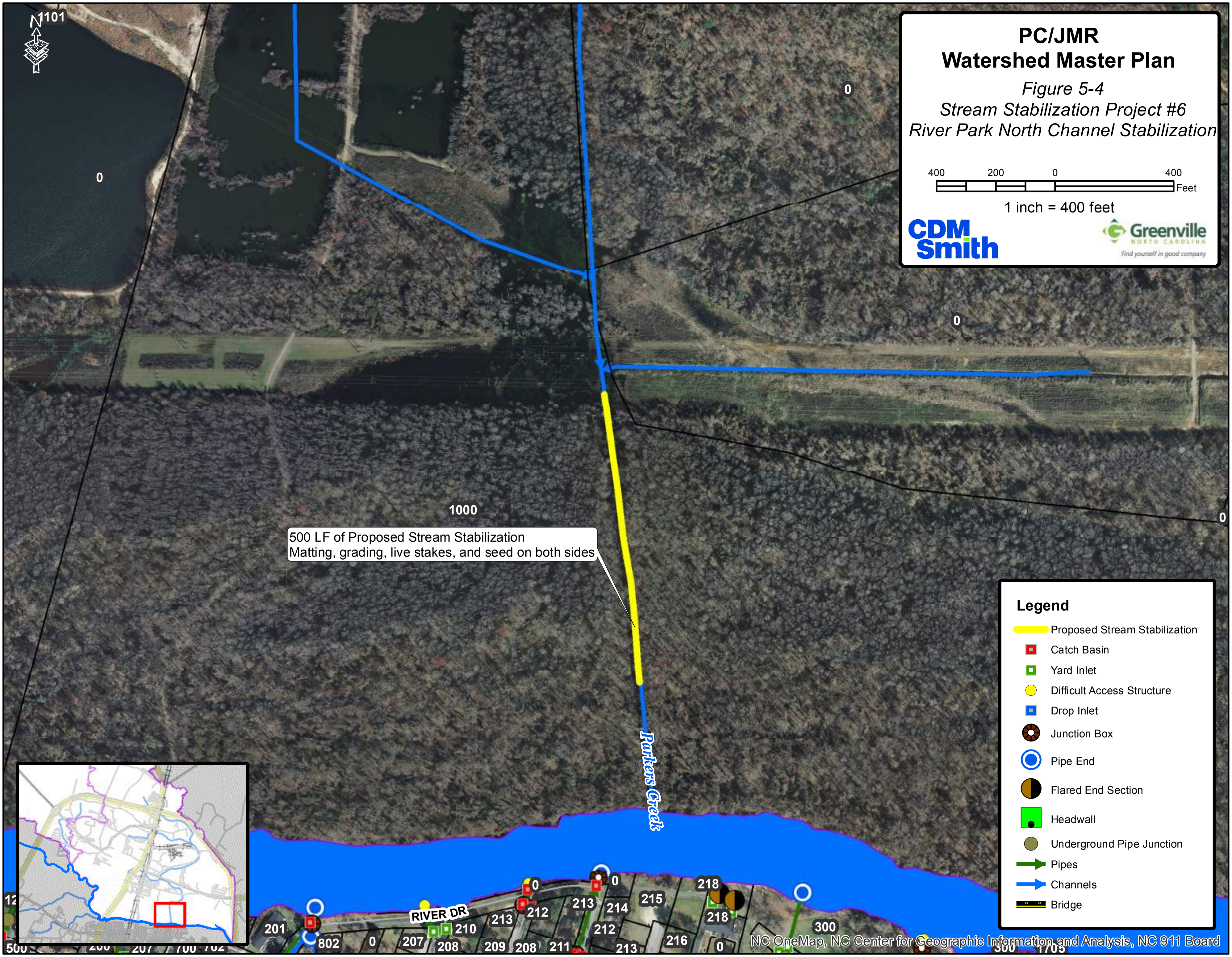
5.1.6 Stream Stabilization Project 6 – PC River Park North Channel

Photograph 5-7.
River Park North near the confluence of Parkers Creek and the Tar River

The Parkers Creek River Park North Channel project is located on Parkers Creek in River Park North. As shown on **Figure 5-4 and Photograph 5-6**, the project begins approximately 900 feet upstream of the confluence with Tar Creek and extends to the confluence. The project reach consists of an incised channel with significant bank scour from high-velocity flows rapidly moving through the straightened channel. The incised channel and elevated banks have disconnected the project reach from its floodplain, and significant ponding occurs within the flooded forest behind berms. The Parkers Creek channel within the project reach differs significantly from the reach upstream, also within River Park North. The upstream reference reach (**Photograph 5-7**) approximately 1,500 feet upstream of the project reach has shallow, vegetated banks and a connected floodplain that supports a healthy cypress forest with evidence of recent recruitment (i.e. seedlings of various ages). Between the natural condition of the upstream reach and the incised reach is a utility easement and evidence of a former beaver dam complex contributing to maintaining the upstream channel grade. The return of beaver dams is threatened by continued maintenance clearing of the utility easement. In the event the beaver dams cease to persist, the incision of the channel will potentially continue upstream resulting in draining of many acres of valuable wetlands.

Photograph 5-8.
Parkers Creek River Park North reference reach

The Parkers Creek River Park North Channel project is located on a third order perennial section of Parkers Creek. The project reach, consisting of approximately 500 feet of straightened channel and scoured bed and banks, has a drainage area of approximately 6,800 acres. Land use surrounding this project consists of forest and facilities associated with River Park North, with residential neighborhoods and agricultural lands present upstream.



PC/JMR
Watershed Master Plan
Figure 5-4
Stream Stabilization Project #6
River Park North Channel Stabilization
400 200 0 400 Feet
1 inch = 400 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
500 LF of Proposed Stream Stabilization
Matting, grading, live stakes, and seed on both sides
Parkers Creek
RIVER DR
1000
Legend
Proposed Stream Stabilization
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
Bridge
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

project reach flows largely north to south, and possesses a 1.5-mile-wide forested buffer on either side of the channel. The bottom width (streambed) is approximately 30 feet wide. Within the project reach, both the left and right banks are 8 to 10 feet tall with bank angles of 75° to near vertical. The average top channel width is approximately 40 feet wide. Bank conditions within the project reach are relatively unstable and are actively eroding as a result of bank scour due to high-velocity flows, lack of on-bank vegetation, and highly-erodible, loamy-sand soils.

The proposed project reach has opportunities for channel improvements and bed and bank stabilization to prevent further erosion and sediment loading to Parkers Creek. As a City-owned park, channel improvements would benefit residents by improving water quality,enhancing wildlife habitat and recreational opportunities, and providing educational benefits. Relatively good accessibility is provided by a River Park North gravel road, but portions of the road are narrow and is routinely flooded, posing a hazard to large vehicles and heavy machinery. Raising and stabilizing the streambed and grading the affected bank to a stable dimension are potential corrective measures. Where grading is limited due to entrenchment and adjacent forest, implementing grade control and bank armoring where severe bank scouring is occurring is an alternative corrective action. While re-establishing channel sinuosity is not recommended due to the the utility easement crossing.

The estimated cost for the Parkers Creek River Park North Channel project, including bed and bank improvements, is $196,000. While proposed construction activities will not affect existing park structures, it may require modification of the access road to accommodate construction vehicles and equipment. Construction activities may also involve minor vegetation removal and tree clearing, and would temporarily close portions of the park to visitors.

5.1.7 Other Minor Stream Improvement Projects

1. **Parkers Creek Lateral 1** – Existing Stabilization in Disrepair: Silt Fence and Riprap along south shore between N Memorial Drive and the railroad bridge is in minor states of disrepair and could be candidate for future rehabilitation (Lat/Long: 35°38′11.79″N; 77°22′18.89″W).

2. **Parkers Creek Lateral 1** – Trash Accumulation: At the Lateral 1 confluence with Parkers Creek, there is significant trash accumulation (Lat/Long: 35°37′59.76″N; 77°21′47.74″W). This location is a potential community stream clean-up candidate. Additionally, there is significant trash on the stream banks behind the recycling facility on Parkers Creek Lateral 1.

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. Nine potential BMP locations were initially identified with five sites recommended. These locations were field visited by CDM Smith staff in October 2015 to determine the feasibility of each site for a BMP. An overview map is provided showing these sites (See **Figure 5-5**).

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.

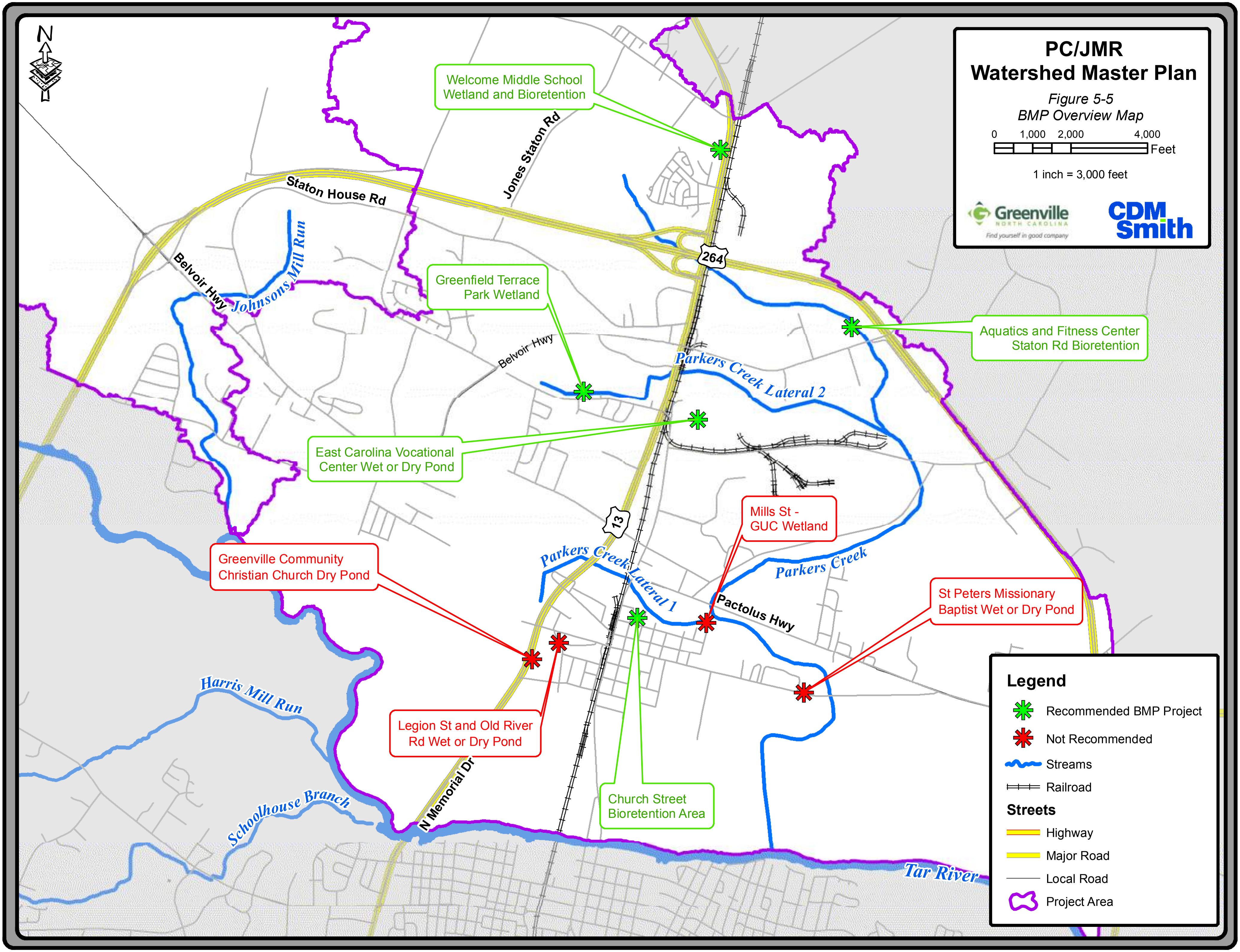
There was one public school and one park located in the PC/JMR Watershed. These locations were closely evaluated due to the either the available space or the large impervious areas (i.e., parking lots) available for treatment, as well as the educational benefits of installing a BMP onsite. The sites identified met multiple criteria for a successful project and were therefore recommended in this Master Plan.

5.3 Recommended BMPs

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

Preliminary conceptual design calculations were completed for each of the three BMPs (see 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. The majority of the recommended BMPs for this watershed were bioretention or stormwater wetlands for the following reasons:

- Large regional BMPs were considered in this watershed since the watershed is not fully developed. However, despite the large open areas across the watershed, large detention facilities are not cost effective for siting a BMP due to the flat land and shallow depths to the water table.
- Given the characteristics of the watershed, one of the most effective forms of water quality treatment is regional detention of stormwater runoff. Wet ponds and wetlands are excellent BMPs at providing such detention as well as providing water quality benefits.
- Stormwater wetlands areas have some of the highest removal rates for nutrients per the BMP manual and, with proper maintenance, their nutrient removal capacity does not diminish over time. The Tar-Pam river basin is identified as a nutrient sensitive watershed and monitoring efforts by the Pamlico-Tar River Foundation support this designation.
- Wet ponds and wetlands provide excellent educational opportunities particularly at schools as the multiple treatment processes within the system provide additional opportunities for education. Furthermore, when added to recreational and residential areas, wet ponds are considered an aesthetic amenity.



PC/JMR
Watershed Master Plan
Figure 5-5
BMP Overview Map
0 1,000 2,000 4,000 Feet
1 inch = 3,000 feet
Greenville NORTH CAROLINA
Find yourself in good company
CDM Smith
N
Welcome Middle School Wetland and Bioretention
Greenfield Terrace Park Wetland
Aquatics and Fitness Center Staton Rd Bioretention
East Carolina Vocational Center Wet or Dry Pond
Mills St - GUC Wetland
Greenville Community Christian Church Dry Pond
St Peters Missionary Baptist Wet or Dry Pond
Legion St and Old River Rd Wet or Dry Pond
Church Street Bioretention Area
Staton House Rd
Jones Staton Rd
Belvoir Hwy
Johnsons Mill Run
Parkers Creek Lateral 2
Parkers Creek Lateral 1
Parkers Creek
Pactolus Hwy
N Memorial Dr
Harris Mill Run
Schoolhouse Branch
Tar River
264
13
Legend
Recommended BMP Project
Not Recommended
Streams
Railroad
Streets
Highway
Major Road
Local Road
Project Area

5.3.1 Water Quality Project 1: Welcome Middle School Wetland

A stormwater wetland is proposed near the entrance to Welcome Middle School at 3101 N Memorial Boulevard (See **Photograph 5-8**). This area is downstream of the school facility and parking lot that currently drains via a drainage channel along N Memorial Drive. The wetland will provide volume control and water quality benefits by detaining and attenuating runoff prior to its discharge into Parkers Creek.

Photograph 5-9. Proposed site for the Welcome Middle School Wetland

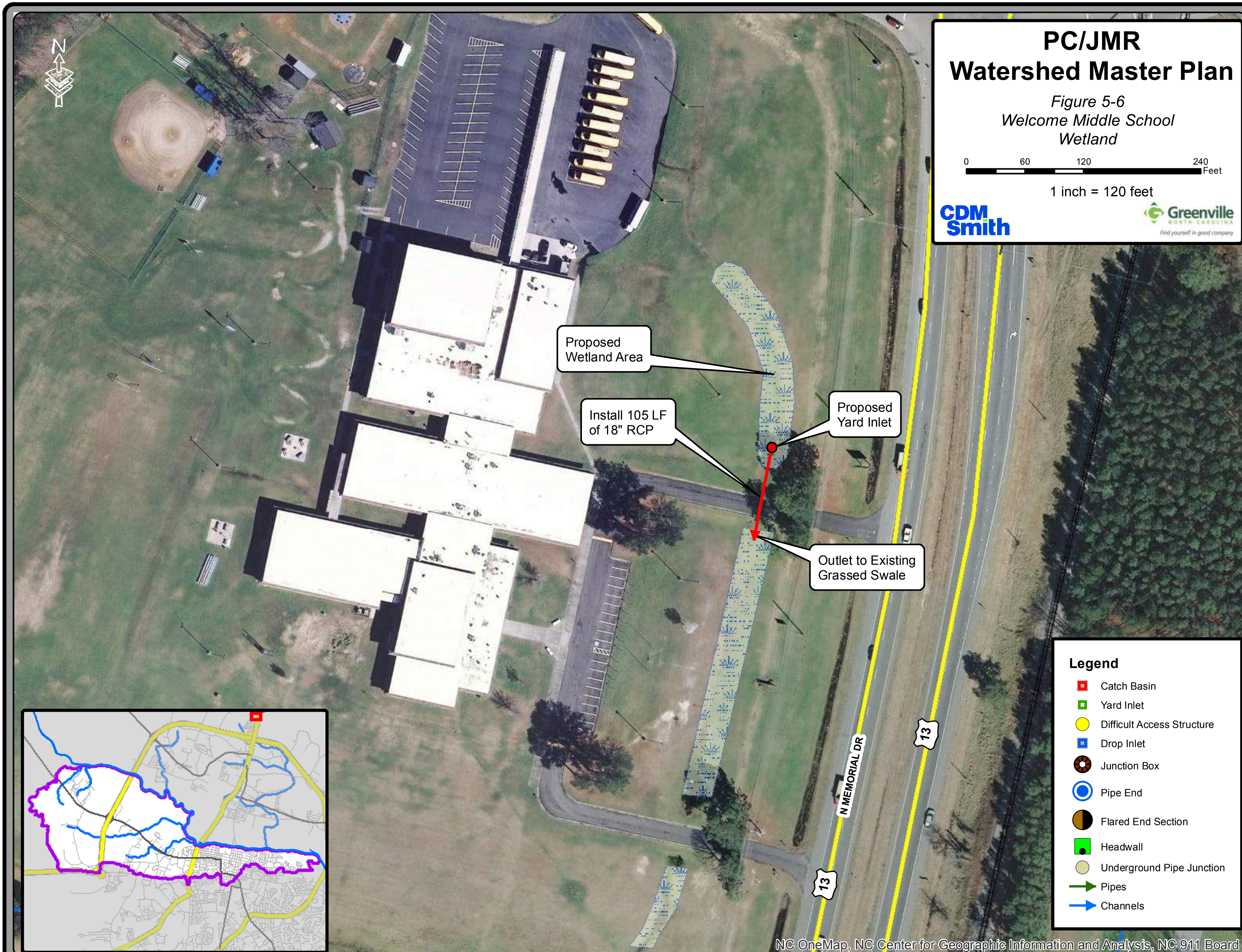
The required surface area for the proposed wetland is approximately 7,200 square feet (0.16 acres). A concept level plan of the proposed improvements is shown in **Figure 5-6**. The proposed wetland project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent parking lot. The proposed impervious areas draining to the proposed pond is approximately 3 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 property owned by the Pitt County Board of Education. In order to construct the wet pond, an easement agreement would be required with the Board of Education. The estimated construction cost for the wetland at Welcome Middle School is $150,000.

PC/JMR Watershed Master Plan

Figure 5-6
Welcome Middle School Wetland



5.3.2 Water Quality Project 2: Greenfield Terrace Park

A benched stormwater wetland is proposed near the entrance to Greenfield Terrace Park at 401 Greenfield Boulevard as shown in **Figure 5-7** and **Photographs 5-9 and 5-10**. This area is located downstream of a closed residential system that encompasses Trent Circle, portions of Haw Drive and Greenfield Boulevard, as well as portions of Woodside Road. The wetland will provide minimal volume control and water quality benefits by detaining and attenuating runoff prior to its discharge into Parkers Creek Lateral 2.

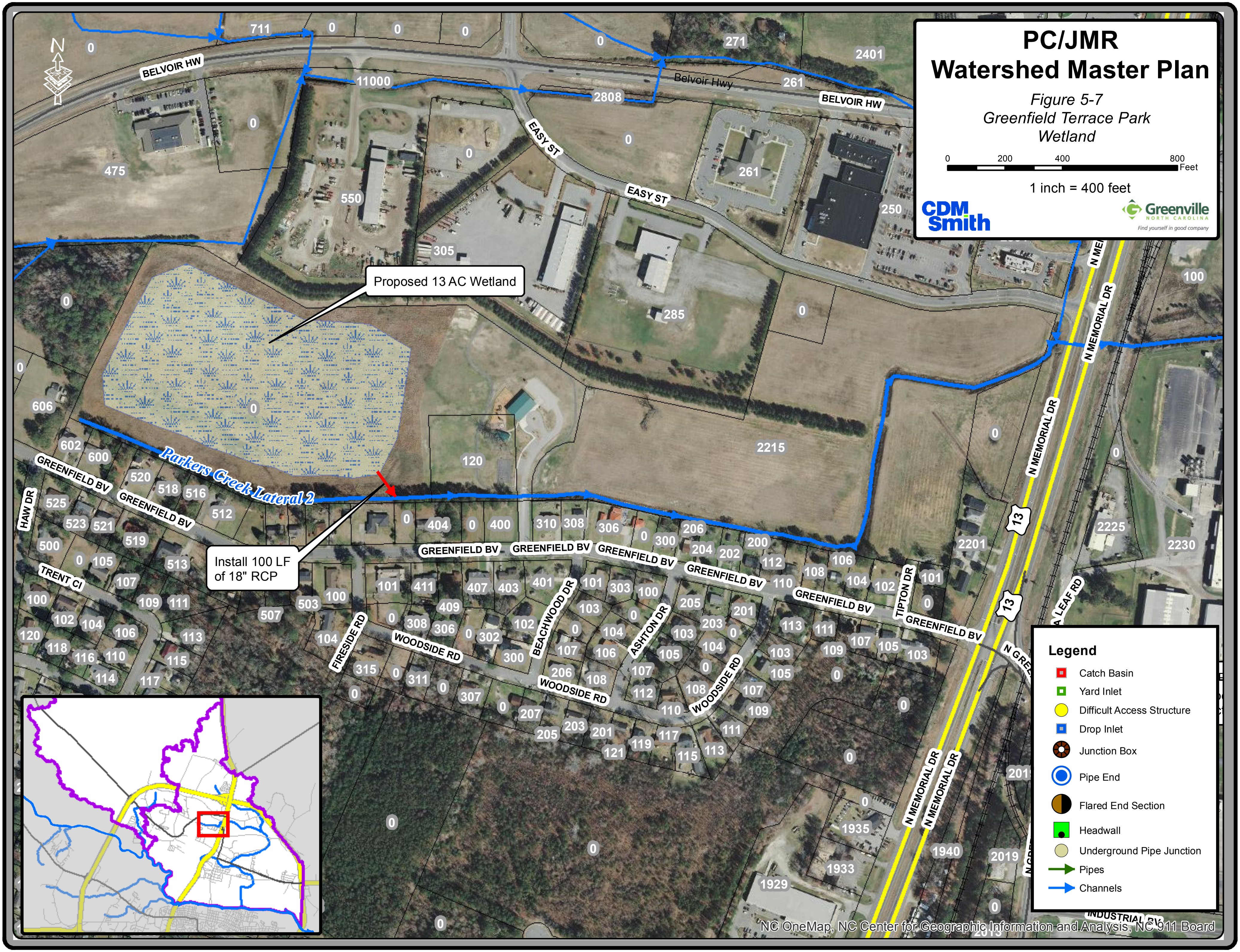
The required surface area for the proposed wetland is approximately 41,600 square feet (0.96 acres). The proposed wetland project consists of the following improvements:

- Install a stormwater wetland designed to treat runoff from the encompassing drainage area. The proposed impervious areas draining to the proposed pond is approximately 5 acres.
- Construct a swale inlet with receiving forebay directing flow into an existing conveyance system.
- Outlet structure
- Sediment disposal area
- Plants

The proposed water quality project is located on property owned by the City of Greenville. The estimated construction cost for the wetland at Greenfield Terrace Park is $220,000, mostly associated with the cost of excavation and soil removal.

Photograph 5-10. Proposed location for the Greenfield Terrace Park Benched Wetland

Photograph 5-11. Proposed location for the Greenfield Terrace Park Benched Wetland


PC/JMR
Watershed Master Plan
Figure 5-7
Greenfield Terrace Park
Wetland
0
200
400
800
Feet
1 inch = 400 feet
CDM Smith
Greenville
NORTH CAROLINA
Find yourself in good company
Proposed 13 AC Wetland
Install 100 LF of 18" RCP
Parkers Creek Lateral 2
BELVOIR HW
Belvoir Hwy
EASY ST
GREENFIELD BV
WOODSIDE RD
TRENT CI
HAW DR
FIRESIDE RD
BEACHWOOD DR
ASHTON DR
TIPTON DR
N MEMORIAL DR
13
Legend
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

5.3.3 Water Quality Project 3: Staton Road Aquatics and Fitness Center

A bioretention area is proposed along the edge or in the middle of the parking lot adjacent to Parkers Creek located behind the Aquatics and Fitness Center at 921 Staton Road as shown in **Figure 5-8** and Photograph 5-11. This area is adjacent to a parking lot that currently drains directly into Parkers Creek. The bioretention area will primarily provide water quality benefits by attenuating runoff prior to its discharge into Parkers Creek. The required surface area for the proposed bioretention is approximately 1,600 square feet (0.04 acres).

Photograph 5-12. Proposed location for the Aquatics Center Bioretention Area

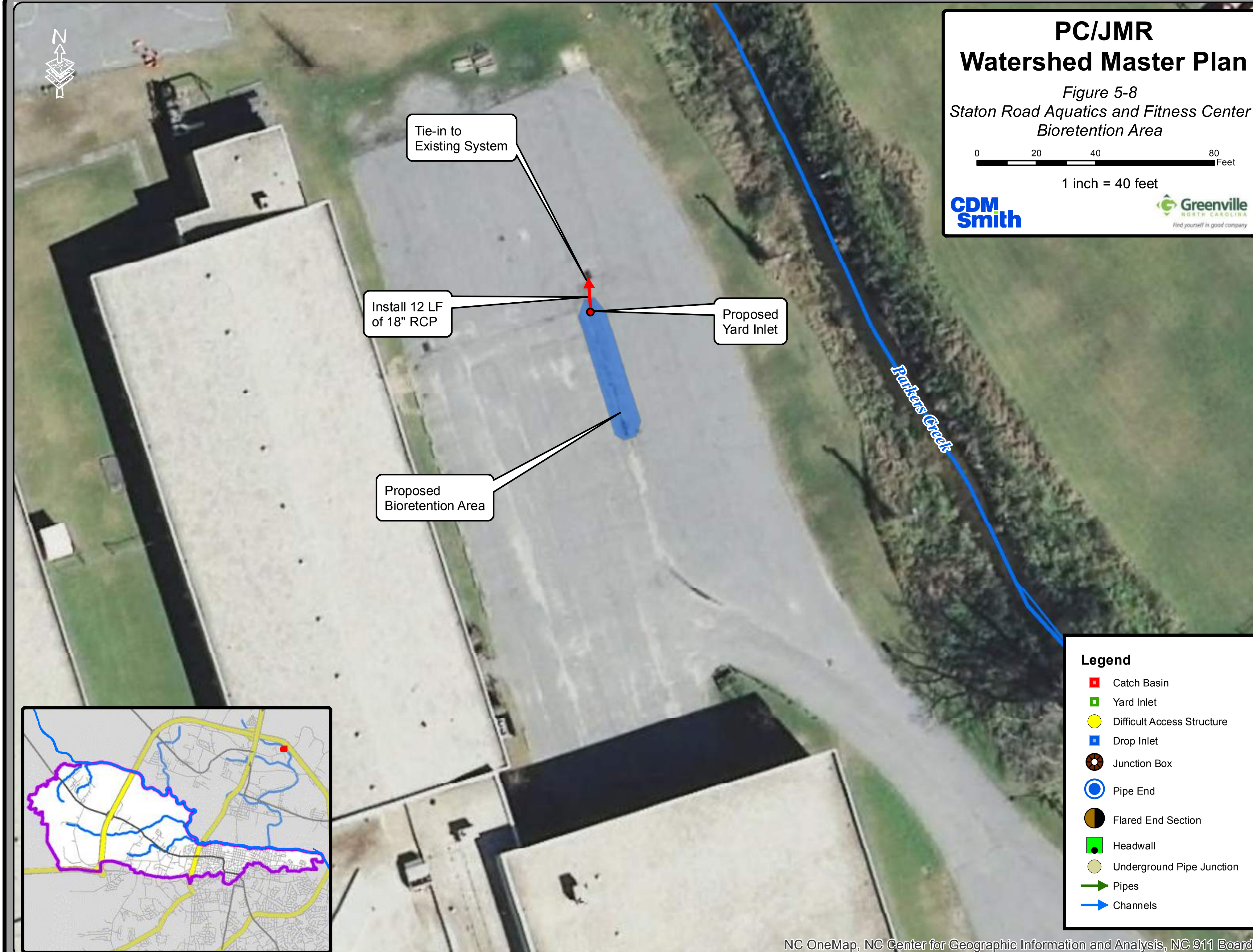
The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent parking lot. The proposed impervious areas draining to the proposed pond is approximately 0.9 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 East Carolina Vocational Center. The estimated construction cost for the bioretention area at The Aquatics and Fitness Center is $120,000.

PC/JMR
Watershed Master Plan

Figure 5-8
Staton Road Aquatics and Fitness Center
Bioretention Area



5.3.4 Water Quality Project 4: East Carolina Vocational Center

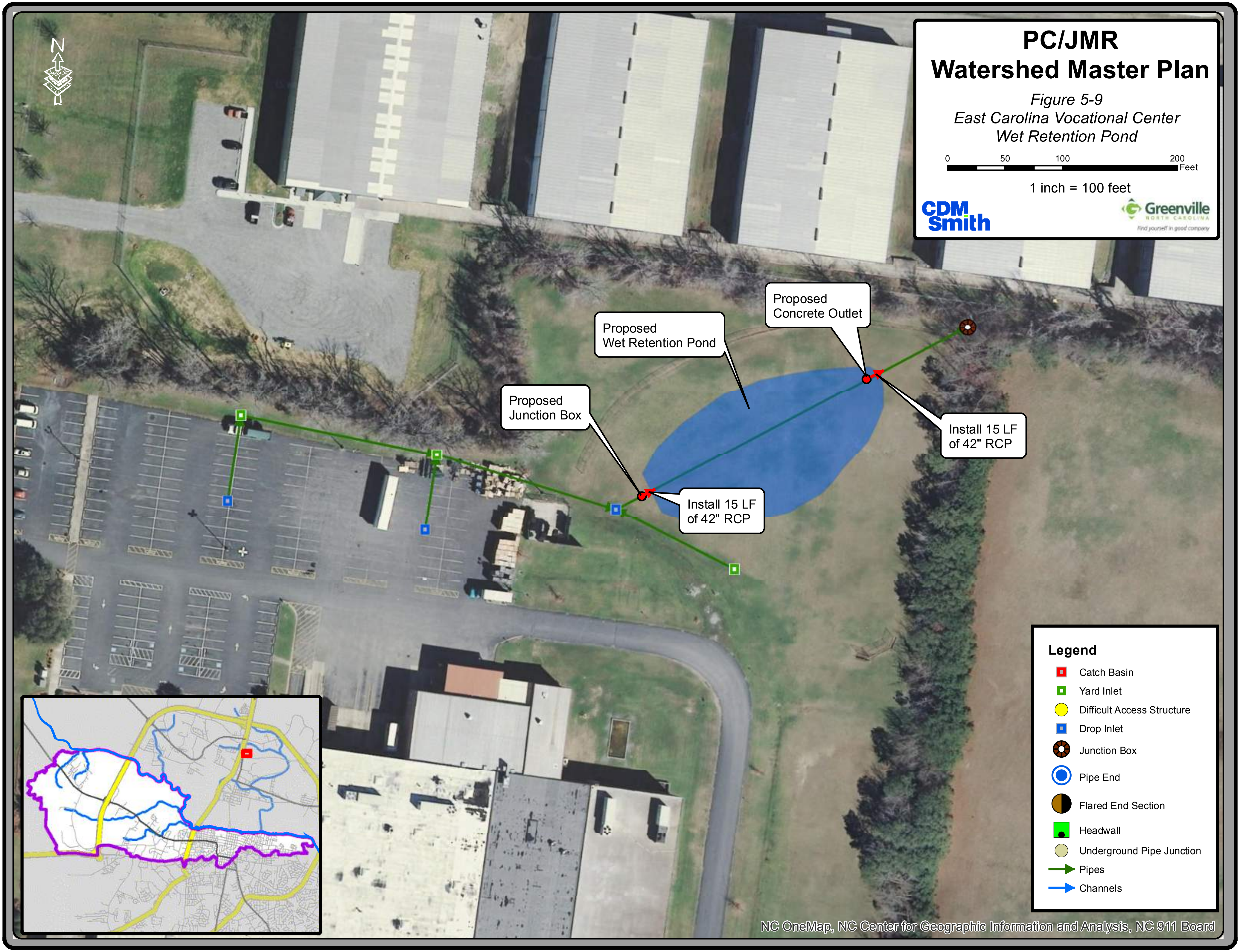
A bioretention area is proposed along the edge of the parking lot adjacent to Parkers Creek located behind the Aquatics and Fitness Center at 921 Staton Road (See **Figure 5-9** and **Photograph 5-12**). This area is adjacent to a parking lot that currently drains directly into Parkers Creek. The bioretention area will primarily provide water quality benefits by attenuating runoff prior to its discharge into Parkers Creek. The required surface area for the proposed bioretention is approximately 1,600 square feet (0.04 acres).

Photograph 5-13. Proposed location for the East Carolina Vocational Center Bioretention Area

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the adjacent parking lot. The proposed impervious areas draining to the proposed pond is approximately 0.9 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 East Carolina Vocational Center. The estimated construction cost for the bioretention area at the East Carolina Vocational Center is $140,000.


PC/JMR
Watershed Master Plan
Figure 5-9
East Carolina Vocational Center
Wet Retention Pond
0 50 100 200 Feet
1 inch = 100 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
N
Proposed Concrete Outlet
Proposed Wet Retention Pond
Proposed Junction Box
Install 15 LF of 42" RCP
Install 15 LF of 42" RCP
Legend
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

5.3.5 Water Quality Project 5: Church Street Bioretention

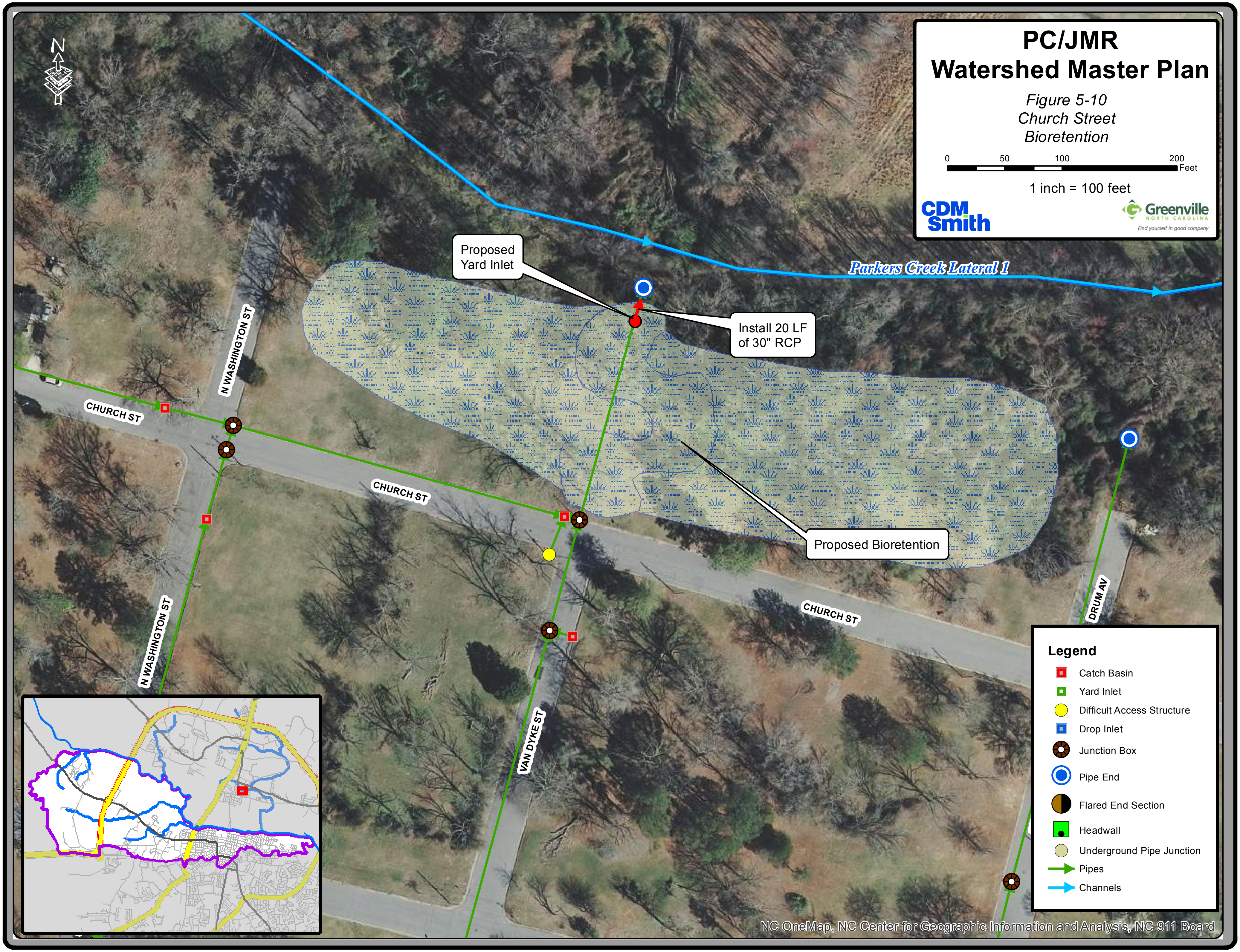
A bioretention area is proposed between Church Street and Parkers Creek Lateral 1 (See **Figure 5-10** and **Photograph 5-13**). This area is adjacent to a parking lot that currently drains directly into Parkers Creek. The bioretention area will primarily provide water quality benefits by attenuating runoff prior to its discharge into Parkers Creek Lateral 1. The required surface area for the proposed bioretention is approximately 1,600 square feet (0.04 acres).

Photograph 5-14. Proposed location for the Church Street Bioretention Area

The proposed bioretention project consists of the following improvements:

- Install a bioretention pond designed to treat runoff from the surrounding roadways. The proposed impervious areas draining to the proposed pond is approximately 0.9 acres.
- Install a yard inlet with an 18″ outfall pipe directing flow into an existing conveyance system.

The estimated construction cost for the bioretention area at Church Street is $200,000.



PC/JMR
Watershed Master Plan
Figure 5-10
Church Street
Bioretention
0 50 100 200 Feet
1 inch = 100 feet
CDM Smith
Greenville NORTH CAROLINA
Find yourself in good company
N
Parkers Creek Lateral 1
Proposed Yard Inlet
Install 20 LF of 30" RCP
Proposed Bioretention
CHURCH ST
CHURCH ST
CHURCH ST
N WASHINGTON ST
N WASHINGTON ST
VAN DYKE ST
DRUM AV
Legend
Catch Basin
Yard Inlet
Difficult Access Structure
Drop Inlet
Junction Box
Pipe End
Flared End Section
Headwall
Underground Pipe Junction
Pipes
Channels
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

SECTION 6
PUBLIC EDUCATION AND OUTREACH

Successful implementation of the PC/JMR Watershed Master Plan and stormwater management as a whole requires extensive public education and outreach. The City has taken important steps in public outreach within the PC/JMR Watershed through the use of direct mail questionnaires, web-based applications, and public meetings. Questionnaires were mailed to residents throughout the watershed in 2013 requesting feedback on flood-prone areas and any water quality concerns. Residents indicating flooding or erosion issues who provided contact information were contacted via phone or email to gather additional details regarding the survey reported property or identified roadway flooding issue. Residents who wanted to show the extent of flooding concerns were interviewed at their residences and the site conditions were evaluated in relation to the local stormwater drainage system. Notes from these interviews and compiled results of the questionnaires can be found in Appendix D.

A public meeting was held on November 12, 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 meeting was held to share results of the Master Plan with the public on November 17, 2015. As selected projects proceed into design and construction, continuous public outreach will be critical to the success of the projects. Most of the proposed improvements include some impacts to private properties which will require permanent drainage easements and temporary construction easements. Public meetings and individual property owner meetings through the design process will help educate property owners on the benefits of the proposed projects and the temporary and permanent impacts from construction.

Aside from the public education and outreach completed for projects specific to the Meetinghouse Branch 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 the stream. For this select group, quarterly newsletters could be mailed presenting information regarding the importance of not illegally discharging items (i.e. 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 would be coordinating with the 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 they learn in school to their parents. A presentation can be done in conjunction with an afternoon spent visiting and cleaning up the nearby stream. The wetland project proposed at Welcome Middle School is an educational outreach opportunity where signage could accompany a functional stormwater BMP. 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 Tar-Pamlico River Basin stormwater program.

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 Meetinghouse Branch 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 proposed flood control project. 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, US Army Corps of Engineers (USACE), Federal Emergency Maintenance Agency (FEMA), and North Carolina Department of Transportation (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 of Engineers 404 Permit

Proposed improvements within the City of Greenville must adhere to the requirements set forth in Sections 401 and 404 of the Clean Water Act. Required permitting can range from activities that are pre-authorized to those requiring a 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 streams or channels that are claimed jurisdictional by the 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.

7.1.1 NWP 3 – Maintenance

This permit authorizes the repair, replacement or rehabilitation of any previously permitted or currently serviceable structure. A PCN is not required if 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 that 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 Quality (DWQ) 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 diameter should be buried to a depth of 20% or greater of the diameter of the culvert.

7.1.2 NWP 13 – Bank Stabilization

This permit authorizes the reshaping of channel banks or bank stabilization activities that are necessary for erosion prevention. The placement of material is prohibited in any special aquatic site in a manner that may impede surface water flow into or out of a wetland area, or in a manner that will be eroded during normal or high flows. The activity must be part of a single and complete project and cannot exceed 1 cubic yard per running foot placed below the high water mark line. If stabilization activities exceed 500 linear feet, then a PCN is required for both the USACE and DWQ. DWQ must also be notified should fill be placed within the streambed.

7.1.3 NWP 27 – Stream and Wetland Restoration Activities

This permit authorizes stream enhancement, stream restoration, and channel relocation for restoration purposes that provide gains in aquatic functions. Stream channelization and the conversion of streams to other aquatic uses such as impoundments or waterfowl habitat are not authorized. A PCN to the USACE is required for any restoration activities occurring on private or public lands. DWQ requires a PCN if impacts are proposed for greater than 500 feet of stream bank or if in-stream structures are used.

Impacts proposed to the streams may need evaluation under the State Environmental Policy Act (SEPA). An Environmental Assessment (EA) is required under SEPA if greater than 500 linear feet of perennial stream is disturbed and stream restoration or enhancement is not performed. Channel disturbances are defined as activities that remove or degrade stream uses such as channelization, culvert placement, riprap, and other hard structures.

A list of some other conditions that should be followed under regulations provided by the USACE and DWQ are as follows:

- Soil erosion and sediment controls must be used and maintained in effective operating conditions during construction, and all exposed soil and fills should be stabilized at the earliest possible date.
- No activity is authorized under any NWP that is likely to jeopardize the existence of a threatened or endangered species, or which will destroy or adversely modify the habitat of such species.
- No activity is authorized that may affect historic properties listed or eligible for listing in the National Register of Historic Places.
- More than one NWP used for a single and complete project is prohibited.

- Impacts to waters of the US should be avoided and minimized to the greatest extent practicable.

  Mitigation in all its forms will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

- Hardening techniques should be avoided and minimized to the greatest practicable extent.

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, DWQ, EPA, SHPO, NCWRC, and USFWS. The application is also made available for public review. There is no defined timeframe for review of the application for an IP; therefore, the permitting process for an IP is typically significantly longer than 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 Parkers Creek and its two laterals from the Memorial Drive culvert crossings to their confluences with Parkers Creek. A floodway is the portion of the floodplain that must remain undeveloped to prevent an increase in the base flood elevation (BFE) of more than a specified amount. The specified amount as regulated by FEMA is typically 1.0 feet. For Parkers Creek, the limits of the FEMA Detailed Study are north of Staton Road to its confluence with the Tar River. For PC Lateral 1, area of the Detailed Study extends west of Memorial Drive On PC Lateral 2, the area of the Detailed Study is Memorial Drive. A floodway is mapped up until Memorial Drive on both Laterals 1 and 2 and to nearly Staton Road on the main stem of PC.

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 the 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 acre. Erosion and Sedimentation Control permits are anticipated for most of the proposed projects as shown in **Table 7-1**.

Table 7-1: Permitting Matrix for Proposed Projects

	FEMA	404/401 (NWP)	404/ 401 (IP)	NCDENR / NPDES	NCDOT	RAILROAD
PRIMARY SYSTEM PROJECTS						
Memorial Drive (Proposed Quadruple 66"RCP)	X	X		X	X	X
N. Greene Street (Proposed Twin 7'x7' RCBC)	X	X		X	X	
Staton Road (Proposed Twin 8'x8' RCBC)	X	X		X	X	
Regional Detention	X		X	X	X	X
SECONDARY SYSTEM PROJECTS						
Countryside/Oak Grove Estates System		X		X		
Greenfield Terrace System		X		X		
Haw Drive System		X		X		
STREAM STABILIZATION PROJECTS						
Parkers Creek Bank Failure	X	X		X		
Greenfield Park Wetland and Floodplain Bench		X		X		
Industrial Blvd Stormwater Outfall		X		X		
River Park North Channel Stabilization	X	X		X		
WATER QUALITY PROJECTS						
Welcome Middle School Wetland				X		
Aquatic Center Bioretention						
Greenfield Terrace Park Wetland				X		
East Carolina Vocational Center Wet Pond				X		
Church Street Wetland				X		

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 a 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 the 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 the 2015 cycle, the CWMTF awarded $19 million to fund projects throughout North Carolina. The Clean Water State Revolving Fund (CWSRF) is another option. It offers low-interest loans that can be used to fund stormwater projects with water quality components. It should be noted that typically, grants require some type of matching funds. The matching requirements vary for each different type of grant. For example, the CWSRF requires a 20 percent match from State based on the amount of Federal dollars awarded while the CWMTF does not have a specified match requirement.

The NCDENR DWR 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. The current matching limit for the program is 50 percent. This past year, the program awarded grants ranging from $16,000 to $200,000. The total amount awarded across nineteen recipients was over $1.3 million.

8.2 Flood Mitigation Funding

FEMA's Flood Mitigation Assistance (FMA) is a pre-disaster grant program designed to provide funding to States and communities to help 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 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 must 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 bonding 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 hand, are backed by income generated by the City through fees collected (i.e. 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 operations of the Stormwater Division as well as capital projects. The enterprise fund was originally established in 2001 with collections beginning in 2003. Since that time the rates have not been adjusted based on the needs of the program. In May 2013, City staff requested a fee increase of $0.50/ERU each year for the next 5 years to support capital projects and completion of the citywide master plan. Once the planning is complete, the City should complete a detailed rate study based on the capital needs identified in the planning process.

The cost estimates provided in this study were prepared to assist City staff in making planning level decisions and prioritizing improvements. These cost estimates are not final design estimates. These costs were developed using recent bid tabulations from other communities and NCDOT projects within North Carolina and include easement acquisition, 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 the prioritization list. The cost estimates are approximate and are subject to change due to local costs for materials, delivery, construction, and other factors. BMP costs are based on the size of the BMP, the estimated excavation required, and any associated structure or 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	
N. Greene Street Crossing (Parkers Creek Lateral 1)	$650,000
Memorial Drive Crossing (Parkers Creek Lateral 2)	$1,170,000
SECONDARY SYSTEM PROJECTS	
Countryside/Oak Grove System (Parkers Creek Lateral 2)	$580,000
Haw Drive/Airport System (Parkers Creek Lateral 2)	$330,000
Greenfield Terrace System (Parkers Creek Lateral 2)*	$5,340,000
STREAM STABILIZATION PROJECTS	
River Park North Channel Stabilization	$200,000
Parkers Creek Bubba Boulevard	$270,000
Greenfield Terrace Park Bank and Buffer Enhancement	$150,000
WATER QUALITY PROJECTS	
Welcome Middle School Wetland and Bioretention (Parkers Creek)	$150,000
Greenfield Terrace Park Wetland (Parkers Creek Lateral 2)	$220,000
Staton Road Aquatics and Fitness Center Bioretention	$120,000
East Carolina Vocational Center (Parkers Creek Lateral 2)	$140,000
Church Street Wetland (Parkers Creek Lateral 1)	$200,000

* Greenfield Terrace System LOS improvements include drainage pipe replacements ($450,00) and detention storage ($4,890,000).

SECTION 10
PRIORITIZATION AND RECOMMENDATIONS

As previously noted, the primary goal of this study is to make improvement recommendations to reduce flooding within the Parkers Creek/Johnsons Mill Run watersheds. Currently, several conveyance systems do not meet the City hydraulic design requirements. CDM Smith has provided recommendations that help to reduce or eliminate the identified problems. Success criteria goals used to measure each 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
- Minimizing easement acquisition

Two different prioritization lists were developed for the proposed projects identified in Sections 4 and 5: Flood Control Improvements, and Water Quality/Stream Stabilization Improvements. Projects were prioritizing using a Prioritization Matrix provided in Appendix M. The improvements were prioritized based on the following factors:

- 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

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. 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 that 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

Prioritization	Project
1	Memorial Drive Crossing (PC Lateral 2)
2	Countryside/Oak Grove System (PC Lateral 2)
3	Greenfield Terrace System (PC Lateral 2)
4	Haw Drive/Airport System (PC Lateral 2)
5	N. Greene Street Crossing (PC Lateral 1)

Table 10-2 shows the recommended priorities for the water quality and stream stabilization projects.

Table 10-2 Water Quality and Stream Stabilization Prioritization

Prioritization	Project
1	Staton Road Aquatics and Fitness Center Bioretention
2	East Carolina Vocational Center Wet Pond
3	Greenfield Terrace Water Quality Wetland
4	Welcome Middle School Wetland
5	Church Street Bioretention
6	River Park North Channel Stabilization
7	Parkers Creek North Channel Stabilization
8	Greenfield Terrace Channel and Buffer Enhancement

Table 10-3 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. In addition the NC 33 culverted crossing of Parkers Creek requires maintenance to adequately convey flows and to minimize future risks to the structures as described in detail in Section 4.1.2. More immediate maintenance needs may present themselves if portions of a conveyance system fail.

Table 10-3 Maintenance Recommendations

Prioritization	Project	Estimated Cost
1	Two pipe ends along Greenfield Terrace are deteriorated and require replacement (Inventory Structure #PCTBO2292 and PCTB02312).	$30,000
2	Two junction boxes along Terrace Court are missing covers (Inventory Structure #PCMB01009 and PCMB01011) and require replacement covers.	$2,000
3	NC 33 culvert barrel sediment and vegetation clearing (PC)	$2,000
4	Repair Existing Streambank Stabilization (PC)	$24,000
5	Parkers Creek/Lateral 1 Trash Removal	$300

REFERENCES

1. Municipal Storm Water Management, by Debo and Reese, 1995
2. National Weather Service http://hdsc.nws.noaa.gov/hdsc/pfds/orb/nc_pfds.html
3. Stormwater Best Management Practices; North Carolina Department of Environment and Natural Resources, Division of Water Quality, July 2007.
4. Urban Hydrology for Small Watersheds, United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division, Technical Release 55, June 1986.
5. 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.
6. 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.
7. Stepenuck KF, Crunkilton RL, Wang L (2002) Impacts of urban land use on macroinvertebrate communities in southeastern Wisconsin streams. Journal of the American Water Resources Association 38(4):1041-1051.
8. Environmental Protection Agency http://www.epa.gov/caddis/ssr_urb_is4.html
9. North Carolina Department of Environment and Natural Resources http://www.ncwater.org/Financial_Assistance/
10. Sheridan. J.M, W.H. Merkel, and D.D. Bosch, 2002. Peak Rate Factors for Flatland
11. Watersheds. Volume 18(1) 65-69. American Society of Agricultural Engineers.
12. Applied Engineering in Agriculture.

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