Report of Findings

Prichard Drainage Study
Toulmin Springs Branch and Gum Tree Branch

For

Mobile Bay National Estuary Program
Mobile County Commission
Project No. MCP-101-15

May 2016

Prepared by:

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1. Executive Summary

1.1 Introduction

At the request of Mobile County Commissioner, Merceria Ludgood, and Mayor Troy Ephriam of the City of Prichard, the Mobile Bay National Estuary Program (MBNEP), through the Dauphin Island Sea Lab (DISL), selected Mobile County as the recipient of a grant in the amount of $50,000 for Professional Services for Project MCP-101-15, Planning and Design of Drainage Improvements in the City of Prichard: Gum Tree Branch and Toulmin Springs Branch Sub watersheds, the *project*. On July 9, 2015, the County Commission approved the Contract for Professional Services by and between DISL, MBNEP, and Mobile County, the *contract*. The contract named Mobile County as the Project Director with Mr., Joe W. Ruffer, P.E., County Engineer, as the Key Person over the development of the *project*. Ms. Roberta Swann executed the contract as the Director of MBNEP, and Mr. David England executed it as the Chief Financial Officer for DISL.

The Mobile County Commission assigned Neel-Schaffer, Inc. (NSI) to provide professional engineering services for the *project* at a meeting held August 10, 2015. A contract for these professional services was executed by the County and NSI on August 26, 2015.

1.2 Purpose

The stated purpose for the *project* is MBNEP's desire to address its Comprehensive Conservation and Management Plan (CCMP) ecosystem restoration and protection (ERP) objective through preliminary planning and design of drainage improvements within the following areas of the City of Prichard:

- Gum Tree Branch sub-watershed of Eight Mile Creek watershed
- Toulmin Springs Branch sub-watershed of Three Mile Creek watershed

Planning and design of these drainage improvements will include environmentally appropriate techniques through the use of low impact development (LID) technology.

1.3 Scope of Service and Budget

The contract between the DISL, MBNEP, and Mobile County stated the scope of services (SOS) and budget as "preliminary planning and design of drainage improvements within the following area of the City of Prichard: Gum Tree Branch sub-watershed of Eight Mile Creek and Toulmin Springs Branch sub-watershed of Three Mile Creek watershed. Funding will be used to develop environmentally appropriate alternatives for improving drainage through the use of LID techniques." The allocated budget for the stated SOS is $50,000.

1.4 Procedural Approval

On September 15, 2015, a meeting at the County Engineering Department was convened to discuss details regarding data collection, results, and recommendations proposed by NSI under the stated SOS. In attendance were Bill Melton, P.E., Environmental Director for Mobile

County; Eddie Kerr and Tina Sanchez, with Mobile County Environmental Department; Mayor Troy Ephriam, Eddie Brown, and Fernando Billups with the City of Prichard; and Brian Morgan, Shane Bergin, and John Murphy with NSI. All parties in attendance approved the following procedures to best accomplish the stated SOS:

- NSI will perform walking surveys for both streams outlined in the stated SOS for data collection
- NSI will collect data via a global positioning system (GPS) device to record any areas in need of extensive maintenance and/or damaged with need of repair.
- NSI will map and collect data on all outfall structures and ditches that flow into both branches
- NSI will provide a report outlining recommendations for maintenance and repair along each branch to include LID solutions where appropriate
- NSI will prepare a cost estimate for removal of obstructions and recommended repair of damaged structures within the two branches

Letter correspondence was conducted with Roberta Swann on September 18, 2015, to outline the SOS provided by NSI and agreed upon by the County and the City. On September 22, 2015, telephone correspondence was conducted between NSI and Ms. Swann, during which Ms. Swann approved the outlined SOS, and NSI was permitted to proceed with data collection. Ms. Swann also informed NSI about current water quality data collection by Dr. Latif Kalin along the Toulmin Springs Branch. NSI contacted Dr. Kalin to obtain a copy of his report and ensure there would be no overlapping issues between his study and the *project*.

Data collection of the *project* began on September 23, 2015. This report outlines the collected data along both branches as well as recommendations for drainage improvements within the *project* area.

1.5 General Discussions and Recommendations For Low Impact Development & Sea Level Rise

1.5.1 Low Impact Development (LID)

MBNEP and Mobile County strongly encourage environmentally appropriate alternatives for improving drainage through the use of LID techniques to the greatest extent possible as outlined in the “Low Impact Development Handbook for the State of Alabama”. This Handbook was developed by a joint effort of the Alabama Department of Environmental Management (ADEM), Alabama Cooperative Extension System (ACES), and Auburn University. It describes LID as an interdisciplinary systematic approach to stormwater management that when planned, designed, constructed, and maintained appropriately can result in improved stormwater quality, improved health of local water bodies, reduced flooding, increased groundwater recharge, more attractive landscapes, wildlife habitat benefits, and improved quality of life. LID minimizes runoff and employs natural processes such as infiltration, evapotranspiration (evaporation and transpiration from plants), and storage of stormwater at multiple fine scale locations within the closest proximity to the stormwater source as possible. Successful implementation of LID recreates a more natural hydrologic cycle in a developed watershed.

Therefore, the use of LID technology in the design of improvements is strongly encouraged at the identified locations outlined in this report.

1.5.2 General LID Recommendations for Toulmin Springs Branch and Gum Tree Branch

The Three Mile Creek Watershed Management Plan identifies impairments to headwaters located at Toulmin Springs Branch as sanitary sewer leaks, illicit discharges, and trash as primary sources of nutrients and pathogens. By addressing these issues with appropriate LID improvements within the project area, the overall quality of life and safety of public spaces in adjacent residential neighborhoods is expected to improve as well. An initial conceptual plan for the Toulmin Springs Branch headwaters has been drafted (Figure 1.5.1), and extending these concepts throughout the project area is an effective way to establish the City's multiple goals. By linking the initial conceptual wetland creation plan at the stream's headwaters with NSI's recommendations, Toulmin Springs Branch could greatly improve its water quality, flow rate, and downstream drainage.

Figure 1.5.1 – Toulmin Springs Branch headwaters conceptual wetland creation plan (taken from Three Mile Creek Watershed Management Plan)

LID should be considered for use in the development of Best Management Practices (BMPs) for the maintenance of the two branches. Heavy maintenance is required throughout both branches to include removal of invasive vegetation species as well as overgrown and problematic vegetation which serves as debris collection points, slowing stormwater drainage. Routine maintenance along both branches should include trash and debris collection, the installation of Gross Pollutant Removal Structures (GPRS) on outfall pipes and inlets, and the removal of sediment to restore natural water depth and volume. Sandy sediments and revegetation of freshwater wetland plants and submerged aquatic vegetation (SAV) may improve water quality in these two systems by filtration and removal of heavy metals and nutrient loads. In areas where traditional concrete structures would be placed, or in areas where damaged concrete should be replaced, a series of open channel stormwater conveyances through rock and sand bottomed step pools could be placed to convert some surface water flow to shallow groundwater flow. This will allow for water quantity and quality treatment as well as providing habitat for wetland species. Another important component to solving drainage problems in this area is public outreach and education. Partnerships are strongly encouraged within community churches, schools, and other groups to achieve intense education and outreach programs that encourage area residents and adjoining property owners within these two watersheds to assist in keeping them clean from litter and debris. Installation of educational signs throughout the watersheds could encourage the surrounding community to take pride in keeping their streams clean.

1.5.3 Sea Level Rise (SLR)

Sea Level Rise (SLR) due to climate change is considered to be one of the largest future vulnerabilities for these two branches. Both sub basins are in close proximity to Mobile Bay and are thus tidally influenced as well as affected by SLR. The Three Mile Creek Watershed Plan outlines the possibility of tidal surge and changing sea levels altering infrastructure and disrupting native habitats in the watershed by negatively affecting some and expanding or creating others. One of the BMPs to prepare for SLR is land acquisition in areas subject to future inundation to be maintained as open spaces in perpetuity. Land acquisition along these two branches in areas that experience regular flooding is strongly encouraged as one method to address future SLR during the development of a long term sustainability plan for the future of these two streams.

2. General Methodology

2.1 Data Collection Process

NSI discussed the use of multiple devices to ensure the data collected is accurate and provides sufficient information to define areas of concern from field investigations. A handheld Trimble unit was used to collect and store information at each data point. Using the Trimble GPS, field investigators collected information, such as the nature of the waterway, potential problems, outfalls, discharge points, and pictures, at each site. Once data collection was complete, the collected site coordinates were mapped and references to data at that location were outlined. This information is provided in Section 6 and 7.

2.2 Estimation of Costs

Preliminary cost estimates were completed by NSI. Estimated cost is based on field investigations, pictures, and recent construction costs of similar work in the Mobile County area. Quantities used for calculations were generalized to delineate the need in each aspect of the project. Quantities are subject to change over time due to the changing nature of the creeks and timing of survey data collection for specific areas. Unit prices are also subject to change, as accessibility (mobilization) can vary greatly depending on location. Estimates of recommended improvements are provided in Section 5.

3. Toulmin Springs Branch

3.1 Description of Project

Toulmin Springs Branch begins at South Leeds Avenue, northwest of Interstate 65 (I-65) and northeast of St. Stephens Road. At the northern extent of the branch, several pipes converge to flow generally south under I-65. Other than concrete and pipe culverts for roadway crossings, the branch is an earthen channel until reaching Hinson Avenue. From Hinson Avenue, the waterway travels southeast via concrete channel for approximately two miles until it returns to an earthen channel approximately 200 feet southeast of South Wilson Avenue. The earthen channel continues until its intersection with Three Mile Creek. A vicinity map of the project area is provided in Section 6.

The channel is characterized by multiple areas of concern that include erosion, dense and overgrown vegetation, heavy sediment deposits, and debris accumulation (primarily empty plastic bottles). Future growth of vegetation in concrete portions could potentially lead to further displacement of concrete sections, in turn, increasing erosion.

3.2 Summary of Findings

Toulmin Springs Branch has several concentrated areas of concern. The section between South Leeds Avenue and I-65 is heavily vegetated. Field investigators observed ponded water upstream due to sediment and debris traps downstream, and possible grading issues. Based on aerial photography, the section between I-65 and Hinson Avenue appears to have been a sloped concrete channel (or similar material) in the past, but heavy vegetation growth has narrowed its footprint preventing proper drainage through this section.

Figure 3.1 – Between S Leeds Avenue and I-65

From Hinson Avenue to South Thomas Avenue the channel is a trapezoidal concrete ditch. This section has vegetation growing through sections of concrete that will ultimately cause a shortened life span if maintenance is neglected. The concrete ditch has a 12-foot wide bottom, 22-foot wide top, and is 5.5 feet in height.

Figure 3.2 – Hinson Avenue looking south

Several bridges have utilities that pass under them, directly in the way of water flow, which cause debris to accumulate at these locations. Areas that have extensive debris caught under the bridge are noted in the summary of findings tables in Appendix A.

Figure 3.3 - Garrison Avenue Bridge

The concrete ditch increases in size approximately 150 feet south of Graham Avenue to a 34-foot wide bottom, 44-foot wide top, and 5.5 feet in height. This increase is likely due to the anticipated increase in stormwater input from a concrete channel entering from the southwest.

Just downstream from South Wilson Avenue, the concrete section ends, and Toulmin Springs Branch returns to an earthen channel through its intersection with Three Mile Creek. This portion has experienced obvious erosion, ponding due to misplaced riprap, heavy vegetation growth, and large amounts of debris deposits. Field investigators determined ponding was largely found around the bridge at South Craft Highway, where riprap has been placed. Investigators also noted leaves caught in residential fences on top of the bank of Toulmin Springs Branch, which indicated constricted flow in the channel, causing flash flooding impacts to this area during inclement weather events. Removing debris and vegetation downstream may relieve much of the congestion upstream.

Figures 6.1 through 6.8 provide maps of problem locations outlined in this report, and Tables A.1 through A.4 (Appendix A) prioritize action items at each location.

Figure 3.4 - 400 Feet southeast of Wilson Avenue

Figure 3.5 - Between Location 60 & 61

3.3 Recommendations

To simplify analysis and understanding of the Toulmin Springs Branch *project* area, it has been divided into three sections (Figures 6.1-6.8). The northern section is an earthen channel from South Leeds Avenue to Hinson Avenue. This section is classified by heavy vegetation that constricts flow with the potential to cause upstream flooding northwest of I-65. The channel is partially defined through this section, but could alter without regular maintenance. This section would highly benefit from short-term improvements that include removal of all overgrown vegetation and sediment accumulation. All invasive vegetation species, such as Chinese Tallow (*Triadica sebifera*), should be removed along this section as well.

The second section identified can be classified as a concrete ditch from Hinson Avenue to just south of Wilson Avenue. The concrete channel routinely increases in geometrical size as more stormwater flow is received from various outfall locations. There are several concrete areas in this section that are recommended for long-term improvements to damage caused by improper maintenance and erosion. LID, such as replacement of concrete with rock and sand bottomed conveyances, should be considered at each of the damaged sections before repairs are made.

Depending on the stability of concrete channel downstream, replacement of the damaged concrete with new concrete may be the most structurally sound alternative. Utility crossings under bridges in this section serve as collection points for debris and constrict the channel. Typically, the utilities crossed one foot to three feet above the bottom of the ditch, ultimately catching debris flowing in the channel. These areas should receive regular maintenance to remove trapped debris. Relocation of these utilities would have long-term benefits in this section of the branch. Another obstacle hindering stormwater flow is the skew of several bridges throughout the length of the branch. Some bridges are skewed more than 30 degrees, reducing the amount of flow that can be conveyed from upstream to downstream. Locations where this occurs have been identified in Figures 6.1 through 6.8 (Section 6). NSI recommends that channel approaches and bridge skew be addressed if any of the identified bridges are to be replaced in the future.

The southern third section of Toulmin Springs Branch, from Wilson Avenue to Three Mile Creek, is an earthen channel that seems to have accumulated much of the debris from the concrete section. Overgrown, heavy vegetation serves as a collection point for debris flowing through the channel. Short-term recommendations for this section include maintenance of the channel through routine removal of overgrown vegetation and debris. Should routine maintenance not reduce debris accumulation and flash flooding in adjacent residential areas, long-term improvements to the stream should be considered. LID rock and sand bottom conveyances could be constructed to transfer some surface water flow to groundwater flow and allow for increased stormwater flow rates. Cost estimates for this type of structure are provided for approximately 2,300 linear feet. Should this course of action not be feasible or in the best interest of the City and its residents, estimates for concrete ditch conversion are provided as well. The remainder of Toulmin Springs Branch as a natural channel until its intersection with Three Mile Creek should be routinely cleared of debris and overgrown and invasive vegetation.

Cost estimates were developed in two separate tiers and are provided in Section 5. Short-term improvements (Table 5.1) include action items that can possibly be addressed with Public Works personnel. The second tier includes long-term improvements, which will provide a sustainable solution to several of the areas of concern noted in Section 3.3. Additional design services would be required to accurately quantify specific features of long-term recommendations. Table 5.2 provides cost estimates for concrete repair and relocation of utilities within the second section of Toulmin Springs Branch. A preliminary cost estimate for ditch to concrete channel conversion is provided in Table 5.3. Table 5.4 provides a preliminary cost estimate for a rock and sand conveyance system within the third section of the branch. A litter trap was also included in the cost estimate for this particular area.

4. Gum Tree Branch

4.1 Description of Project

Gum Tree Branch consists of three sections that converge to deposit into Eight Mile Creek. The first section begins as a culvert at the intersection of St. Stephens Road (Highway 45) and Elba Avenue then flows northeast until it intersects with the second section of Gum Tree Branch, just northwest of the Whatley Avenue terminus. The third section begins at the southeast terminus of Rebel Road, behind Prichard Public Works, and flows generally north until depositing into Eight Mile Creek behind Prichard's Wastewater Treatment Facility. The three sections are comprised largely of earthen ditches, rip rap channels, and one concrete ditch section along the third section. Most of the roadway crossings consist of concrete box culverts. An aerial map of the project location can be found in Section 7.

Gum Tree Branch is characterized by multiple areas of concern including erosion, vegetation, heavy sediment deposits, concrete damage, and debris accumulation.

4.2 Summary of Findings

Gum Tree Branch contains multiple restrictions along the length of the project area. Most of the culverts, mainly pipe culverts, are deteriorating due to age and wear. Most of the first section of Gum Tree Branch has low water levels, indicating sufficient grading in this area of the creek. A portion from Thompson Boulevard to I-65 narrows and is deep throughout, when observed at normal flow conditions. The increased water depth in this area is most likely due to damming by riprap at the bridge on Thompson Boulevard.

Figure 4.1 - Between West Main Street & West Turner Road

Figure 4.2 - Between West Main Street & West Turner Road

Figure 4.3 - Bridge at West Turner Road

Field investigators also observed heavy sediment accumulation between East Turner Road and Whistler Street. While this is a relatively short portion of the branch, it has caused upstream damming noted by the limited freeboard of adjacent box culverts.

Figure 4.4 - Culvert at Whistler Street

Maps highlighting the various characteristics of Gum Tree Branch, along with corresponding summary tables specifying data collected at each, can be found in Appendix B.

4.3 Recommendations

Recommendations for Gum Tree Branch entail short-term LID improvements. The majority of flow hindrances are due to debris accumulation, which could be remedied by routine maintenance. Another potential limiting factor of flow is insufficient culvert size at road crossings required for the current flow rate. Long-term recommendations include replacement of these structures to allow for more efficient stormwater flow upstream of these areas.

Areas of concern are outlined in Tables B.1 through B.4, found in Appendix B. The features identified in Appendix B were used to create cost estimates for improvements along Gum Tree Branch. Sedimentation items are in place to remove excessive amounts of sediment deposited into the creek bottom, that in-turn increases upstream flooding. There are also several locations where concrete damage has occurred within the third section of the branch. Multiple debris restrictions throughout the branch were identified. To improve functionality of the waterway, debris should be removed. Locations of identified sedimentation, concrete damage, and debris accumulation are shown in Section 7 (Figures 7.1-7.8).

Several road crossing culverts have been identified to potentially limit flow and cause upstream flooding. Culverts can vary in construction cost due to size, material, and placement. In order to provide an accurate cost estimate, further analysis and design work would be needed. A preliminary estimate of construction improvements can be found in Tables 5.5 and 5.6.

Cost estimates were developed in two separate tiers, the first of which is short-term improvements. Table 5.5 includes features that can possibly be addressed with Public Works personnel. The second tier includes long-term improvements that will provide a sustainable solution to several of the areas of concern noted in the report. Table 5.6 provides preliminary cost estimates for the recommended long-term improvements, but additional design services would render a more accurate quantification of these features.

5. Estimation of Cost

Table 5.1 – Toulmin Springs Branch (Tier 1)

Short-Term Improvements				
Item	Unit	Quantity	Unit Cost	Cost
Clearing	LF	3,100	$ 25.00	$ 77,500.00
Herbicide	SF	126,000	$ 0.10	$ 12,600.00
Unclassified Excavation	CY	300	$ 30.00	$ 9,000.00
Removal of Litter	LS	1	$ 10,000.00	$ 10,000.00
Silt Fence	LF	3,600	$ 2.00	$ 7,200.00
			Subtotal:	**$ 116,300.00**
			(8%) Mobilization:	$ 9,304.00
			Total Construction:	**$ 125,604.00**

Table 5.2 – Toulmin Springs Branch (Tier 2)

Long-Term Improvements				
Item	Unit	Quantity	Unit Cost	Cost
Clearing & Grubbing	LF	3,100	$ 50.00	$ 155,000.00
Unclassified Excavation	CY	900	$ 20.00	$ 18,000.00
Borrow Excavation	CY	600	$ 25.00	$ 15,000.00
Removal of Litter	LS	1	$ 10,000.00	$ 10,000.00
Utility Relocation	Each	9	$ 10,000.00	$ 90,000.00
Concrete Ditch Repairs	SY	272	$ 200.00	$ 54,400.00
Hydro seeding	SY	10,000	$ 2.00	$ 20,000.00
Erosion Control Mats	SY	10,000	$ 2.00	$ 20,000.00
Silt Fence	LF	17,000	$ 2.00	$ 34,000.00
			Subtotal:	**$ 416,400.00**
			(8%) Mobilization:	$ 33,312.00
			Subtotal Construction:	**$ 449,712.00**
			(10%) Engineering/Survey:	$ 44,972.00
			(15%) CE&I:	$ 67,457.00
			Total Project Cost:	**$ 562,141.00**

Table 5.3 – Toulmin Springs Branch (Tier 2)

Long-Term Improvements				
Item	Unit	Quantity	Unit Cost	Cost
Concrete Ditch Construction	SY	14,000	$ 200.00	$ 2,800,000.00
LID, Energy Dissipaters, Etc.	SY	14,000	$ 200.00	$ 2,800,000.00
Restore to Natural Channel	LS	1	$ 3,400,000.00	$ 3,400,000.00
Litter Traps	Each	1	$ 500,000.00	$ 500,000.00
			Subtotal:	**$ 9,500,000.00**
			(8%) Mobilization:	$ 760,000.00
			Subtotal Construction:	**$ 10,260,000.00**
			(10%) Engineering/Survey:	$ 1,026,000.00
			(15%) CE&I:	$ 1,539,000.00
			Total Project Cost:	**$ 12,825,000.00**

Table 5.4 – Toulmin Springs Branch (Tier 2)

Long-Term Improvements				
Item	Unit	Quantity	Unit Cost	Cost
Limestone Rock	CY	18,750	$ 45.00	$ 843,750.00
Sand	CY	3,410	$ 20.00	$ 68,200.00
LID, Energy Dissipaters, Etc.	SY	14,000	$ 200.00	$ 2,800,000.00
Restore to Natural Channel	LS	1	$ 3,400,000.00	$ 3,400,000.00
Litter Traps	Each	1	$ 500,000.00	$ 500,000.00
			Subtotal:	**$ 7,611,950.00**
			(8%) Mobilization:	$ 609,000.00
			Subtotal Construction:	**$ 8,220,950.00**
			(10%) Engineering/Survey:	$ 822,095.00
			(15%) CE&I:	$ 1,233,143.00
			Total Project Cost:	**$ 10,276,188.00**

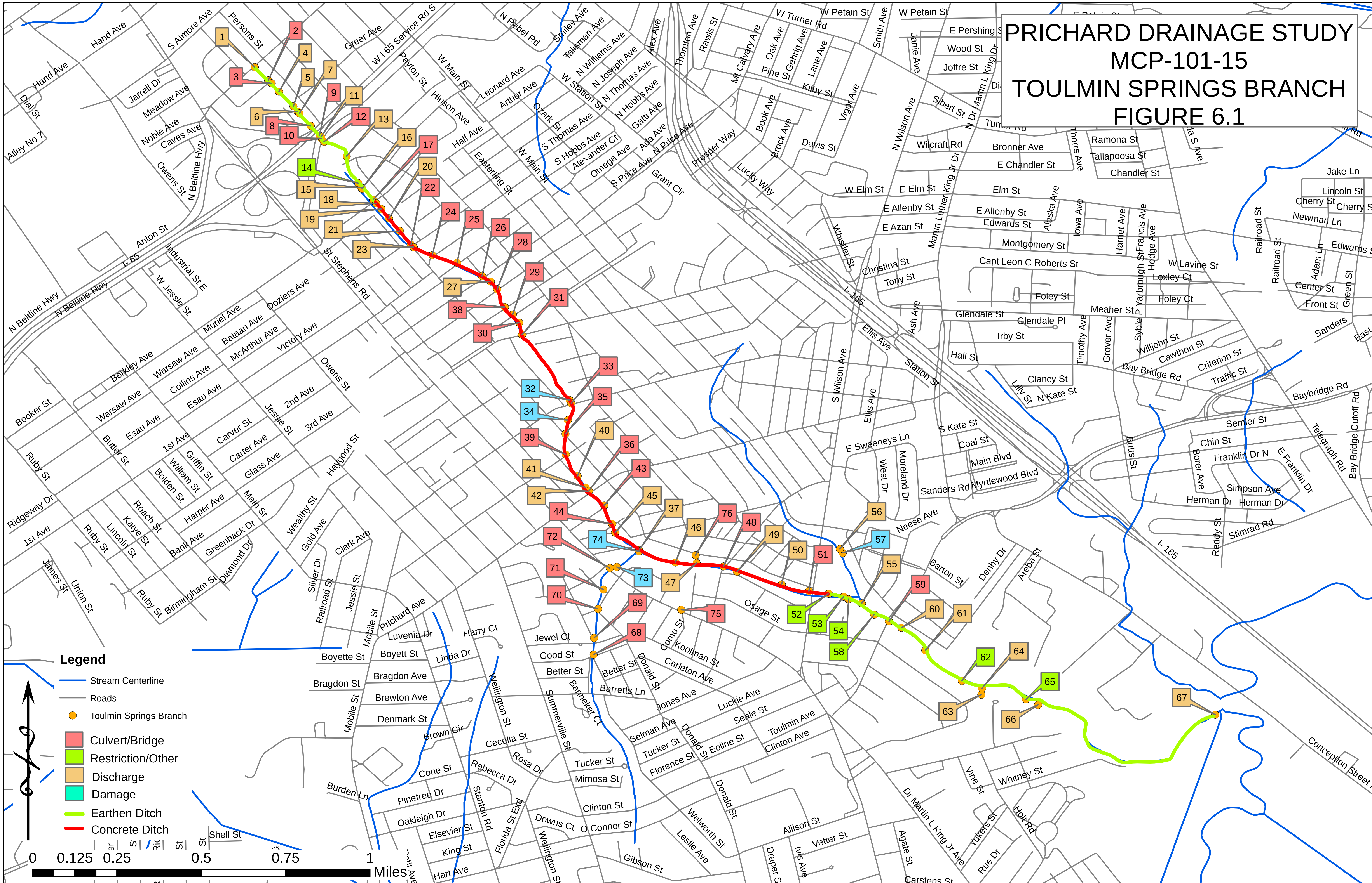
Table 5.5 – Gum Tree Branch (Tier 1)

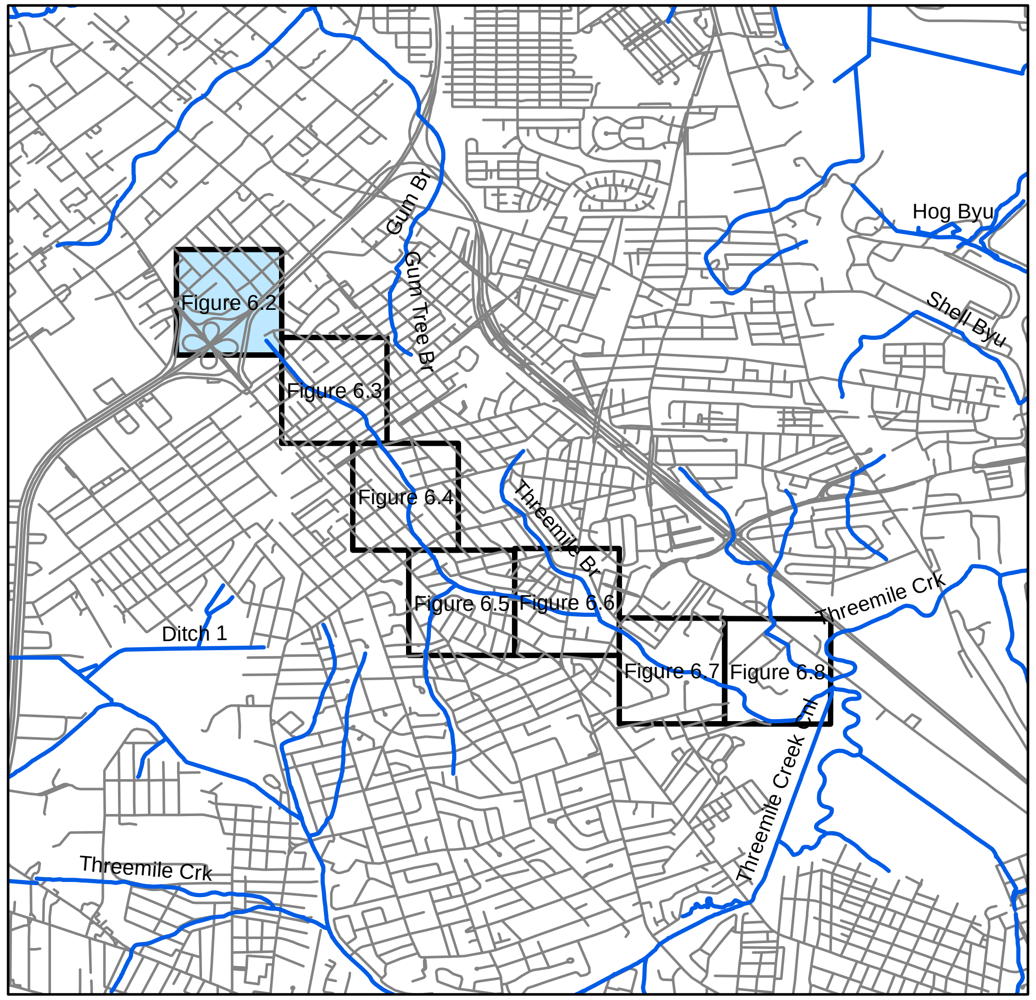
Short-Term Improvements				
Item	Unit	Quantity	Unit Cost	Cost
Clearing	LF	1,300	$ 25.00	$ 32,500.00
Herbicide	SF	46,800	$ 0.10	$ 4,680.00
Unclassified Excavation	CY	2,00	$ 30.00	$ 6,000.00
Removal of Litter	LS	1	$ 10,000.00	$ 10,000.00
Silt Fence	LF	2,600	$ 2.00	$ 5,200.00
			Subtotal:	**$ 58,380.00**
			(8%) Mobilization:	$ 4,670.00
			Total Construction:	**$ 63,050.00**

Table 5.6 – Gum Tree Branch (Tier 2)

Long-Term Improvements				
Item	Unit	Quantity	Unit Cost	Cost
Clearing & Grubbing	LF	1,300	$ 50.00	$ 65,000.00
Removal of Culvert	LF	240	$ 300.00	$ 72,000.00
Unclassified Excavation	CY	1,200	$ 30.00	$ 36,000.00
Borrow Excavation	CY	900	$ 30.00	$ 27,000.00
Removal of Litter	LS	1	$ 10,000.00	$ 10,000.00
Concrete Ditch Repairs	SY	30	$ 250.00	$ 7,500.00
Concrete Box Culvert	SY	960	$ 150.00	$ 144,000.00
Hydro seeding	SY	1,200	$ 2.00	$ 2,400.00
Erosion Control Mats	SY	1,200	$ 3.00	$ 3,600.00
Silt Fence	LF	2,600	$ 2.00	$ 5,200.00
			Subtotal:	**$ 372,700.00**
			(8%) Mobilization:	$ 29,816.00
			(3%) Maintenance of Traffic:	$ 11,181.00
			Subtotal Construction:	**$ 413,697.00**
			(10%) Engineering/Survey:	$ 41,370.00
			(15%) CE&I:	$ 62,055.00
			Total Project Cost:	**$ 517,122.00**

6. – Toulmin Springs Branch Maps


PRICHARD DRAINAGE STUDY
MCP-101-15
TOULMIN SPRINGS BRANCH
FIGURE 6.1
Legend
Stream Centerline
Roads
Toulmin Springs Branch
Culvert/Bridge
Restriction/Other
Discharge
Damage
Earthen Ditch
Concrete Ditch
0 0.125 0.25 0.5 0.75 1
Miles



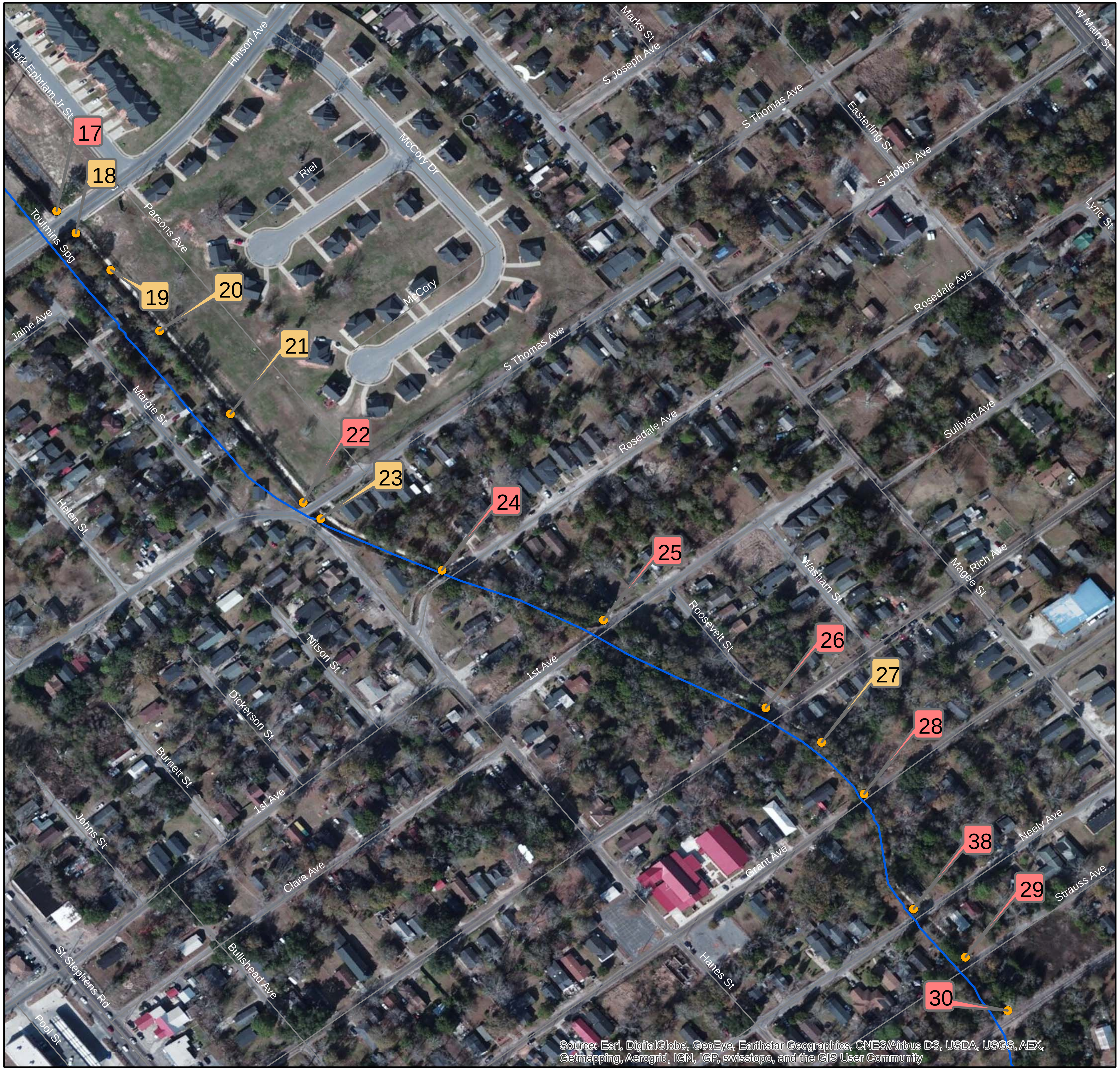
PRICHARD DRAINAGE STUDY
MCP-101-15
TOULMIN SPRINGS BRANCH

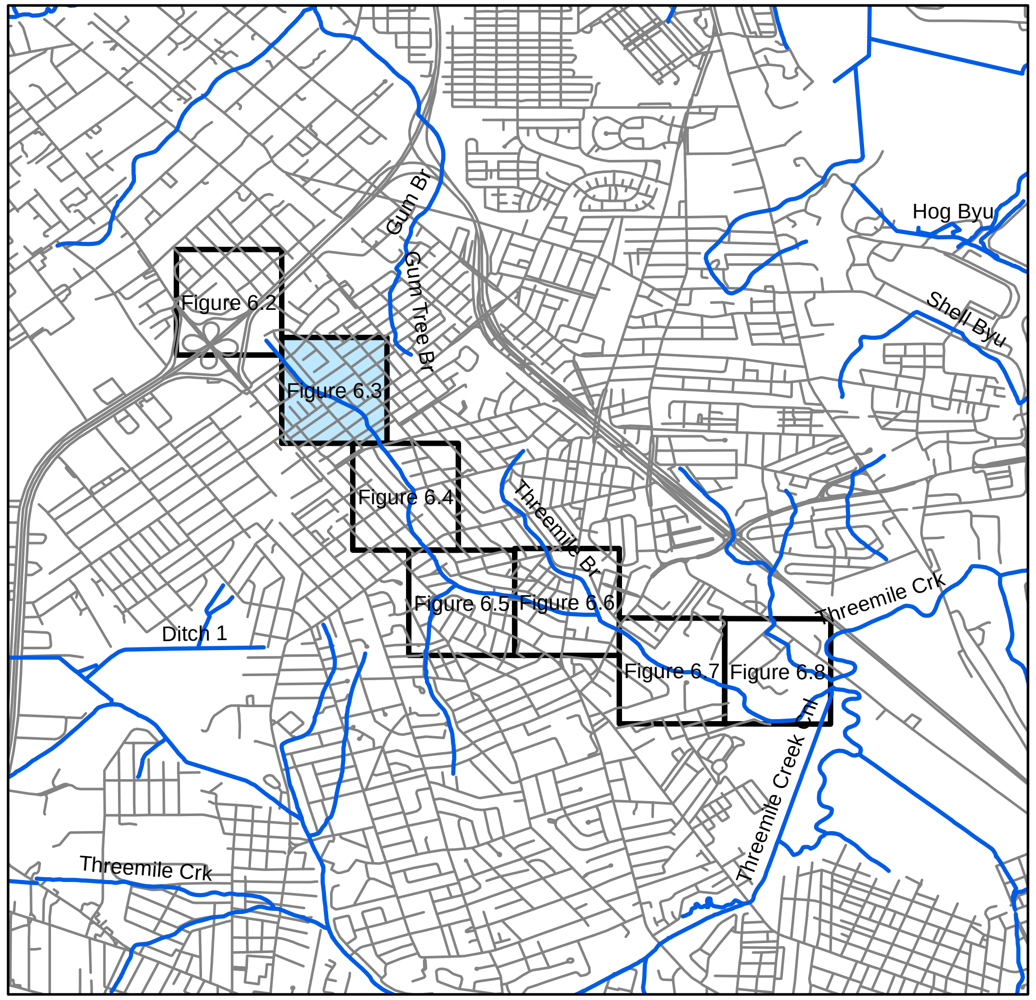
Legend

- Stream Centerline
- Roads
- Toulmin Springs Branch
- Culvert/Bridge
- Restriction/Other
- Discharge
- Damage

0 120 240 480 720 960 Feet

Figure 6.2





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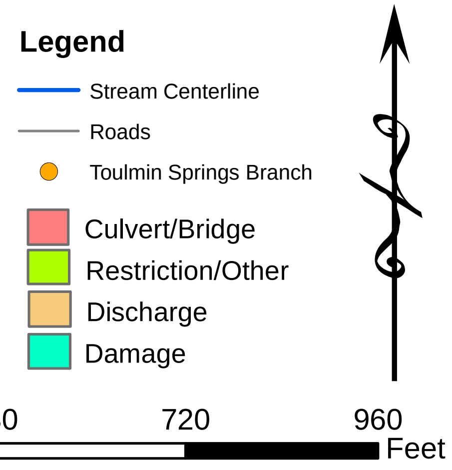
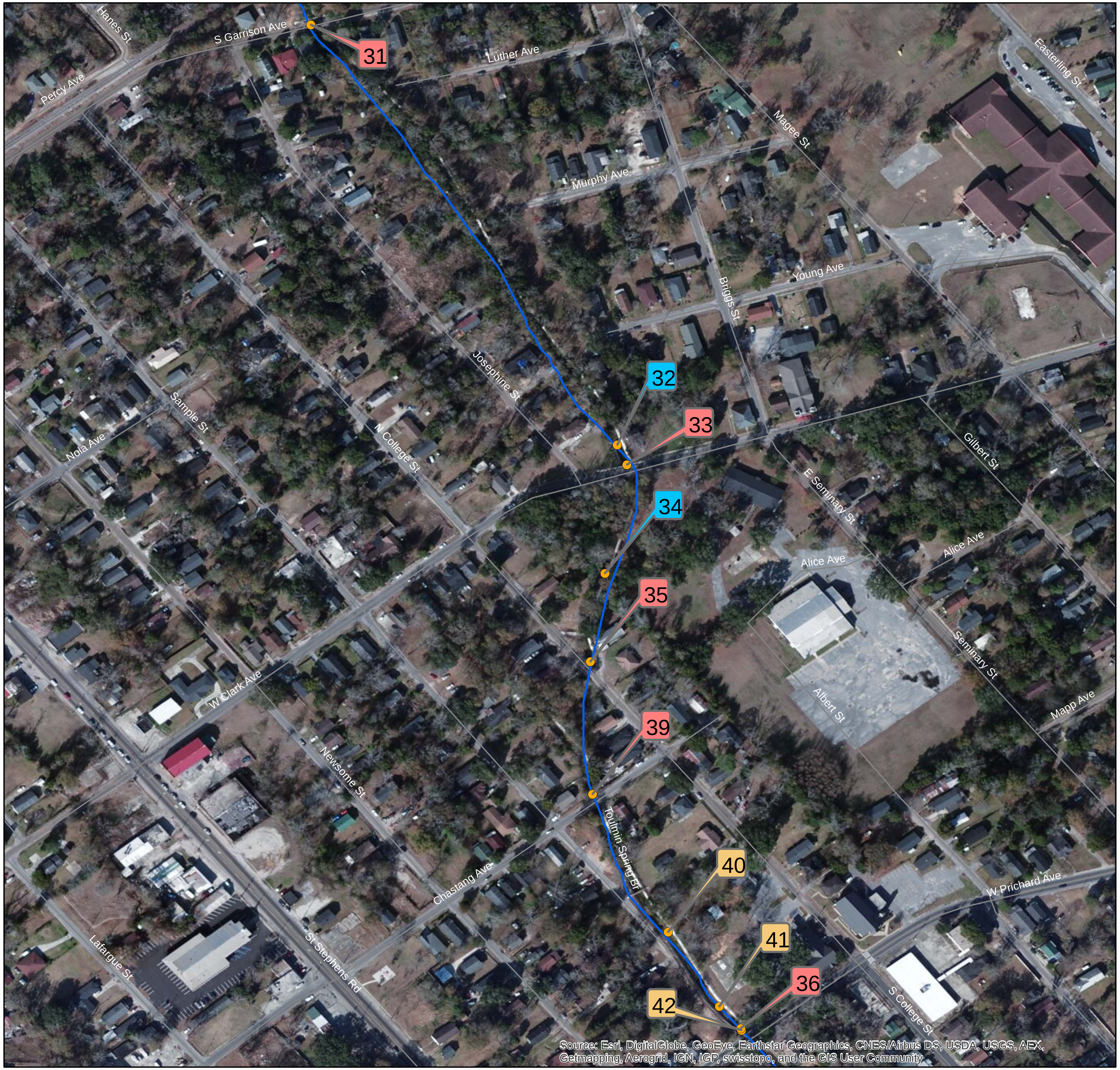
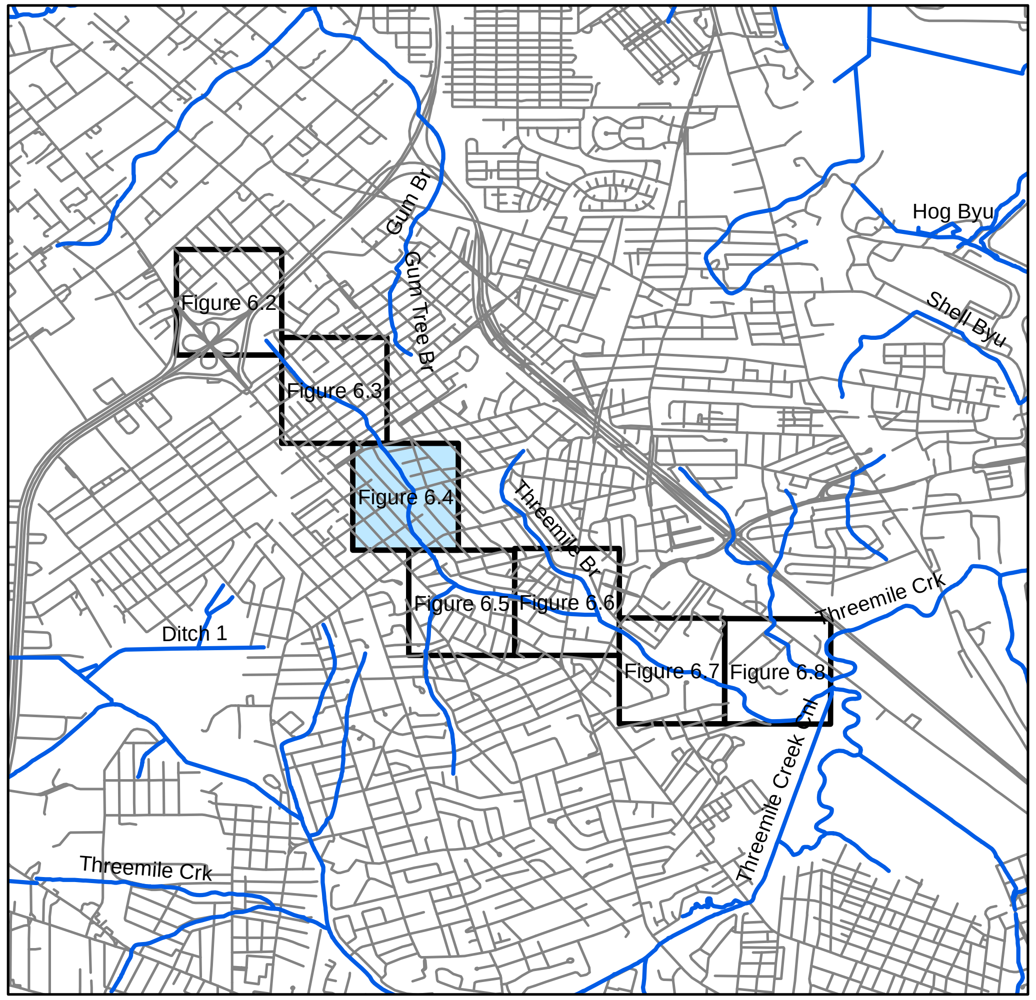


Figure 6.3





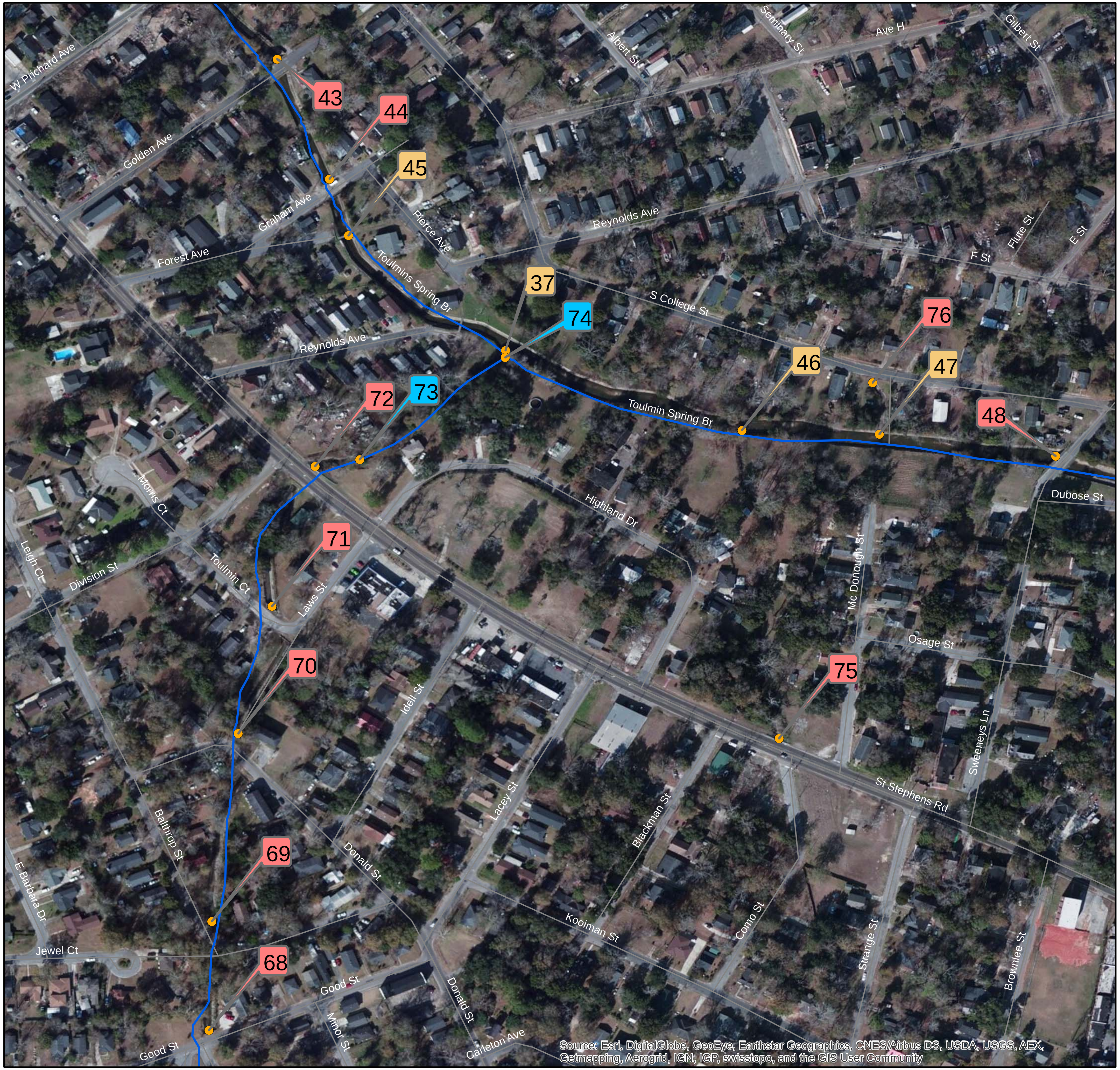
PRICHARD DRAINAGE STUDY
MCP-101-15
TOULMIN SPRINGS BRANCH

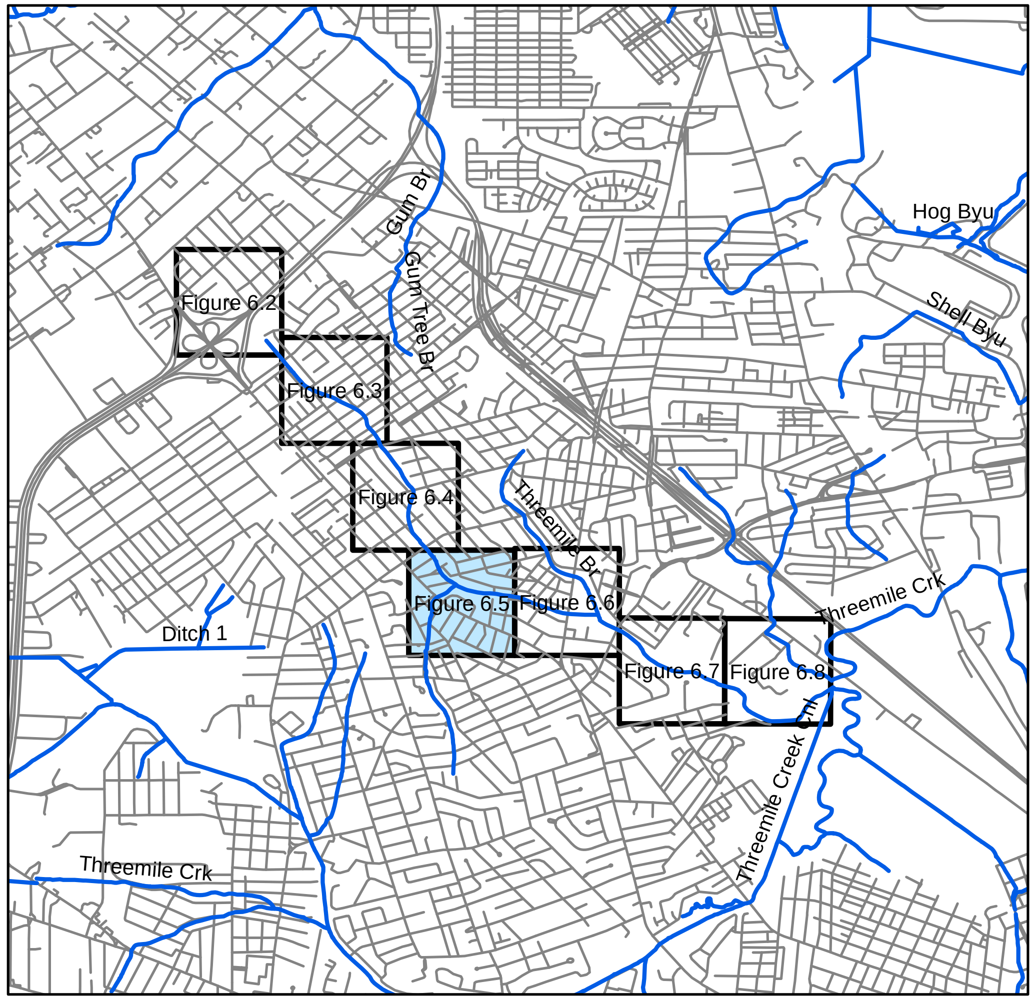
Legend

- Stream Centerline
- Roads
- Toulmin Springs Branch
- Culvert/Bridge
- Restriction/Other
- Discharge
- Damage

0 120 240 480 720 960 Feet

Figure 6.4





PRICHARD DRAINAGE STUDY
MCP-101-15
TOULMIN SPRINGS BRANCH

Legend

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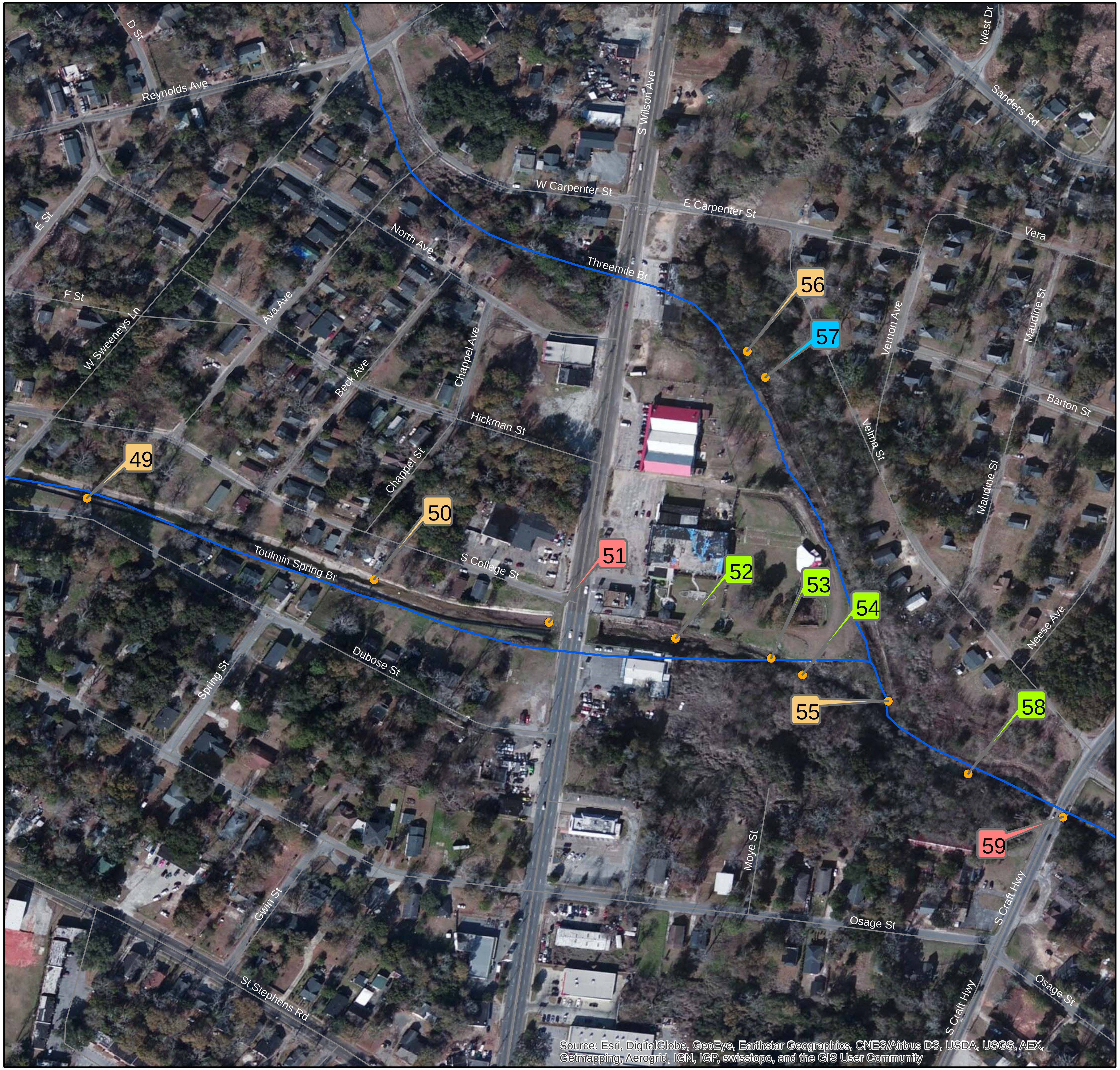
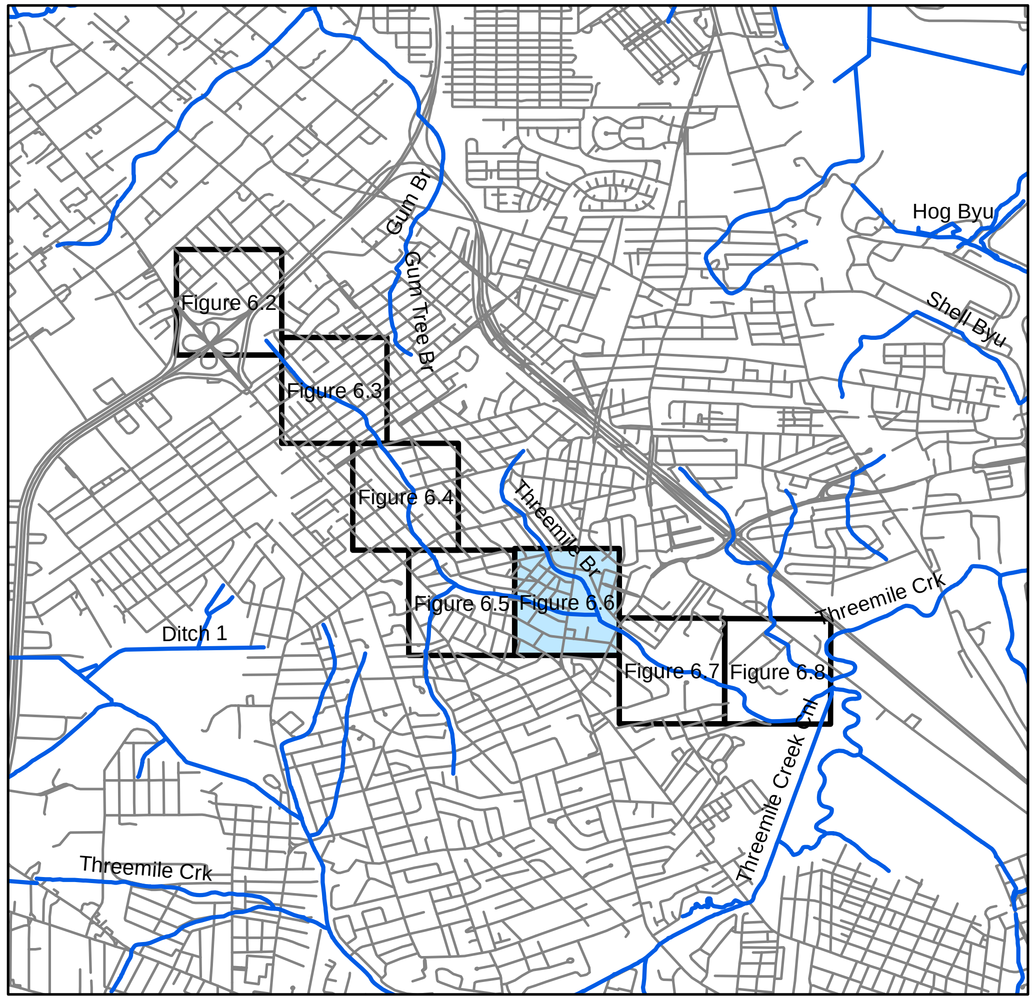
0 120 240 480 720 960 Feet

Figure 6.5





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Legend

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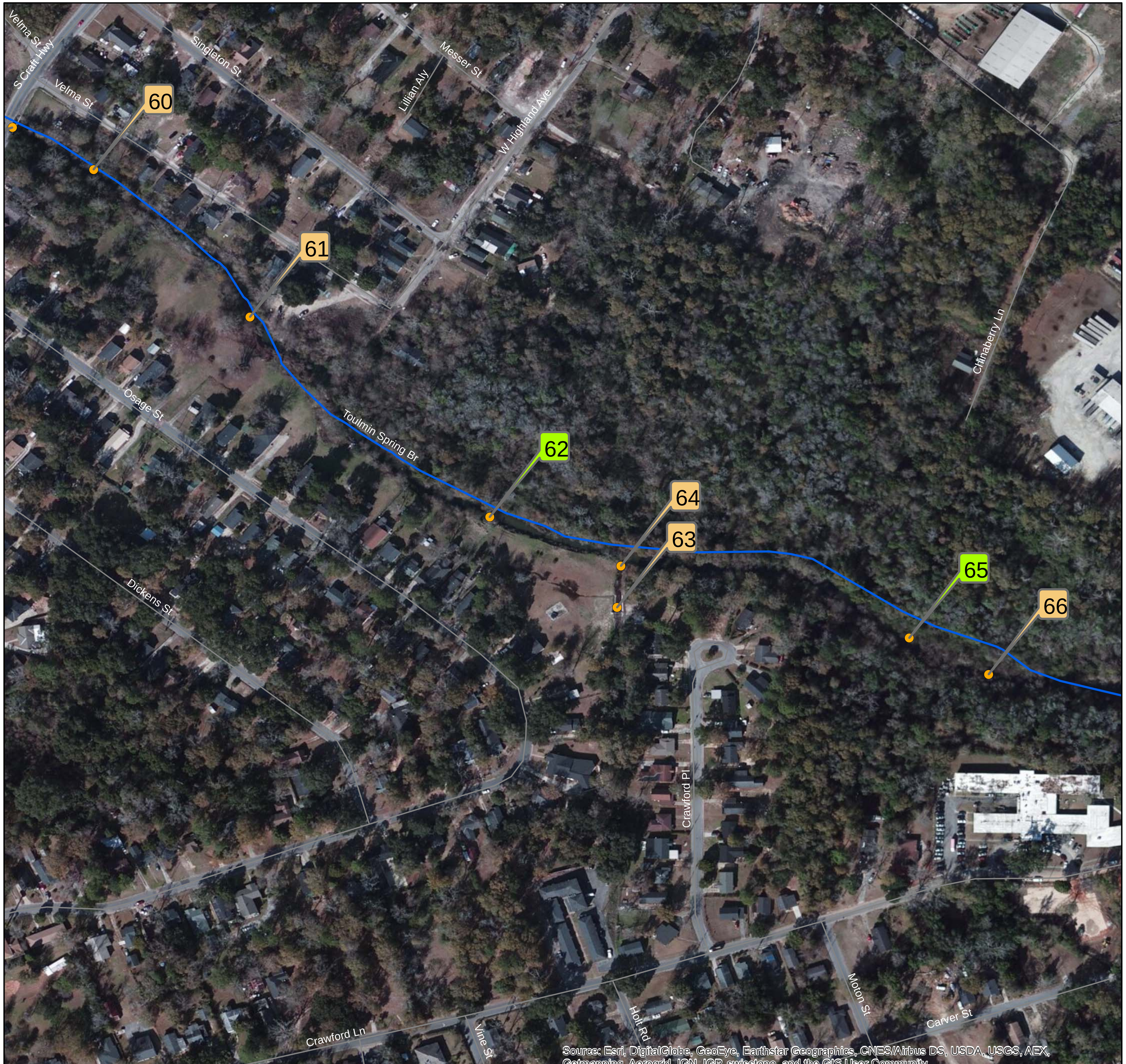
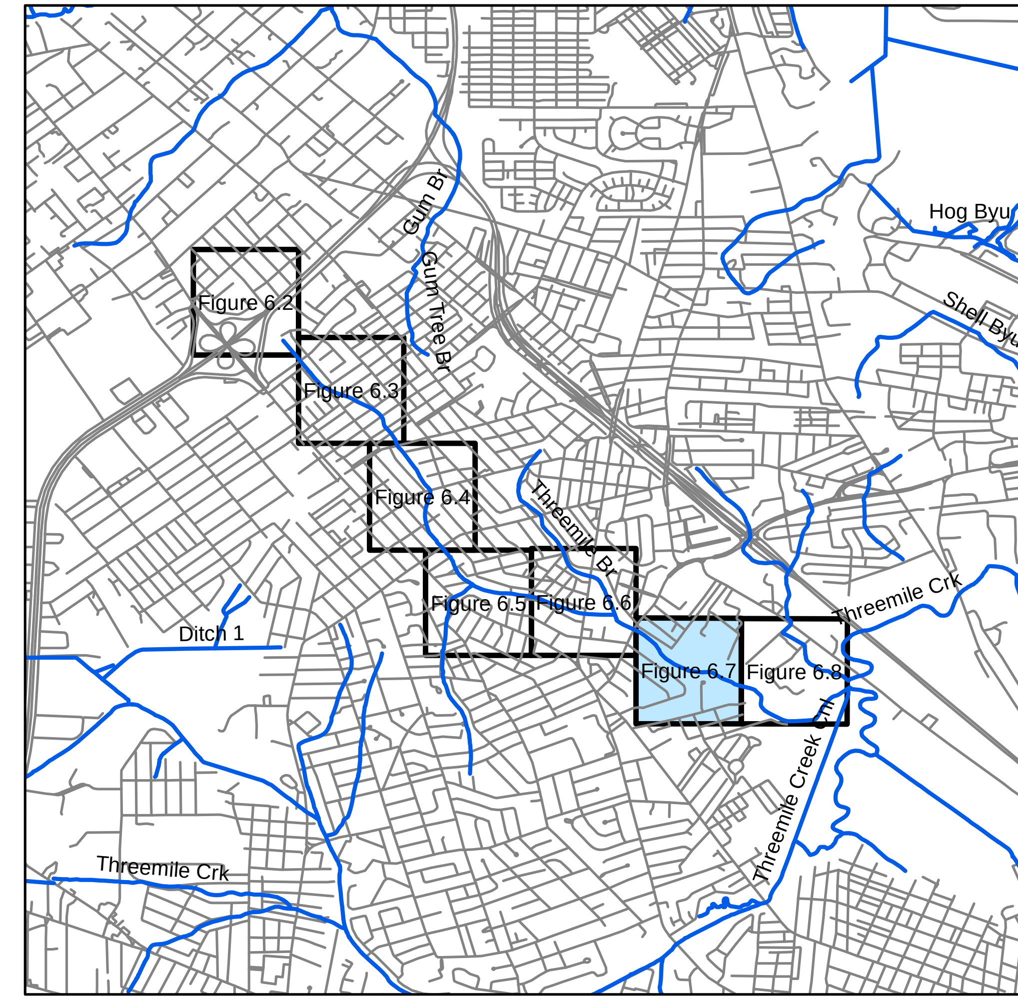
0 120 240 480 720 960 Feet

Figure 6.6





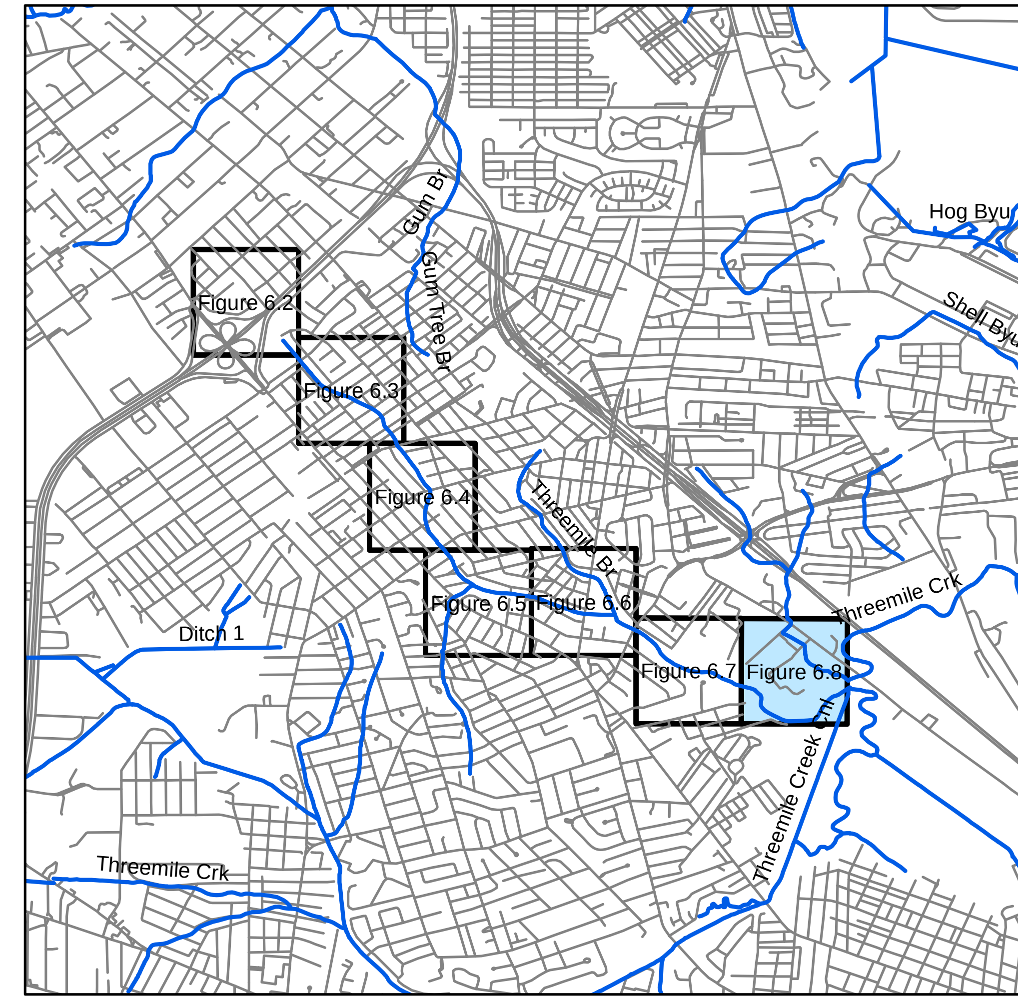
PRICHARD DRAINAGE STUDY
MCP-101-15
TOULMIN SPRINGS BRANCH

Legend

- Stream Centerline
- Roads
- Toulmin Springs Branch
- Culvert/Bridge
- Restriction/Other
- Discharge
- Damage

0 120 240 480 720 960 Feet

Figure 6.7



PRICHARD DRAINAGE STUDY
MCP-101-15
TOULMIN SPRINGS BRANCH

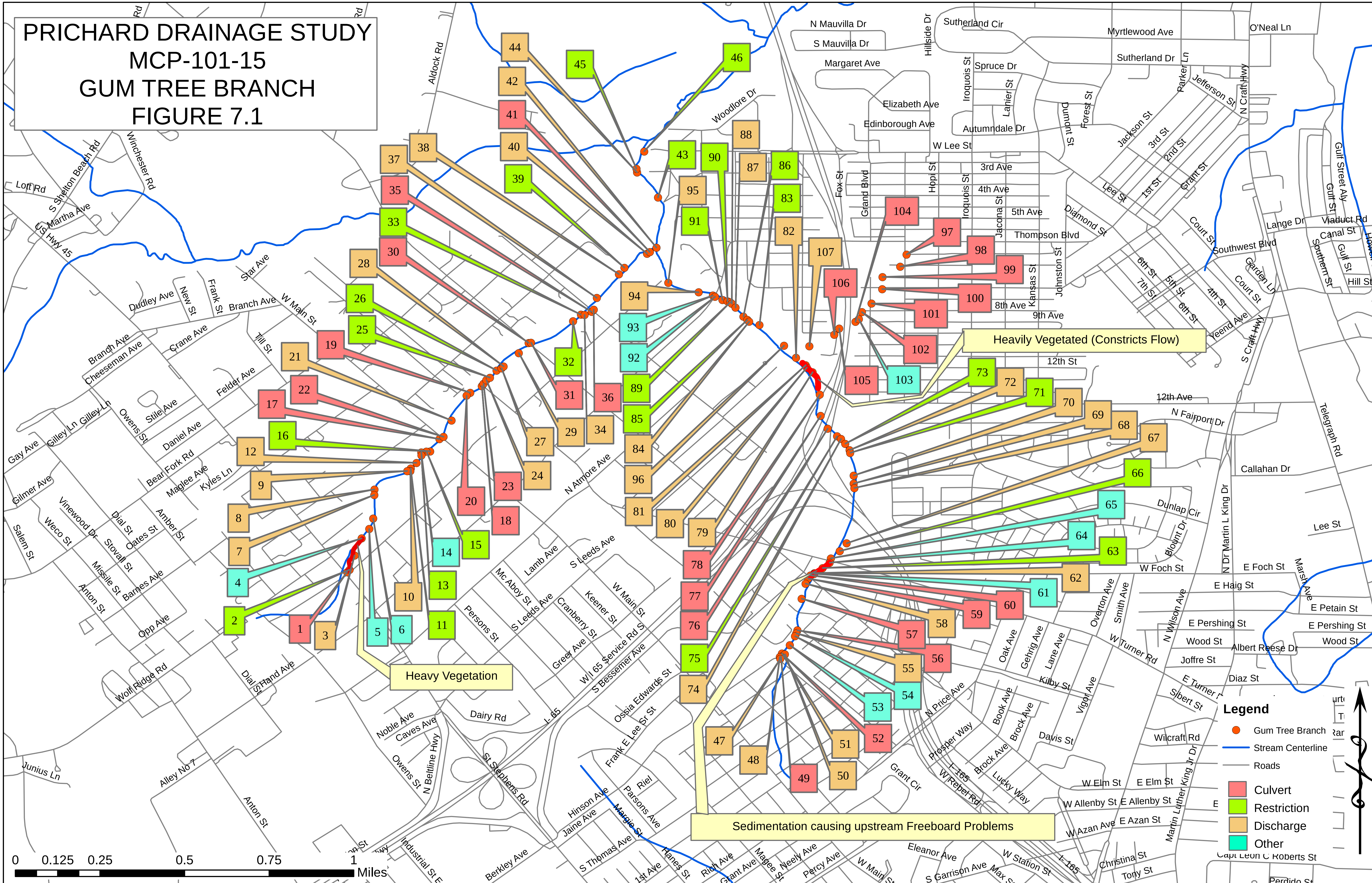
Legend

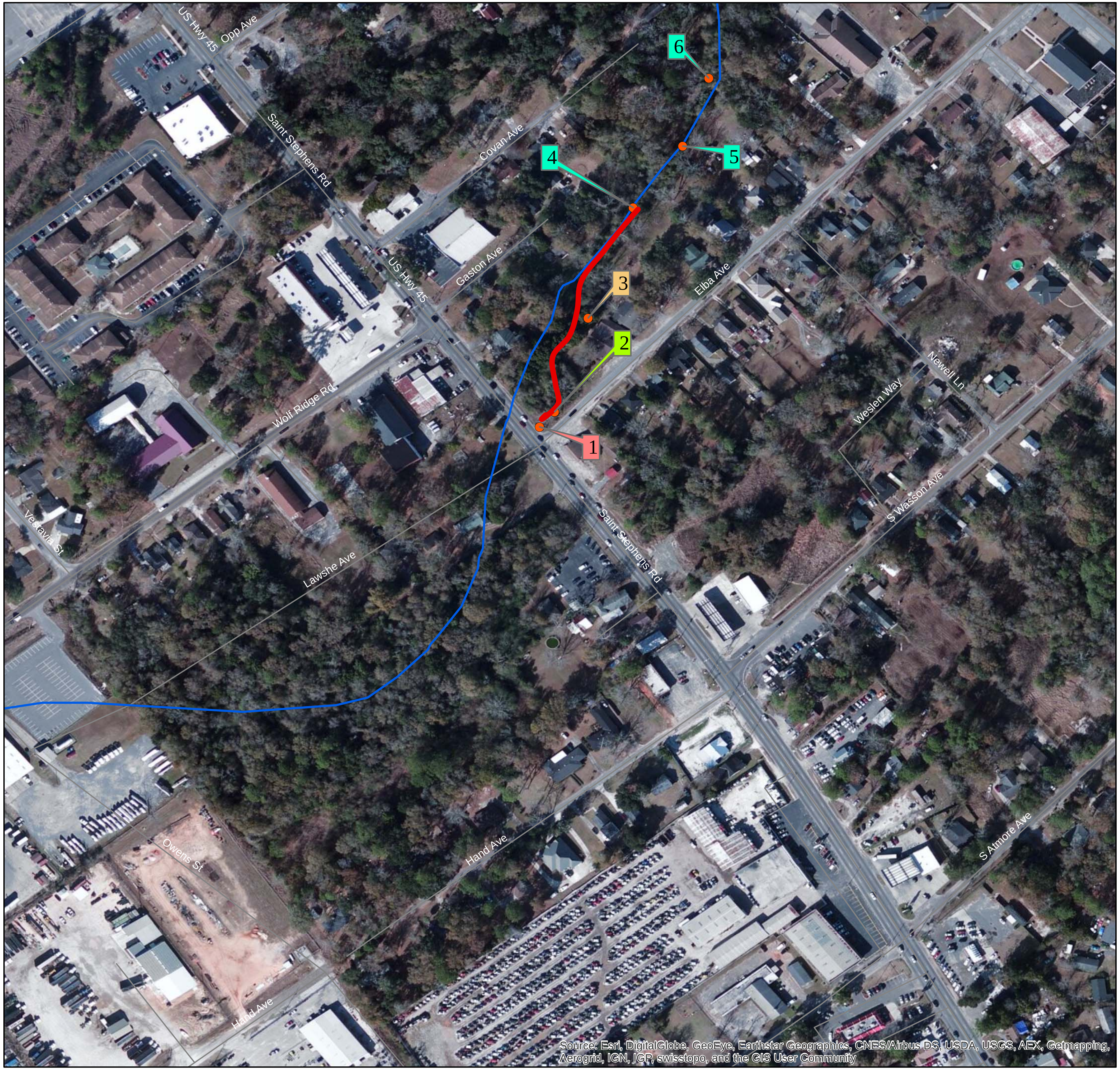
- Stream Centerline
- Roads
- Toulmin Springs Branch
- Culvert/Bridge
- Restriction/Other
- Discharge
- Damage

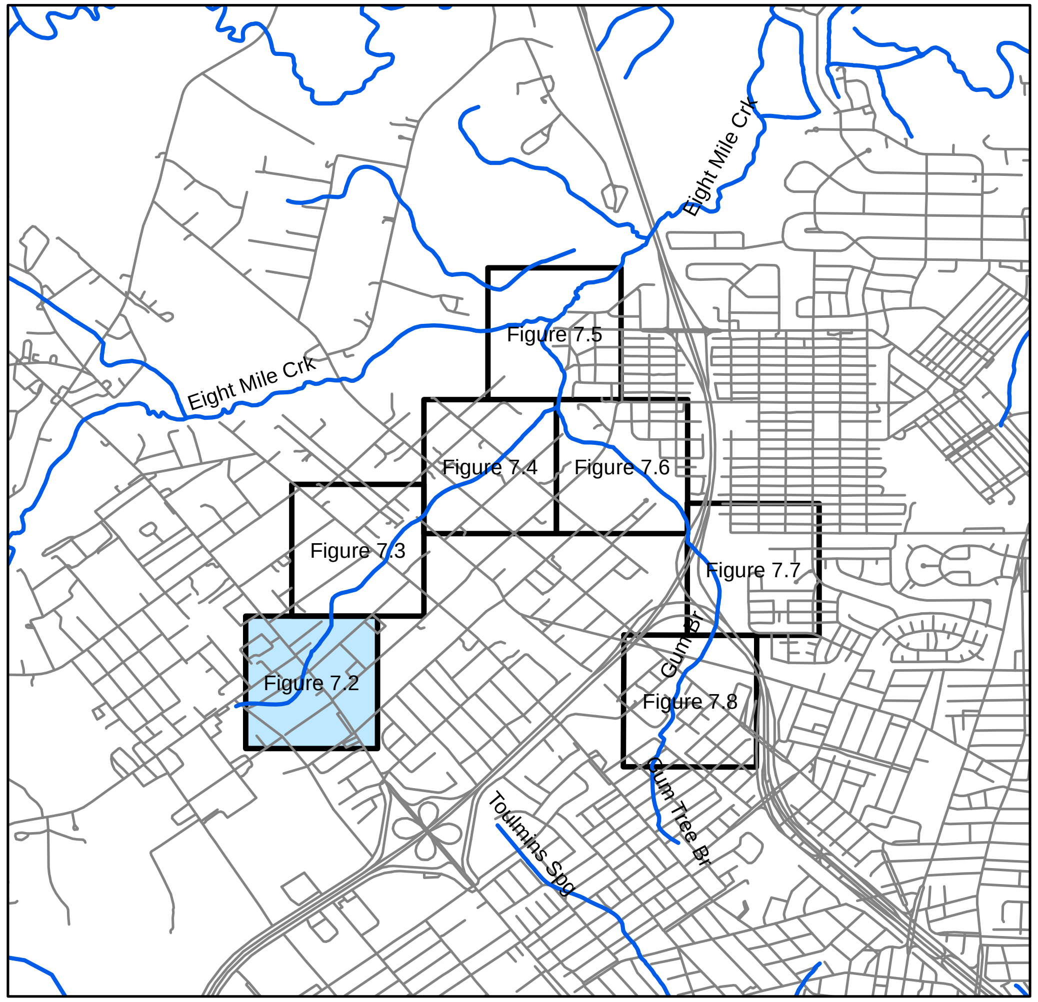
0 120 240 480 720 960 Feet

Figure 6.8

7. – Gum Tree Branch Maps


PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH
FIGURE 7.1
Heavily Vegetated (Constricts Flow)
Heavy Vegetation
Sedimentation causing upstream Freeboard Problems
Legend
Gum Tree Branch
Stream Centerline
Roads
Culvert
Restriction
Discharge
Other
0
0.125
0.25
0.5
0.75
1
Miles





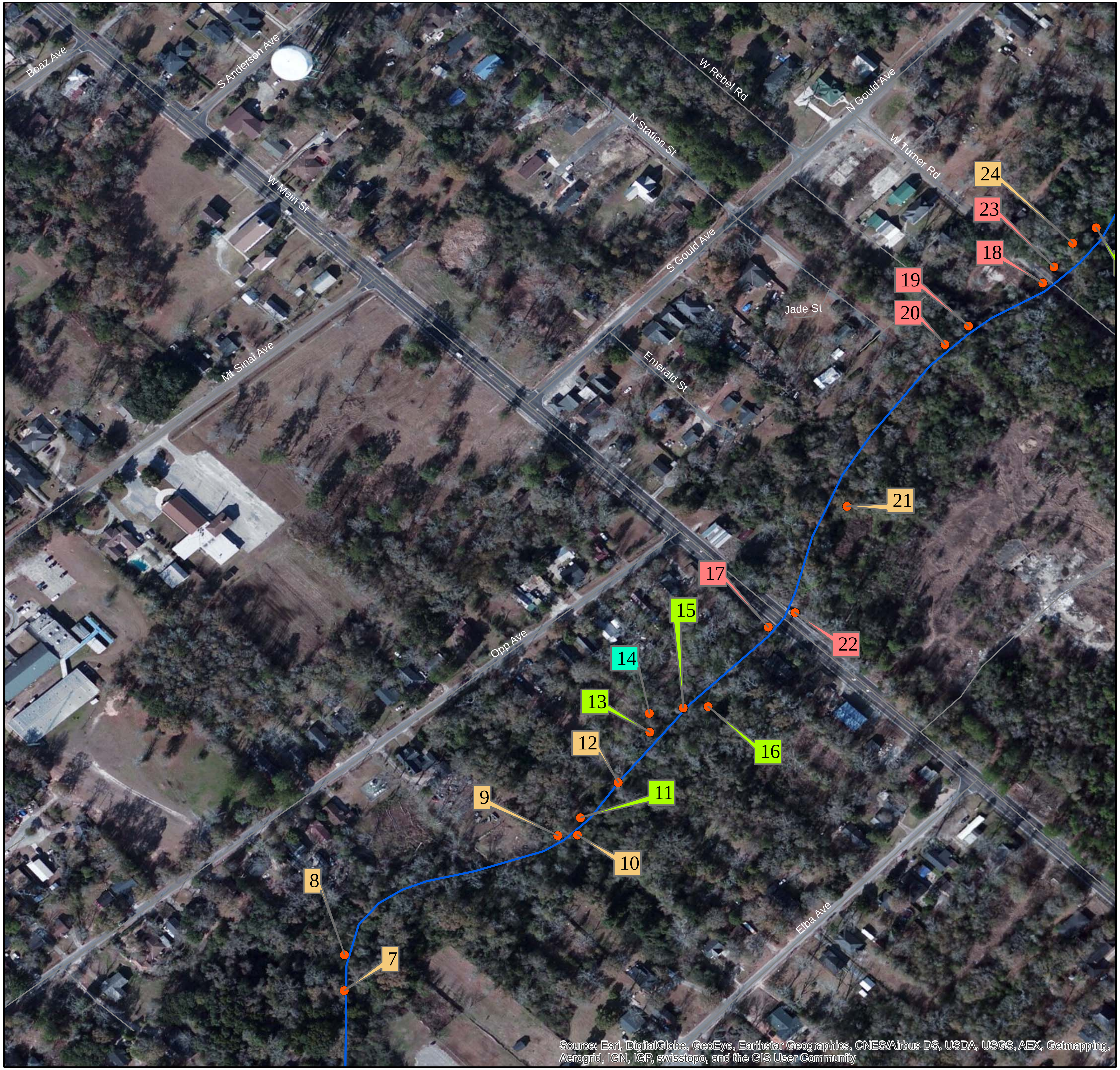
PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

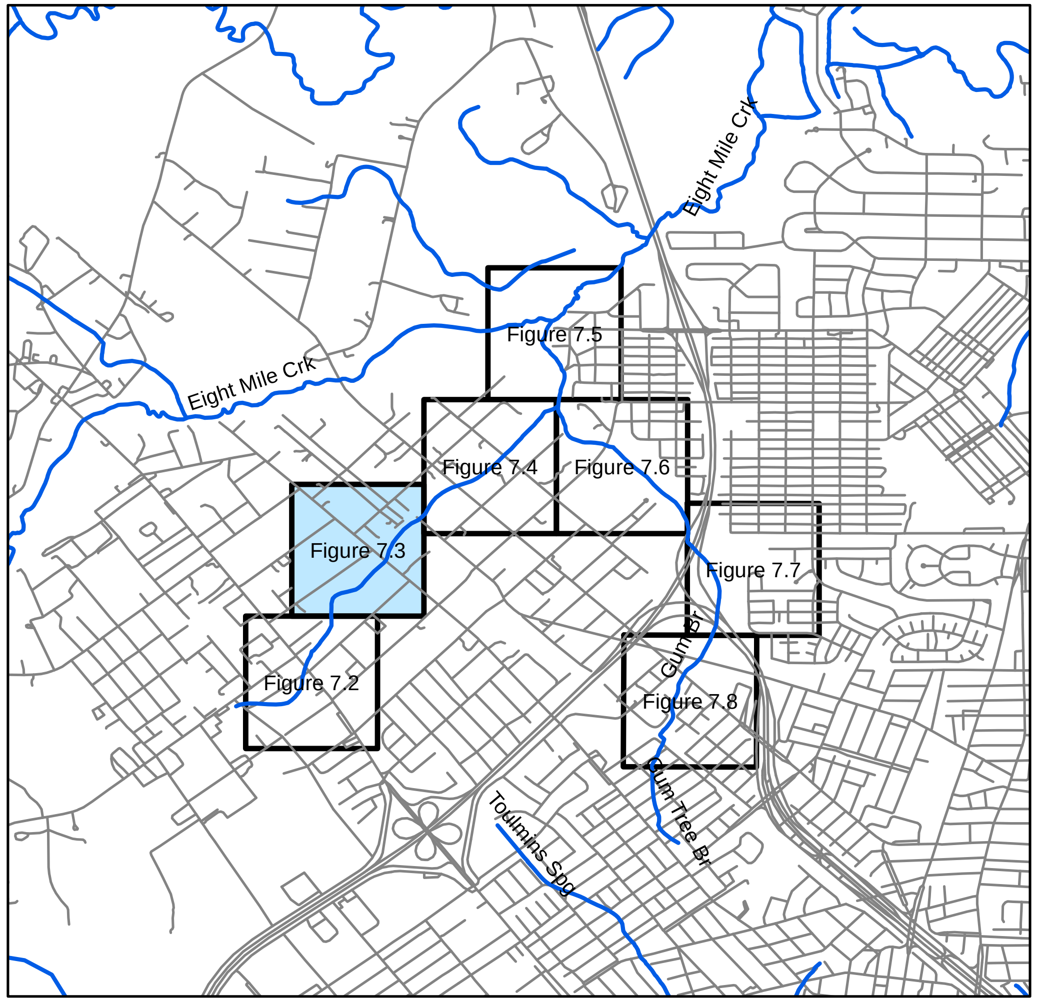
Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.2





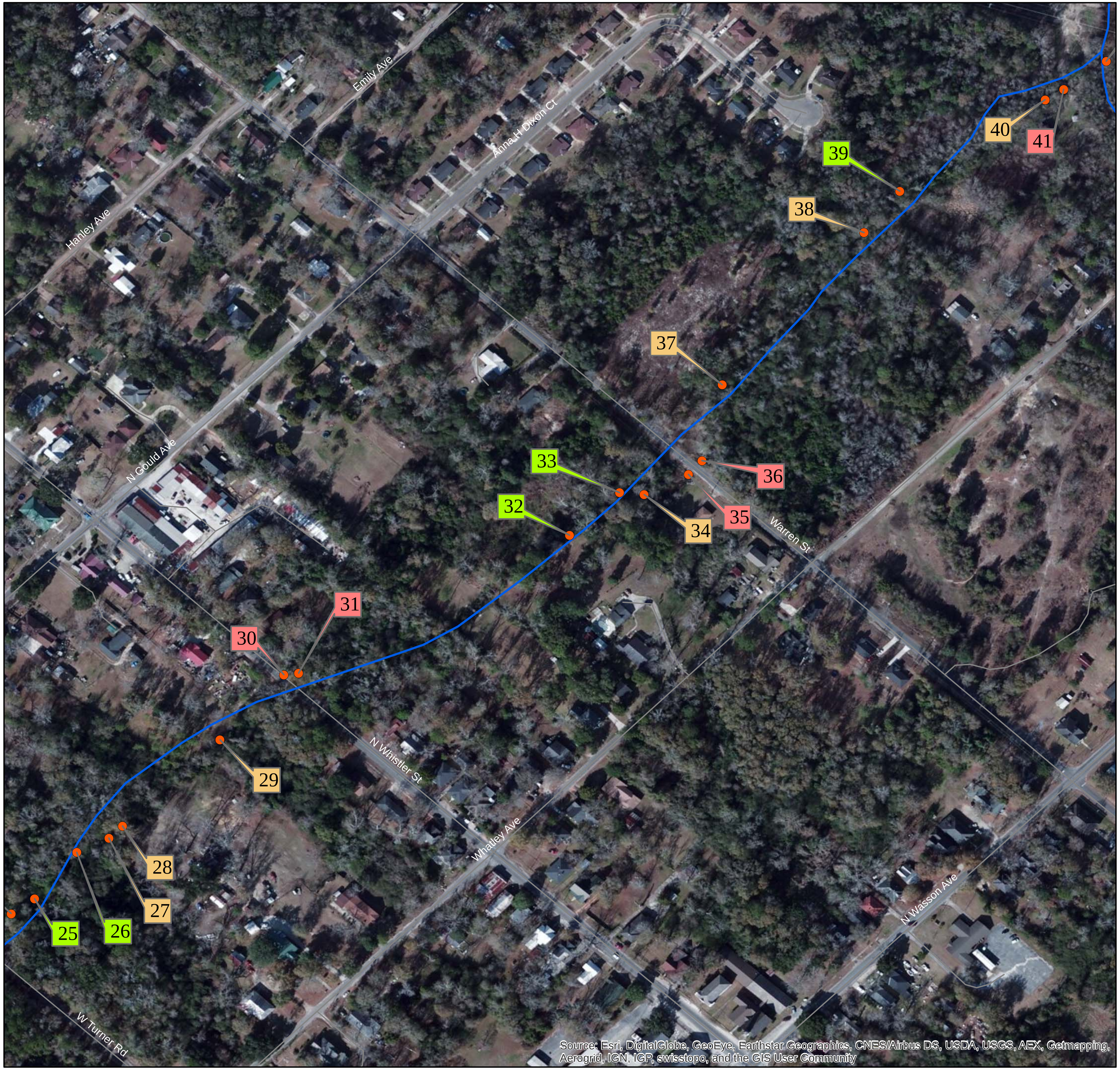
PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

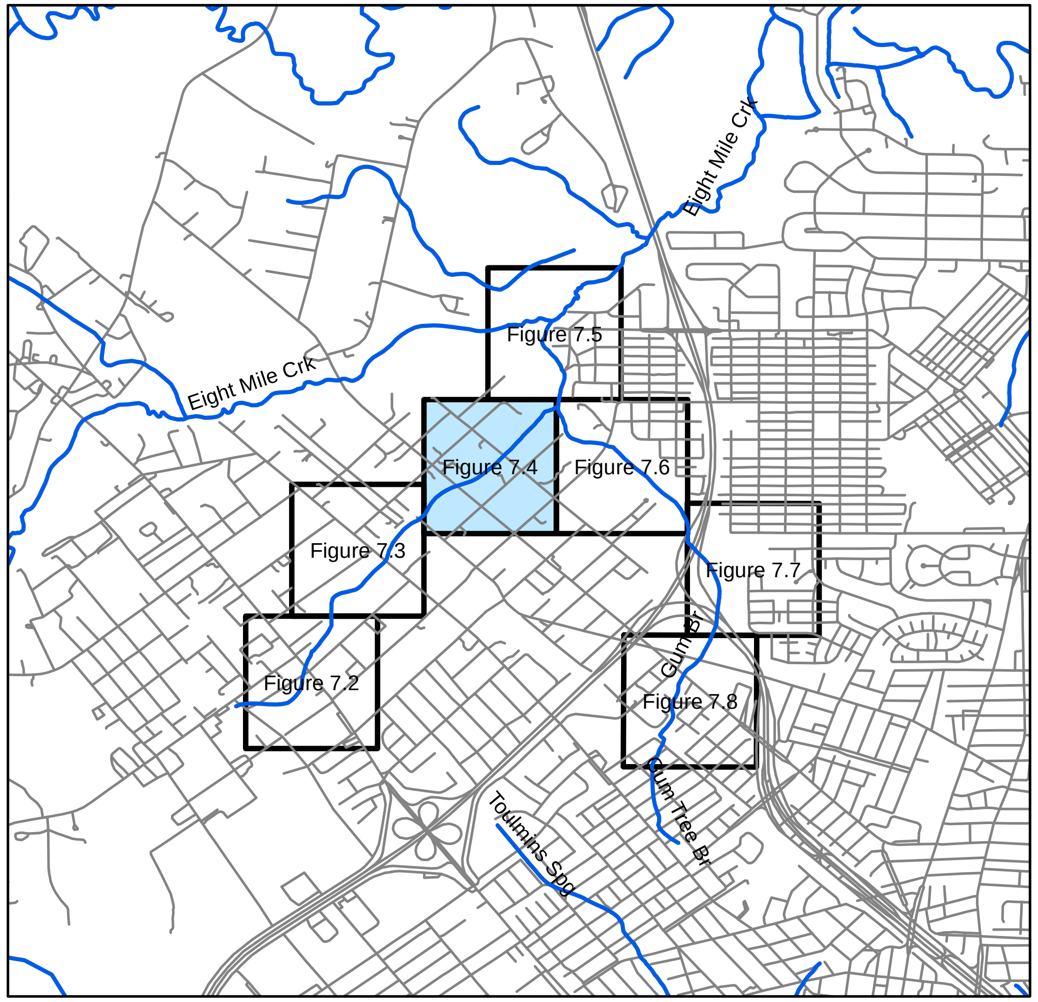
Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.3





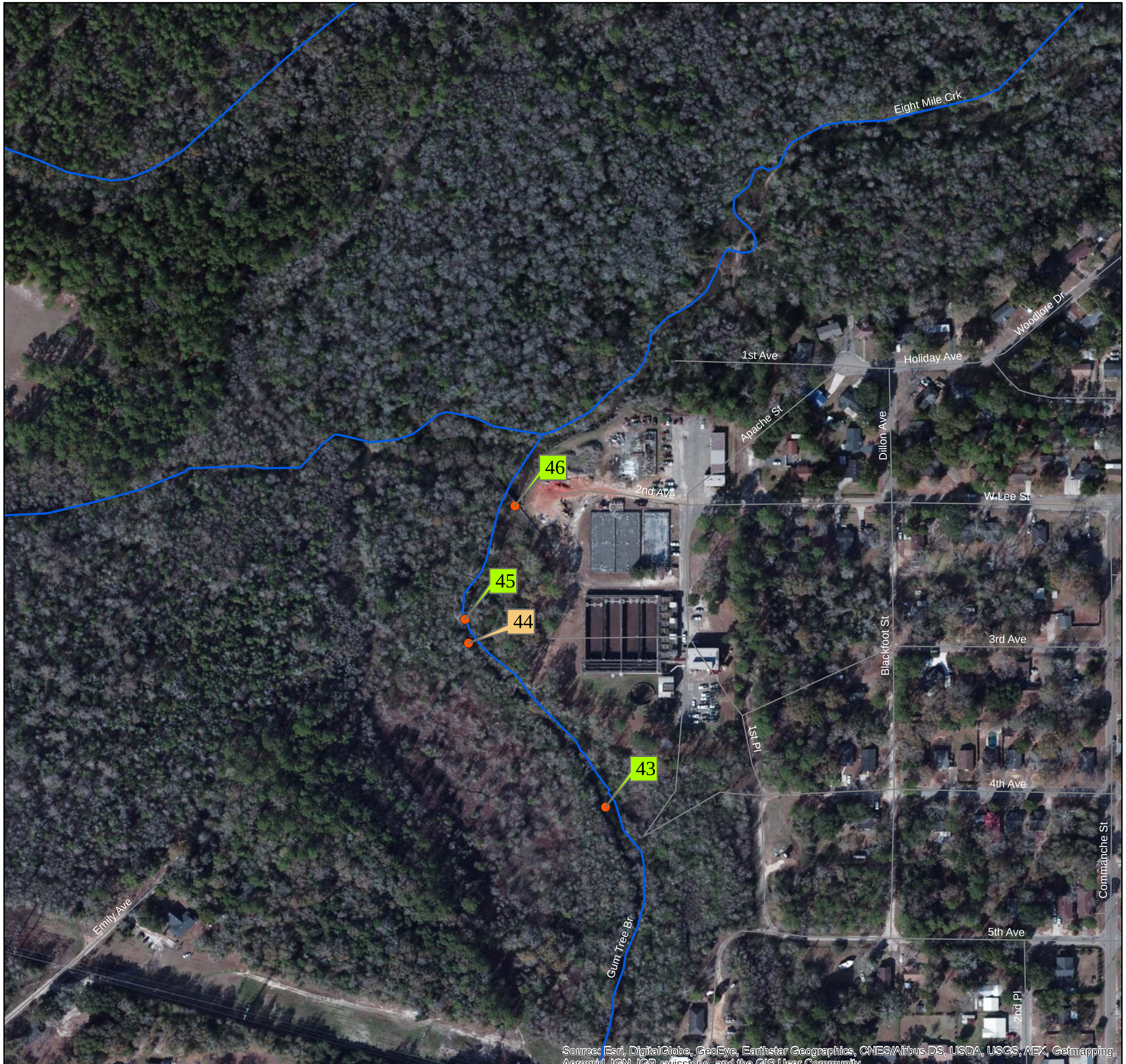
PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

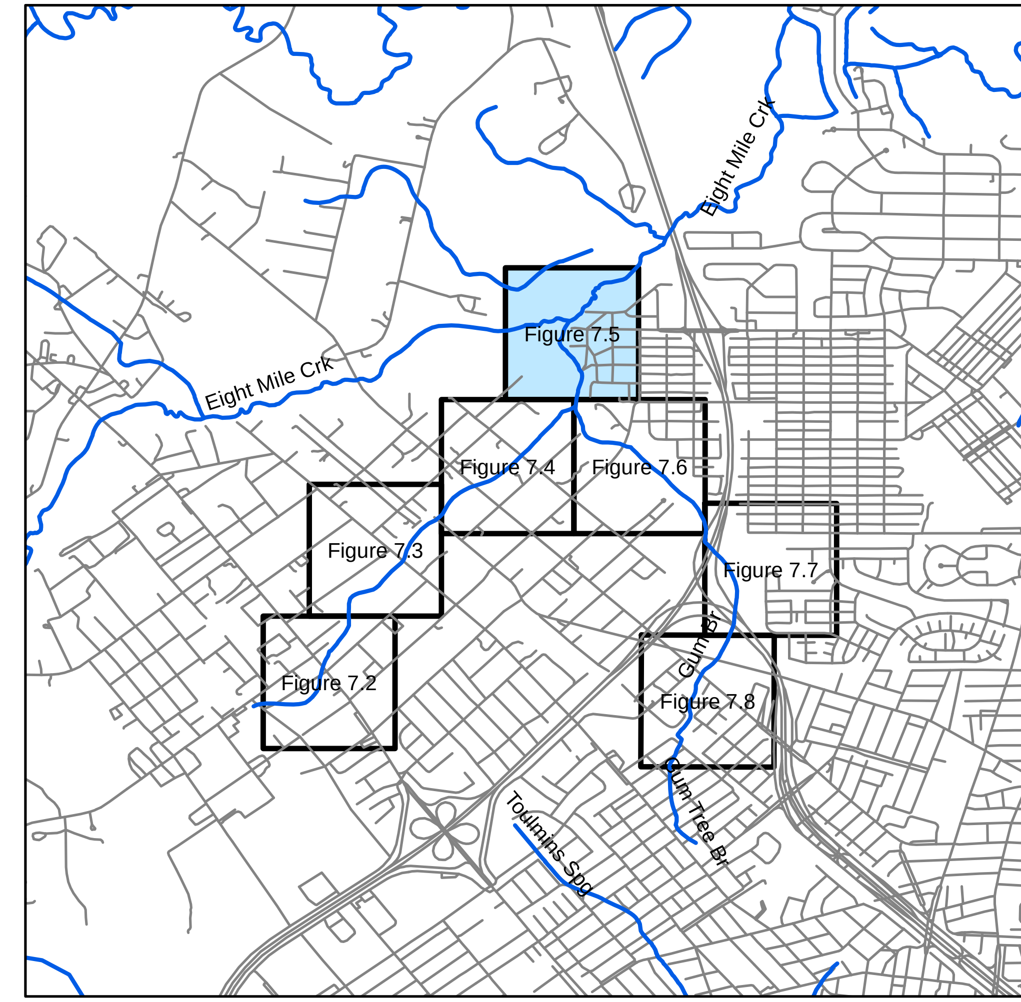
Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.4





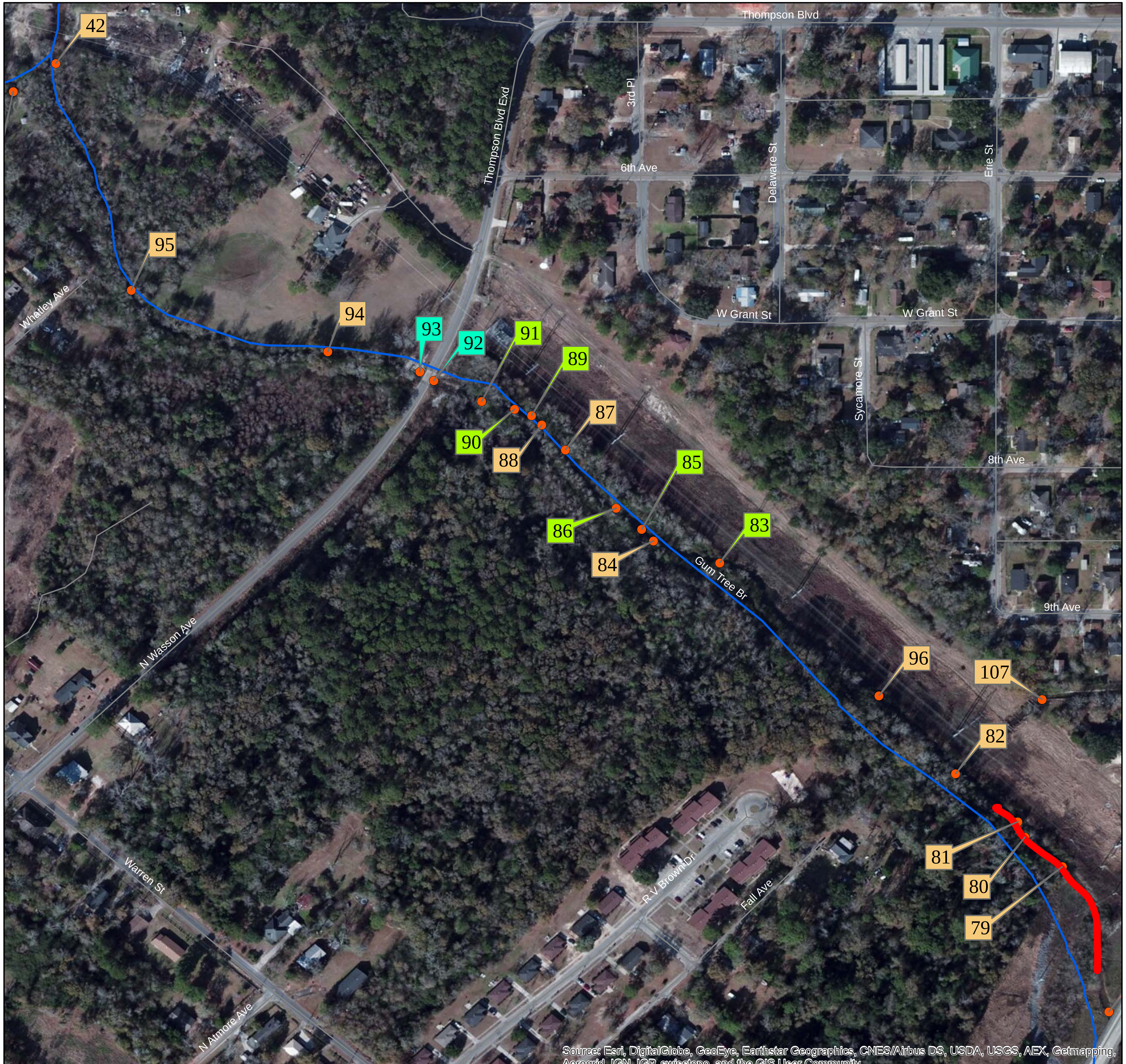
PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

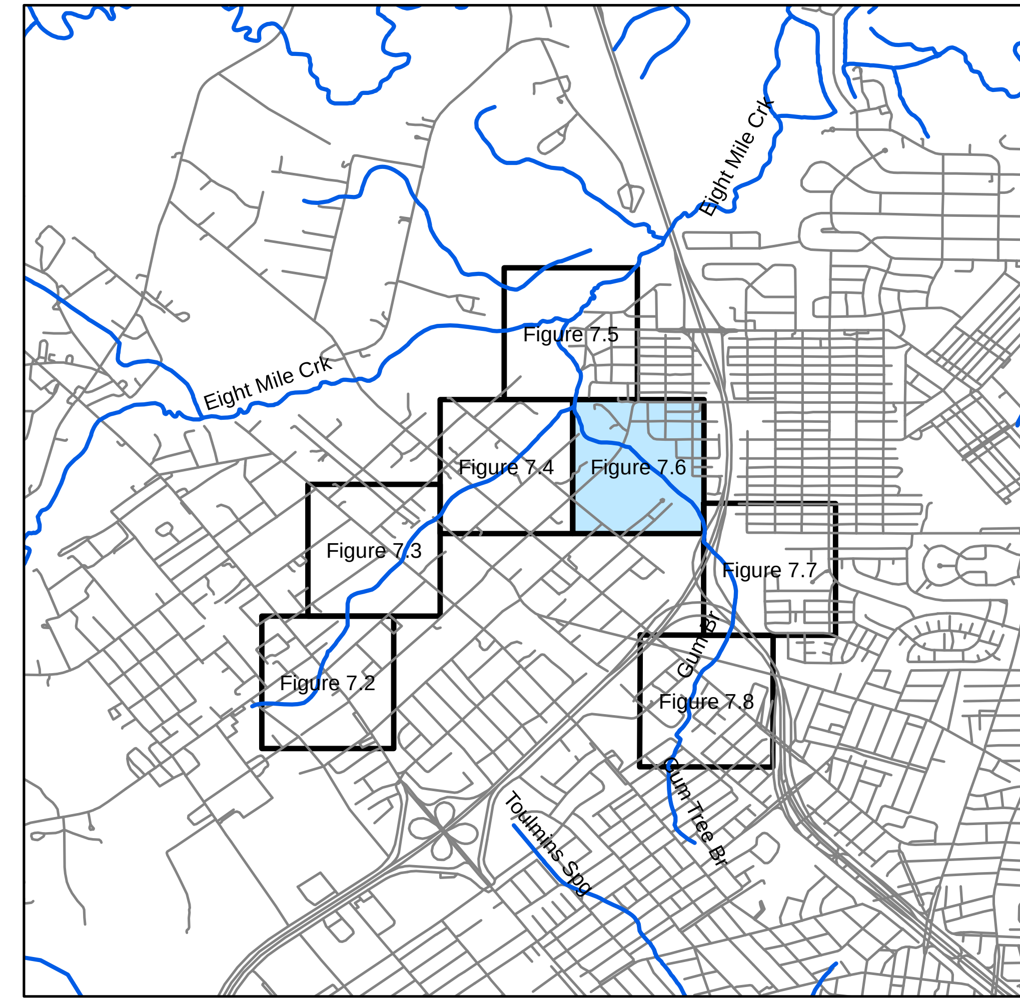
Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.5





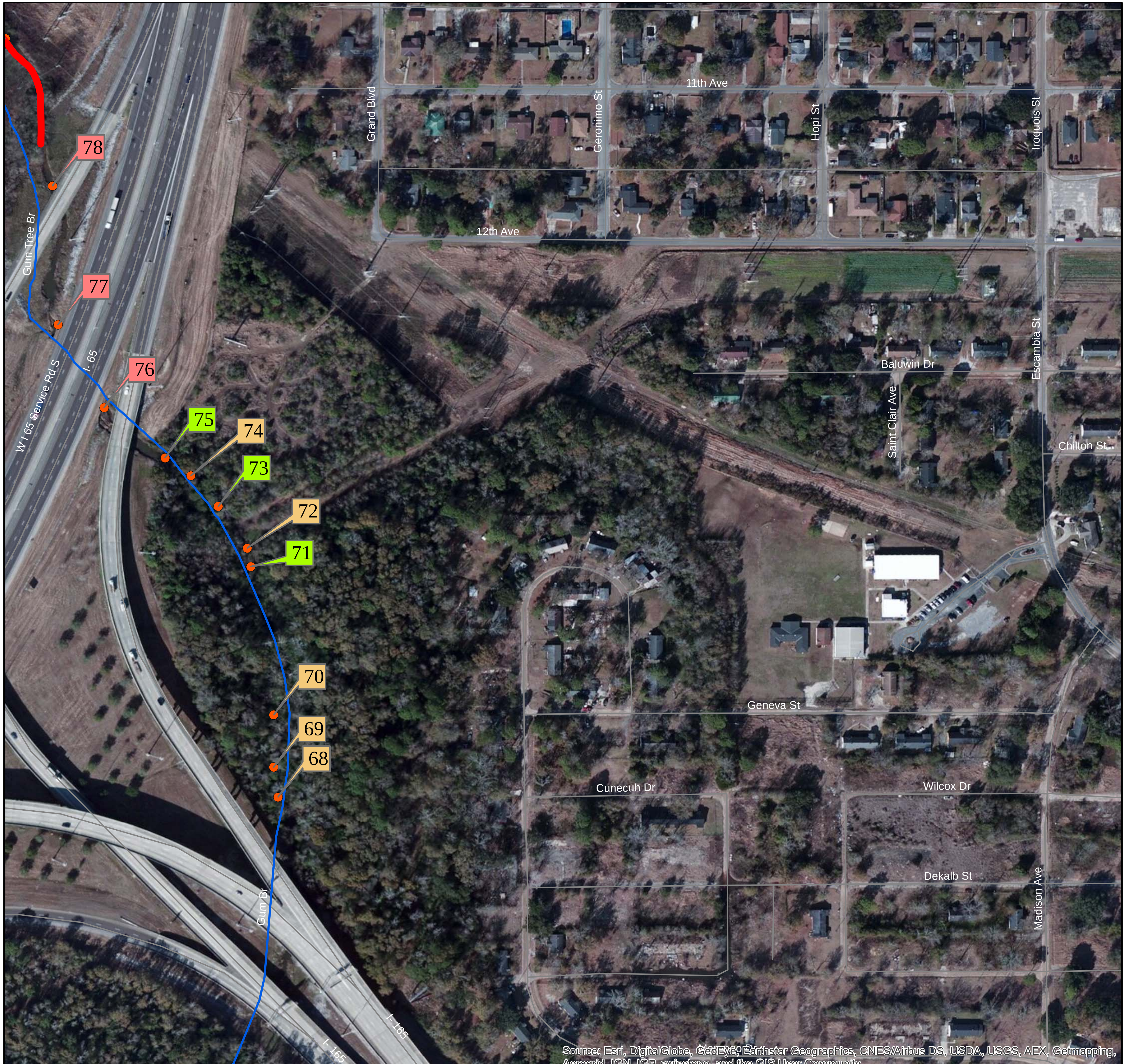
PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

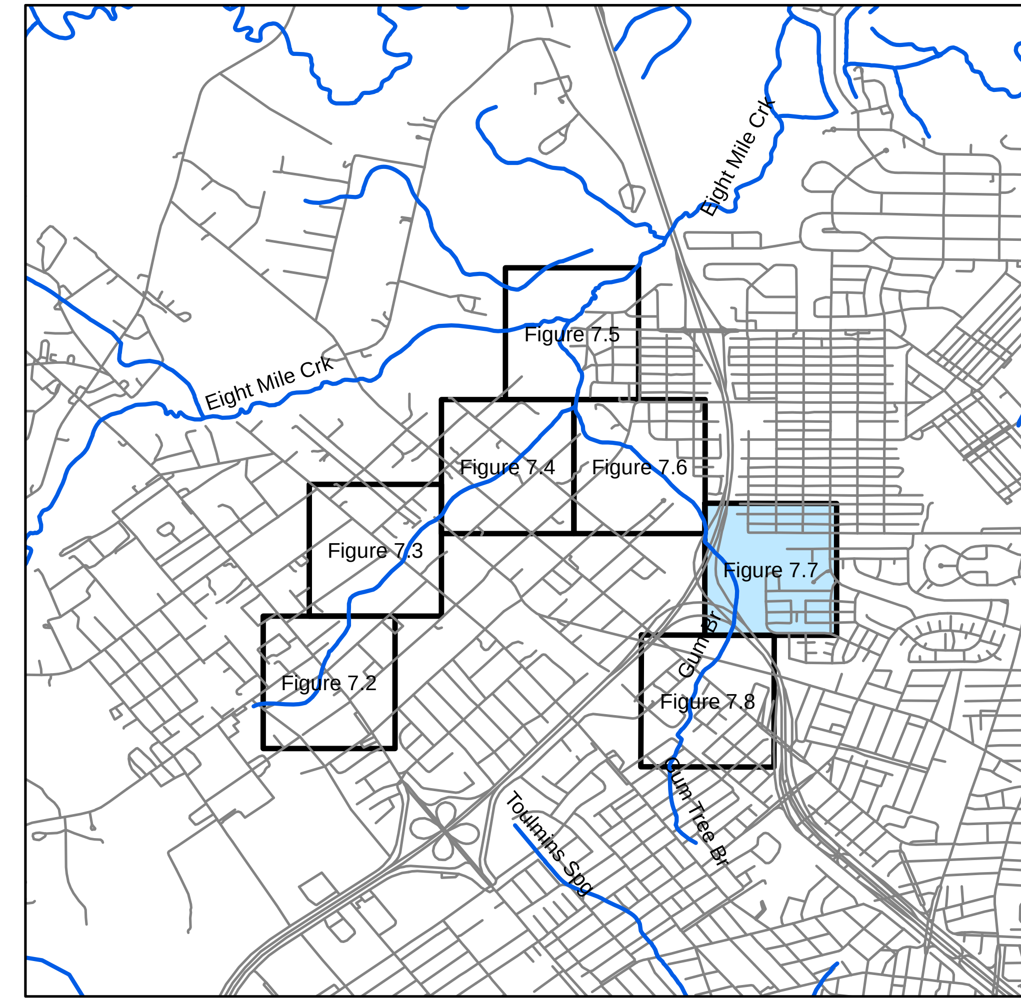
Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.6





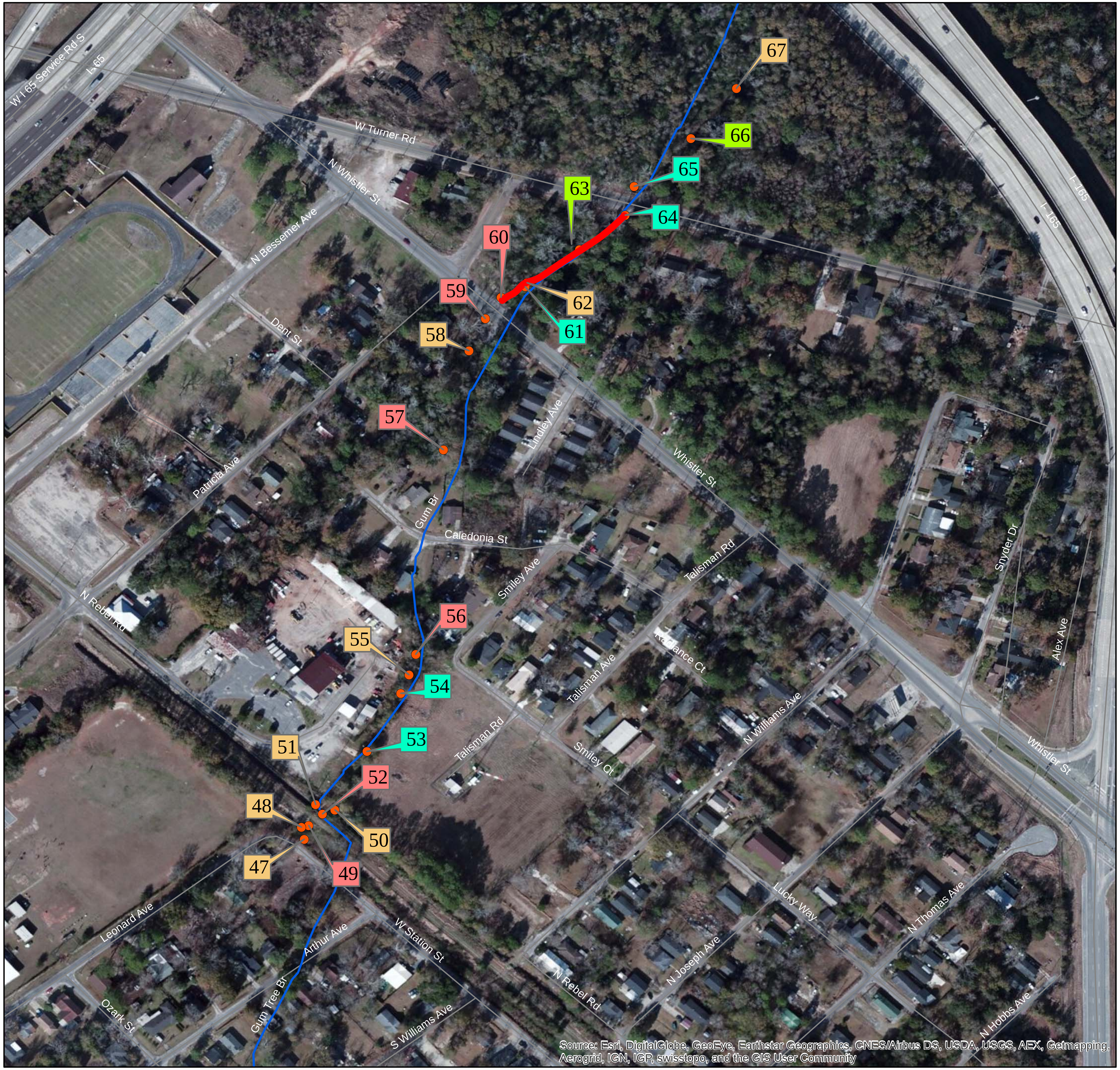
PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

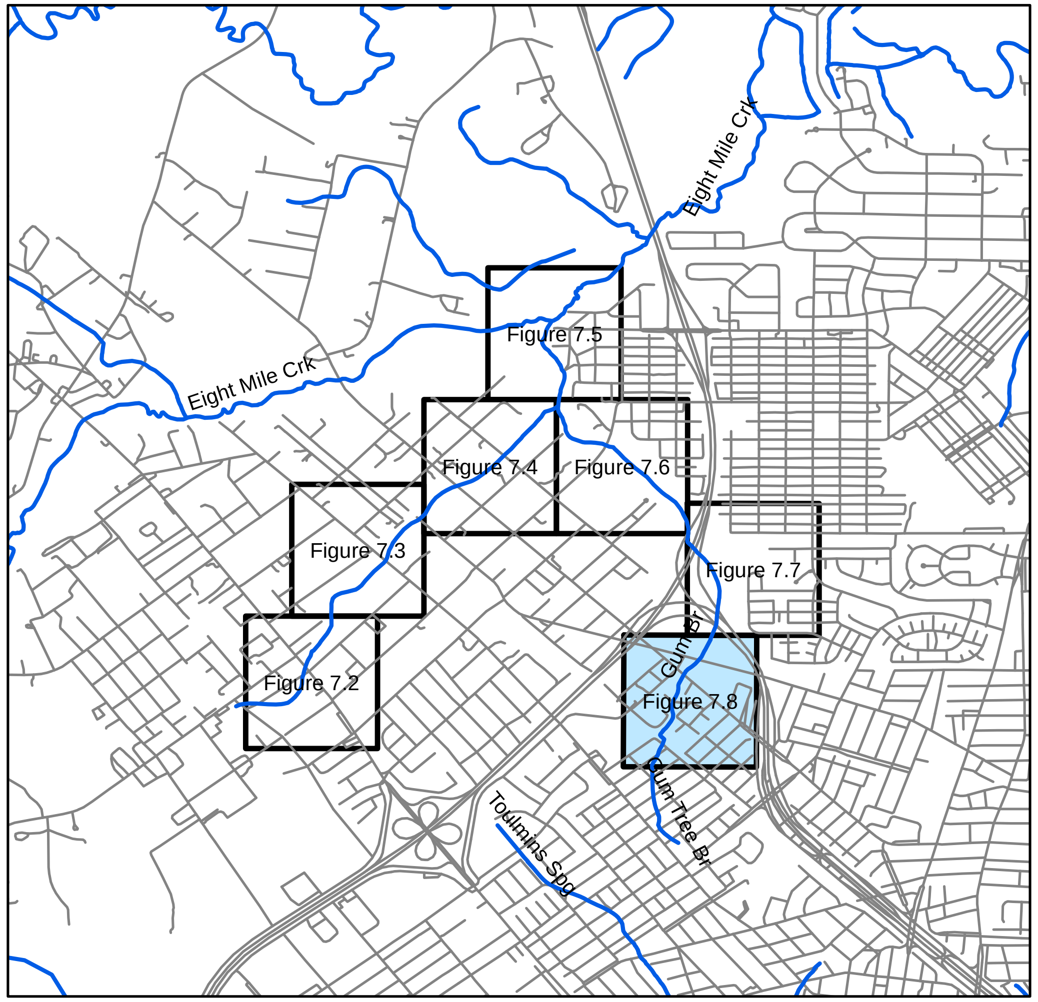
Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.7





PRICHARD DRAINAGE STUDY
MCP-101-15
GUM TREE BRANCH

Legend

- Gum Tree Branch
- Stream Centerline
- Roads
- Culvert
- Restriction
- Discharge
- Other

0 120 240 480 720 960 Feet

Figure 7.8

Appendix A – Toulmin Springs Branch Summary of Findings

Summary of Findings

Toulmin Springs Branch

Characteristic: Restrictions

Table - A.1				**Photo ID Toulmin Springs - Restrictions**	
Figure No.	**Charcteristics**	**Priority**	**Remarks**	**IMAGE_1**	**IMAGE_2**
14	Restriction (Debris)	2		1	
52	Channel Characteristics	3	Toulmin Springs Branch returns to a Earthen Channel	2	8
53	Restriction (Debris)	1	Photo ID Toulmin Springs Restrictions Photos 9-13	3	
54	Restriction (Debris)	1		4	
58	Restriction (Debris)	1		5	
62	Restriction (Debris)	1		6	
65	Restriction (Debris)	1		7	
	Restriction (Debris)	1	From Hinson Ave to Rosedale Ave, heavy vegetation in Concrete Ditch		

Summary of Findings

Toulmin Springs Branch

Characteristic: Culverts/Bridges

Table - A.2					Photo ID Toulmin Springs - Culvert/Bridge		
Figure No.	**Charcteristics**	**Priority**	**Remarks**	**Discharge at Location**	**IMAGE_1**	**IMAGE_2**	**IMAGE_3**
2	Culvert	2	48" HDPE		1	31	
3	Culvert				2		
8	Culvert	1	Double Barrel 5'x4' Box Culvert (3' Freeboard) (Debris Upstream End)		3	32	
9	Culvert				4	33	
10	Culvert	2	Double Barrel 5'x4' Box Culvert (3' Freeboard)		5	34	
12	Culvert				6	35	45-56
17	Culvert	2	Double Barrel 6'x6' Box Culvert (4.5' Freeboard)		7	57-64	
22	Bridge	3	Hydraulic Opening: 22'x5.5' Skew: None		8	36	
24	Bridge	3	Hydraulic Opening: 20'x5.4' Skew: None	4-18" RCP	9	72	
25	Bridge	2	Hydraulic Opening: 20'x5.6' Skew: 30°	4-18" RCP	10	73	
26	Bridge	3	Hydraulic Opening: 16'x5.0' Skew: None	3-18" RCP	11	74	
28	Bridge	2	Hydraulic Opening: 21'x5.0' Skew: 30°	2-24" RCP	12	65	75
29	Culvert	3	Double Barrel 5'x10' Box Culvert	Trapezoidal Ditch (3' Bottom)	14	67-68	
30	Culvert	3	Triple 72" Steel Pipe Culvert	1-42"x26" RCAP, 1-36" RCP	15		
31	Bridge	2	Hydraulic Opening: 28'x5.0' Skew: None (Debris caught in Utilities)		16		
33	Bridge	2	Hydraulic Opening: 28'x6.3' Skew: 30° @ Exit	1-15"RCP,1-12"RCP,1-24"CMP,1-18"RCP	37	76	
35	Bridge	1	Hydraulic Opening: 28'x4.5' Skew: 70°		17	69-70	77
36	Culvert	1	Double Barrel 7'x12' Box Culvert (Debris and Sedimentation)	1-48" RCP	19	38	
38	Bridge	1	Hydraulic Opening: 21'x4.5' Skew: None (Debris under Bridge)	1-18" RCP	13	78	
39	Bridge	3	Hydraulic Opening: 28'x4.9' Skew: None	1-27" RCP, 1-12" RCP	18		
43	Culvert	1	Triple Barrel 6'x9' Box Culvert (Debris and Sedimentation at Downstream End)	1-18" RCP	39		
44	Bridge	3	Hydraulic Opening: 38'x5.0' Skew: None		20		
48	Bridge	2	Hydraulic Opening: 41'x8.0' Skew: 30° (Debris under Bridge)	2-18" RCP	21	79-80	71
51	Culvert	3	Triple Barrel 8'x12' Box Culvert		22	40	
56	Tributary Culvert	3	Double Barrel 5'x10' Box Culvert		23	41	44
59	Bridge	3	Hydraulic Opening: 30'x6.0' Skew: None		24	42	81-82
68	Tributary Culvert	3	Single Barrel 7'x12' Box Culvert		28		
69	Tributary Culvert	3	Tributary Box Culvert	1-18" RCP, 2-24"RCP			
70	Tributary Culvert	3	Tributary Box Culvert		27		
71	Tributary Culvert	3	Double Barrel 5'x6' Box Culvert		26		
72	Tributary Culvert	3	Double Barrel 5'x6' Box Culvert		25		
75	Tributary Culvert	3	Double Barrel 3'x6' Box Culvert		29	43	
76	Tributary Culvert	3	Double Barrel 3'x5' Box Culvert		30		

Summary of Findings

Toulmin Springs Branch

Characteristic: Discharge Points

Table - A.3

				Discharge Channel Dimensions (Feet)			Photo ID Toulmin Springs - Discharge			
Figure No.	Charcteristics	Priority	Remarks	Bottom Width	Top Width	Height	IMAGE_1	IMAGE_2	IMAGE_3	IMAGE_4
1	Discharge	3	1-12" RCP, 1-48" RCP	4	10	4	1	28	40	41
4	Discharge	3	1-42" HDPE				2	29	42-44	
5	Discharge	3	1-36" HDPE				3			
6	Discharge	1	1-24" HDPE (Debris at Outfall)				4	30		
7	Discharge	3		6	8	3	5			
11	Discharge	1	1-24" RCP (Sedimentation)	6	2.5	8	6	31		
13	Discharge	1	1-30" HDPE (Sedimentation)				7			
15	Discharge	3	1-24" RCP				32			
16	Discharge	3		2	6	3	8			
18	Discharge	3		10	16	8	9	33		
19	Discharge	3	1-18" HDPE				10	34		
20	Discharge	3	1-30" RCP				11			
21	Discharge	3	1-30" HDPE				12			
23	Discharge	3	1-30" RCP				13			
27	Discharge	3	1-24" RCP				14			
37	Discharge	3	Debris in Picture is in process of being removed	10	20	5.5	35			
40	Discharge	3	1-15" RCP				15			
41	Discharge	3	1-15" RCP				16			
42	Discharge	3	1-15" RCP				16			
45	Discharge	3	1-24" RCP				17	36		
46	Discharge	3		4.5	11	4	18			
47	Discharge	3		5.5	4	12	19			
49	Discharge	3	1-24" RCP				20			
50	Discharge	3	1-15" RCP				37			
55	Discharge	1	Heavy Sedimentation	15	25	6	21	38		
60	Discharge	3	1-18" RCP				22			
61	Discharge	3	1-40"x66" RCAP				23			
63	Discharge	3		10	16	4	24	39		
64	Discharge	3		10	16	4	25			
66	Discharge	3		7	10	3	26			
67	Discharge	3	Discharge of Toulmin Springs Branch to Three Mile Creek				27			

Summary of Findings

Toulmin Springs Branch

Characteristic: Damage

Table - A.4				Photo ID Toulmin Springs -Damage	
Figure No.	**Charcteristics**	**Priority**	**Remarks**	**IMAGE_1**	**IMAGE_2**
32	Damage	1	South Wing and Concrete Bottom - Minor Damage - 50 LF	1	
34	Damage	1	North Wing Collapsed - 28 LF	2	6
57	Tributary Damage	1	Wing Failure - 25 LF	3	7
73	Tributary Damage	1	Wing Failure - Multile Locations	4	
74	Tributary Damage	1	Bottom and Wing Failue - 25 LF	5	

Appendix B – Gum Tree Branch Summary of Findings

Summary of Findings

Gum Tree Branch

Characteristic: Restrictions

Table - B.1

Figure No.	Characteristics	Priority	Remarks	Photo ID Gum Tree -Restrictions IMAGE_1	IMAGE_2	IMAGE_3
2	Restriction (Debris)	2		4	27	
5	Begin Channel Restriction	2	Channel is constrained by Embankment on Southeast side (From 12' wide to 7' wide)			
6	End Channel Restriction	2	Channel is constrained by Embankment on Southeast side	5	28	
11	Restriction (Debris)	2		3		
13	Restriction (Abandoned Culvert)	1	Abandoned Culvert catches Debris, limiting flow (8'x8'x3')	2	26	
15	Restriction (Debris)	2				
16	Restriction (Debris)	2		1	25	
25	Restriction (Debris)	2		6	32-36	
26	Restriction (Debris)	2		7		
32	Restriction (Debris)	2		8		
33	Restriction (Debris)	2		9	37-41	
39	Restriction (Debris)	2		10		
42	Intersection Point	2		11		
43	Restriction (Debris)	2		42	43	
45	Restriction (Debris)	2		12	44	
46	Restriction (Debris at Bridge)	1	Supports for Utility Crossing Bridge creates debris catch field	13		
63	Restriction (Debris)	1		24	45-46	
66	Restriction (Debris)	2		23		
71	Restriction (Debris)	2		22		
73	Restriction (Debris)	2		21	31	
75	Restriction (Debris)	2		20		
83	Restriction (Debris)	2		19		
85	Restriction (Sedimentation and Debris)	2		18		
86	Restriction (Debris)	2		17		
89	Restriction (Sedimentation)	1		16	30	47-49
90	Restriction (Sedimentation and Debris)	1		15	29	
91	Restriction (Debris)	2		14		

Summary of Findings

Gum Tree Branch

Characteristic: Discharge Points

Table - B.2					Discharge Channel Dimensions (Feet)			Photo ID Gum Tree - Discharge		
Figure No.	Characteristics	Priority	Remarks	Discharge at Location	Bottom Width	Top Width	Height	IMAGE_1	IMAGE_2	IMAGE_3
3	Discharge Point	3	12" HDPE					4		
7	Discharge Point	3	Earthen Trapezoidal		5	7	3	5	41	49
8	Discharge Point	3	Earthen Trapezoidal		5	6	4	3	40	
9	Discharge Point	3	Earthen Trapezoidal		3	6	3	39		
10	Discharge Point	3	Earthen Trapezoidal		3	4	2	2	38	
12	Discharge Point	3	Earthen Trapezoidal		2	3	2	1		
21	Discharge Point	3	Earthen Trapezoidal		3	8	4	6		
24	Discharge Point	3	Earthen Trapezoidal		6	11	5	7		
27	Discharge Point	3	Earthen Trapezoidal		9	12	5	8		
28	Discharge Point	2	Earthen Trapezoidal		9	11	4	9	52	53
29	Discharge Point	2	Earthen Trapezoidal		5	11	4	10	54-58	
34	Discharge Point	3	Earthen Trapezoidal		3	6	2	11		
37	Discharge Point	3	Earthen Trapezoidal		1.5	4	5.5	13		
38	Discharge Point	3	Earthen Trapezoidal		1	3	3	12		
40	Discharge Point	3	Earthen Trapezoidal		4	5	4	14		
44	Discharge Point	2	Earthen Trapezoidal (Sedimentation Issue)		4	8	6	15	42	
47	Discharge Point	3	Earthen Trapezoidal		4	12	5	37	48	51
48	Discharge Point	3	Earthen Trapezoidal		6	14	8	36		
50	Discharge Point	3	Earthen Trapezoidal		8	17	8	35		
51	Discharge Point	3	Earthen Trapezoidal		5	10	3	34		
55	Discharge Point	3	12" RCP					33		
58	Discharge Point	3	Concrete Trapezoidal		5	6	0.5	32		
62	Discharge Point	3	Earthen Trapezoidal		6	12	3	31		
67	Discharge Point	3	Earthen Trapezoidal		10	12	3	30		
68	Discharge Point	3	Earthen Trapezoidal		4	12	9	29		
69	Discharge Point	3	Earthen Trapezoidal		2	6	7	28		
70	Discharge Point	3	Earthen Trapezoidal		2	7	6	27		
72	Discharge Point	3	Earthen Trapezoidal		5	8	3	26		
74	Discharge Point	3	Earthen Trapezoidal		1	5	5	25		
79	Discharge Point	3	Earthen Trapezoidal		6	12	4	24		
80	Discharge Point	3	Earthen Trapezoidal		2	5	4	23		
81	Discharge Point	2	Earthen Trapezoidal (Sedimentation Issue)		4	7	5	22	47	50
82	Discharge Point	3	Earthen Trapezoidal		16	24	6	46		
84	Discharge Point	3	Earthen Trapezoidal		2	7	3	20		
87	Discharge Point	3	Earthen Trapezoidal		4	5	3	19		
88	Discharge Point	2	Earthen Trapezoidal (Debris in Discharge Channel)		5	7	3	18	44	
94	Discharge Point	3	6" HDPE					16		
95	Discharge Point	3	Earthen Trapezoidal	24" Steel Pipe	1.5	3	3	17	43	
96	Discharge Point	2	Concrete Trapezoidal (Blown Out)		4	4	8	21	45	

Summary of Findings

Gum Tree Branch

Characteristic: Culverts

Table - B.3

Figure No.	Characteristics	Priority	Remarks	Discharge at Location	Photo ID Gum Tree - Culvert IMAGE_1	IMAGE_2	IMAGE_3	IMAGE_4
1	Culvert	3	Double Barrel 6'x5' Box Culvert	30" RCP	1	25	41	
17	Culvert	1	54" RCP (Broken, No Flow), 42" RCP (No Flow), 8'x10' Box Culvert (3' Sedimentation)		24	40	46	
18	Culvert				2	26		
19	Culvert	1	Abandoned 10'x20' Arch Culvert (Heavy Sedimentation Due to Damage)		3	27		
20	Culvert				4	50-77		
22	Culvert	3	Single Barrel 8'x10' Box Culvert		5	28	42	
23	Culvert				29			
30	Culvert	3	Single Barrel 10'x12' Box Culvert		78	79		
31	Culvert				6	80		
35	Culvert	2	4-60" CMP Culverts (Smaller Capacity than upstream)		7	30	43	47
36	Culvert				8	31		
41	Culvert	1	36" Residential RCP (Restricts Flow & Damaged)		9	32	81-83	
49	Culvert	2	Double 48" RCP (Broken)		16	37		
52	Culvert				84			
56	Culvert	3	Single Barrel 4'x12' Box Culvert		15			
57	Culvert				14	36		
59	Culvert	2	Single Barrel 5'x12' Box Culvert (Limited Freeboard)	30" RCP	13	35		
60	Culvert				12			
76	Culvert	1	Triple Barrel 7'x12' Box Culvert		11	34	45	
77	Culvert				10	33	44	48
97	Culvert	1	Single Barrel 5'x8' Box Culvert	36"x60" RCAP	49			
98	Culvert	1	Single Barrel 4'x8' Box Culvert		23			
99	Culvert	1	Double Barrel 4'x5' Box Culvert		22			
100	Culvert	1	Double Barrel 4'x5' Box Culvert	18" RCP	21			
101	Culvert	1	Double Barrel 4'x5' Box Culvert		20			
102	Culvert				19			
104	Culvert	1	Double Barrel 4'x5' Box Culvert	4' Wide Earthen Ditch	39			
105	Culvert				18	38		
106	Culvert	1	Double Barrel 4'x5' Box Culvert		17			

Summary of Findings

Gum Tree Branch

Characteristic: Other

Table - B.4					Discharge Channel Dimensions (Feet)			Photo ID Gum Tree - Other		
Figure No.	Characteristics	Priority	Remarks	Discharge at Location	Bottom Width	Top Width	Height	IMAGE_1	IMAGE_2	IMAGE_3
4	Utility Crossing	2	Sewer Pipe Crossing (Consticts Flow)					2		
14	Utility (Manhole)	3						1		
53	Concrete Ditch Damage	2	West Wing Blow Out (16 LF) (Includes 3-18x11 Eliptical Pipes)					9	15	
54	Concrete Ditch Damage	2	West Wing Blow Out (20 LF)					8	14	
61	Begin Concrete Ditch	3	Good Condition		12	15.8	5	7		
64	Bridge	3	No Issues Noted					6	19	20
65	Bridge	3	No Issues Noted	72" RCP				5	13	21
78	Bridge	3	No Issues Noted (Signficant Hydraulic Opening)					12		
92	Bridge	3	Hydraulic Opening: 6'x30' Skew: No					4		
93	Bridge							3		
103	Begin Concrete Ditch	3	Good Condition		6	14	4	11	17	18
107	Channel Characteristics	3	Begin Channel as Concrete Ditch		10	17	3.5	10	16	