Watershed Plan and Preliminary Characterization Report

FOR

CHATTANOOGA CREEK

WATERSHED

City of Chattanooga
Water Quality Management
Department of Public Works - Engineering

October 9, 2013

	Revision	Date
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ACRONYMS

CITY	City of Chattanooga
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DO	Dissolved Oxygen
EPA	Environmental Protection Agency (United States)
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
GPS	Global Positioning System
I & I	Inflow and Infiltration
ICM	Impervious Cover Model
IDP	Illicit Discharge Potential
LID	Low Impact Development
NPL	National Priorities List
NPDES	National Pollutant Discharge Elimination System
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PHF	Pesticides, Herbicides and Fertilizers
PW	Public Works
RPA	Regional Planning Agency
SEP	Supplemental Environmental Project
SSO	Sanitary Sewer Overflow
SWM	Stormwater Management
TDEC	Tennessee Department of Environment and Conservation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
US (EPA)	United States Environmental Protection Agency
USGS	United States Geologic Survey
WPA	Works Progress Administration

DEFINITIONS

303(d) list - List of impaired and threatened waters that the Clean Water Act requires all states to submit for EPA approval every two years on even-numbered years.

305(b) report - National Water Quality Inventory Report to Congress. The report that a state must submit to EPA every two years for approval. The 303(d) list is produced from this report

Base Flow - Is the component of stream flow that can be attributed to groundwater discharge into the stream. During dry periods, the majority of stream flow is comprised of base flow.

Benthic Macroinvertebrates – Insects, mollusks, crustaceans, worms and other organisms without a backbone that live in, on or near a waterbody.

Best Management Practices (BMP) – A method, activity, maintenance procedure or other management practice for reducing the amount of pollution entering a waterbody. BMPs can be structural or non-structural. Structural BMPs are physical controls such as detention ponds. Non-structural BMPs are non-physical entities such as enforcement, education, etc.

Brownfield Site – any real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Canopy – The branches of trees, which cast shade over the stream.

Coliform Bacteria – Bacteria which is found in the intestinal tract of warm-blooded animals and may include many species of bacteria such as *Escherichia coli*, and fecal streptococci.

Combined Sewer Overflow – A discharge of untreated sewage and stormwater to a stream when the capacity of a combined storm/sanitary sewer system is exceeded by storm runoff.

Combined Sewer System – A wastewater collection and treatment system in which domestic and industrial wastewater is combined with storm runoff.

Dissolved Oxygen – The amount of oxygen present in a waterbody and available for fish and other aquatic animals to use.

Electro-fishing – A technique in which electric current is applied to the water surface, stunning fish.

Habitat – The part of the physical environment where plants and animals live.

Headwater – The source and upper part of a stream.

Illicit Discharge Potential (IDP) – A numerical ranking system, which incorporates a series of quantifiable indices having a direct impact on water quality.

Inflow and Infiltration (I & I) – Excess water that flows into sewer pipes from groundwater and stormwater. Groundwater *infiltrates* into sewer pipes through holes, cracks, joint failures, and faulty connections. Stormwater *inflows* into sewers through downspouts, foundation drains, storm drain cross-connections, and holes in manhole covers.

National Pollutant Discharge Elimination System (NPDES) – The NPDES Stormwater Program is a comprehensive two-phased national program for addressing the non-agricultural sources of stormwater discharges which adversely affect the quality of our nation's waters. The NPDES permitting mechanism is used to prevent harmful pollutants from being washed by stormwater runoff into local waterbodies.

Polynuclear Aromatic Hydrocarbons (PAHs) – PAHs are one of the byproducts from the incomplete combustion of hydrocarbons, such as coal and gasoline. They are toxic to aquatic life and highly carcinogenic to humans.

Pollutant – Any substance that, when present in a hydrologic system at sufficient concentration, degrades water quality in ways that could become harmful to human and/or ecological health or that may impair the use of water for recreation, agriculture, industry, commerce or domestic purposes.

Total Daily Maximum Load (TMDL) – A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant.

Watershed Basin - Also called drainage basin, is the area of land where all surface water converges to a single point, usually to a river.

Watershed - A smaller area within a watershed basin, usually drains to a creek.

Watershed Sub-basin - An even smaller area within a watershed. It drains a more specific, smaller, area either to an outfall or straight to a creek or stream.

Wetlands – Ecosystems whose soil is saturated for long periods seasonally or continuously, including marshes, swamps and ephemeral ponds.

Executive Summary

The Chattanooga Creek Watershed Plan was written to identify key issues within the watershed and sub-basins; and to pinpoint monitoring and data gaps. This document will be used as a tool for the City of Chattanooga, Water Quality Management Program (City) to develop a strategic approach toward total watershed management. Included in this document are the critical elements necessary for watershed characterization:

- Watershed Description and Background
- Current Land Use
- Water Quality Data
- Regulatory Status
- Future Development Plans

Due to its long history of industrial pollution, elevated levels of fecal coliform, and habitat alteration due to anthropogenic activity, the Chattanooga Creek watershed has been identified as a priority watershed within the Chattanooga City limits,. A portion of the Chattanooga Creek was listed as a Superfund site in 1995. The Chattanooga Creek area was once a thriving economy. Efforts have been made to clean up pollution and give the community members a sense of pride for their community and the environment; however opportunities remain for improvement.

This Watershed Plan presents the data necessary to characterize the watershed and identifies any monitoring or data gaps. It lists the priority sub-basins and key issues of concern, and then presents solutions to solve identified issues. Furthermore, the plan outlines a strategy to educate and involve its community members in order to successfully improve the water quality of Chattanooga Creek.

It was determined that the Chattanooga Creek Watershed is impaired by *E. coli*, habitat alteration, low dissolved oxygen, PCBs, and dioxins. *E. coli* contamination and habitat alterations have been identified as the most prevalent water quality concerns. Key issues were identified as:

- Elevated levels of fecal coliform present in the Creek
- Habitat Alteration due to anthropogenic activities
- Industrial pollution

The sub-basins identified as being "priority" were C0103-01, C01-41, and DA 9. These were named priority based on the illicit discharge potential (IDP) score, number of superfund sites, area, and any other undesirable characteristics. Mitigation efforts will begin in these sub-basins and address the key issues of concern.

I. Introduction

The Clean Water Act (CWA) developed a mechanism for achievement of a national objective "...to restore and maintain the chemical, physical and biological integrity of the nation's waters." Section 305(b) of the CWA requires States to inventory the "health" of waters within their jurisdiction and list those waterbodies failing to meet water quality standards. Impaired waters, failing to meet their intended uses, must be listed under Section 303(d) of the CWA. Waters that have been placed on the 303(d) list must have a Total Maximum Daily Load (TMDL) determined for the pollutant of concern.[i]

A total of 16.4 miles of streams in the Chattanooga Creek Watershed are listed on the Environmental Protection Agency's (EPA) 305(b) National Water Quality Inventory Report to Congress as *impaired.* Tennessee Department of Environment and Conservation (TDEC) has determined that Chattanooga Creek, Gillespie Springs Branch, McFarland Springs Branch, and an unnamed tributary to Chattanooga Creek, are to be listed on the 303(d) list as "not supporting" of their designated uses; thereby making them priorities for water quality improvement efforts. Causes of impairment include pathogens, low dissolved oxygen, habitat alteration, Dioxins, and PCBs.[ii] Additionally, fish consumption advisory is in effect for fish caught in Chattanooga Creek due to PCBs and Chlordane.[iii]

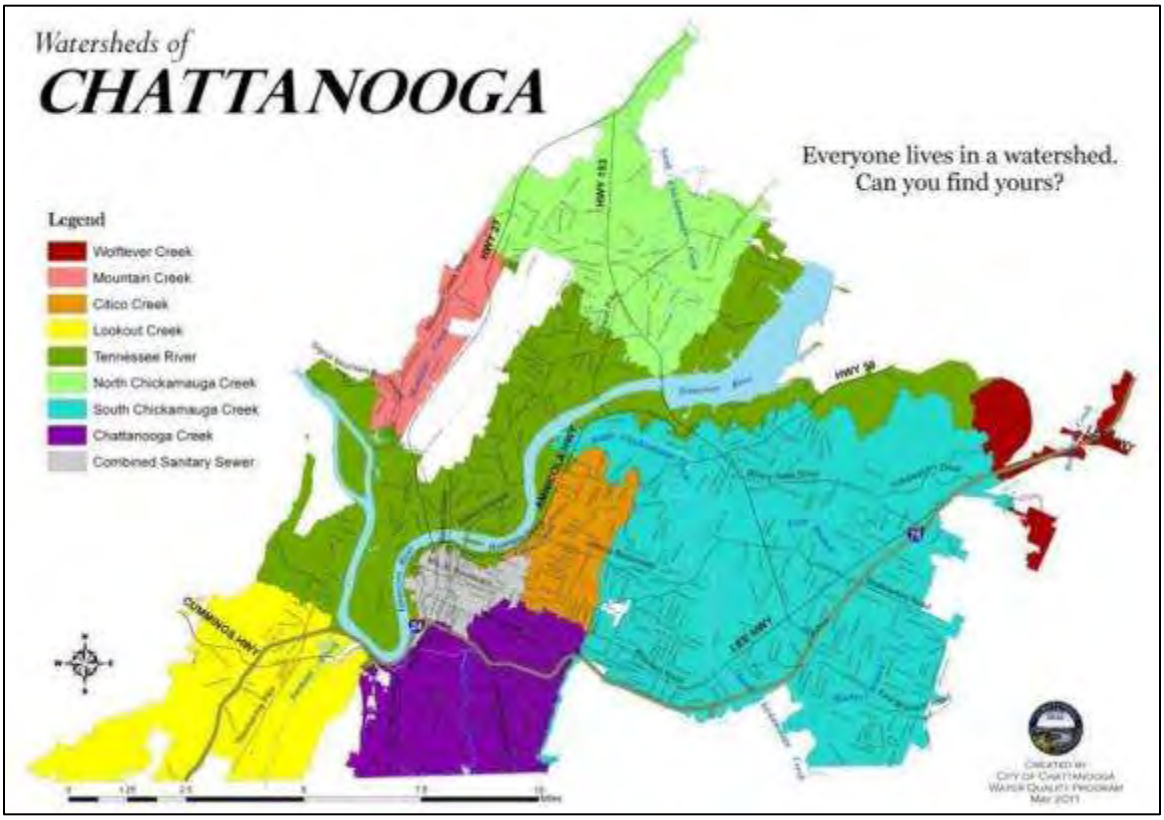

Figure 1 Chattanooga Watersheds-Chattanooga Creek (including Dobbs Branch) shown in purple

This document is written as a primary step in the development of a comprehensive Watershed Plan for the Chattanooga Creek Watershed. The scope of this document is to:

- define the goals, objectives and implementation guidelines of the Watershed Plan;
- evaluate current watershed conditions, including existing land use, social demographics, and water quality data;
- develop a sub-basin priority ranking system;
- develop a list of early action (restoration) projects;
- identify key stakeholders and establish partnerships with the community leaders; and
- develop a community education/outreach awareness program.

Mission:

It is the City's vision to restore the waterways within the Chattanooga Creek Watershed as close to their natural state as possible, promote a healthy and sustainable ecosystem, protect the watershed from future degradation, and most importantly improve the quality of life within this watershed.

Strategies:

- Improve water quality through the implementation of green infrastructure that will reduce the pollutant loading from contaminated surface runoff and combined sewer overflows.
- Reduce flooding and promote infiltration through addition of parks, open spaces, and healthy riparian areas that incorporate green infrastructure.
- Perform remediation of brownfield and Superfund sites.
- Remove PCBs and Chlordane from Chattanooga Creek so the Fish Consumption Advisory can be lifted.
- Address the issues of fecal coliform levels due to Combined Sewer Overflow (CSO) outfalls.
- Increase public awareness and develop stewardship of the watershed

II. Chattanooga Creek Watershed Description

Chattanooga Creek is located in the Middle Tennessee-Chickamauga Watershed, Hydrologic Unit 06020001, which is a part of the Upper Tennessee Watershed Basin. It is a third order stream fed by Dobbs Branch, Gillespie Springs Branch, McFarland Springs Branch, and an unnamed tributary. Chattanooga Creek begins on the slopes of Lookout Mountain in Northwest Georgia and travels for approximately 26 miles, flowing through neighborhoods and commercial and industrial zones, until it reaches its outfall to the Tennessee River, just upstream of Nickajack Reservoir.[iv] The Chattanooga Creek Watershed drains approximately 6,603 acres of land.

The Chattanooga Creek Watershed is bordered by Lookout Mountain to the west, downtown Chattanooga to the north, the Georgia state line to the south, and the eastern border running between Dobbs Branch and Chattanooga Creek. For purposes of this plan, the "Chattanooga Creek Watershed" will consist of Chattanooga Creek, Gillespie Springs Branch, McFarland Springs Branch, and an unnamed tributary. The area in which Dobbs Branch is located will be considered its own watershed.

Sub-Basins - Chattanooga Creek Watershed

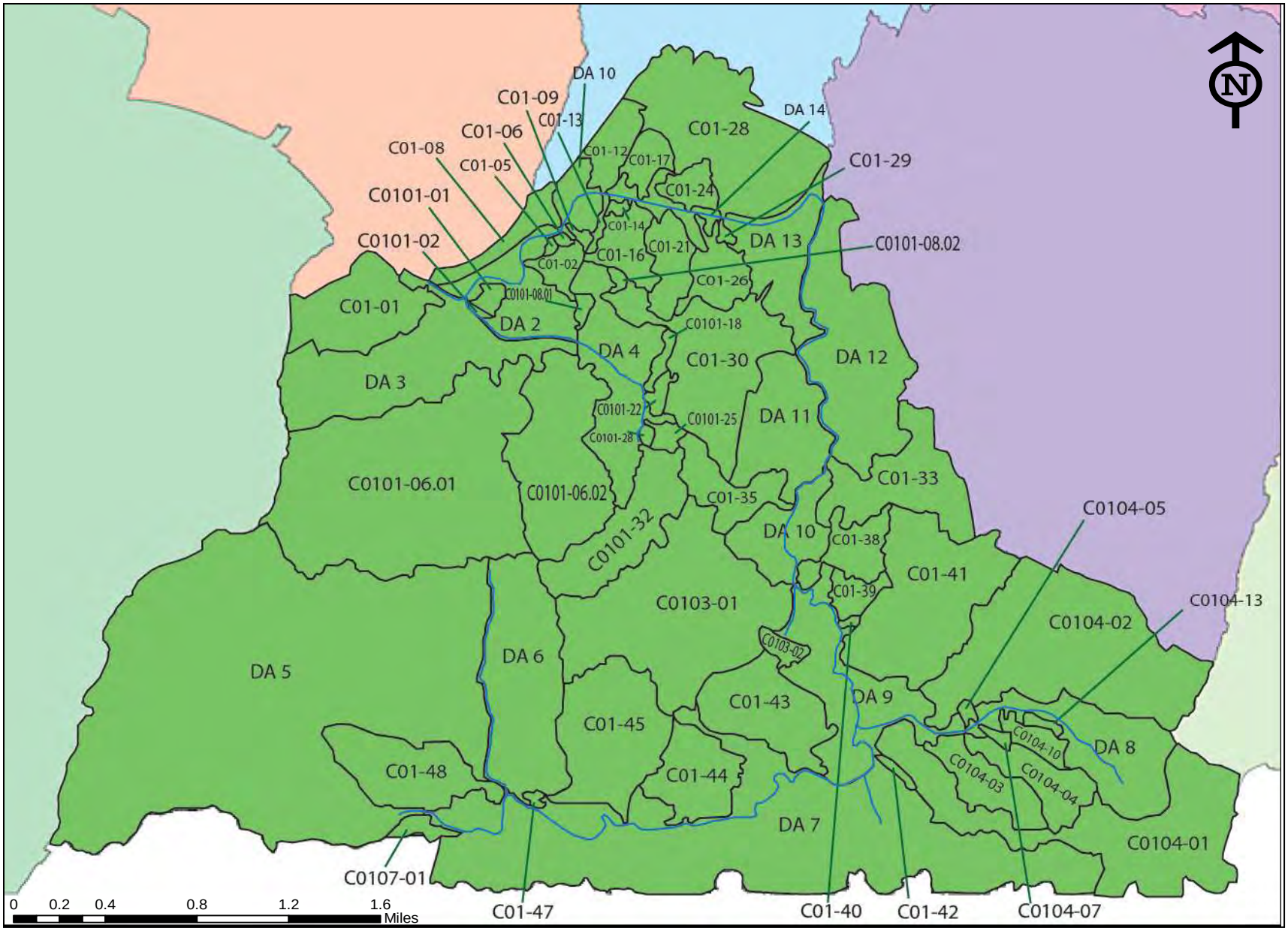

Figure 2 Sub-Basin Borders

Just under half of Chattanooga Creek and its tributaries have been transformed from their natural condition to box culverts, pipes, ditches, improved channels, or drains. Fifty-five percent of the stream remains a natural channel. Fifteen percent has been converted to an improved channel, meaning the natural channel has been modified to address the issues of flooding, stream bank erosion, sedimentation, or to improve habitat. Channel modification is typically done by straight-lining or deepening the stream channel.[v] Thirteen percent of the stream has been converted to ditches, twelve percent into pipes, and four percent is now box culverts.

Table 1 Channel type and length

Type of Channel	Length (ft)
Natural Channel	33,928
Box Culvert	2,616
Pipe	7,224
Ditch	7,970
Improved Channel	9,561
Drain	223
Assumed Conveyance	299

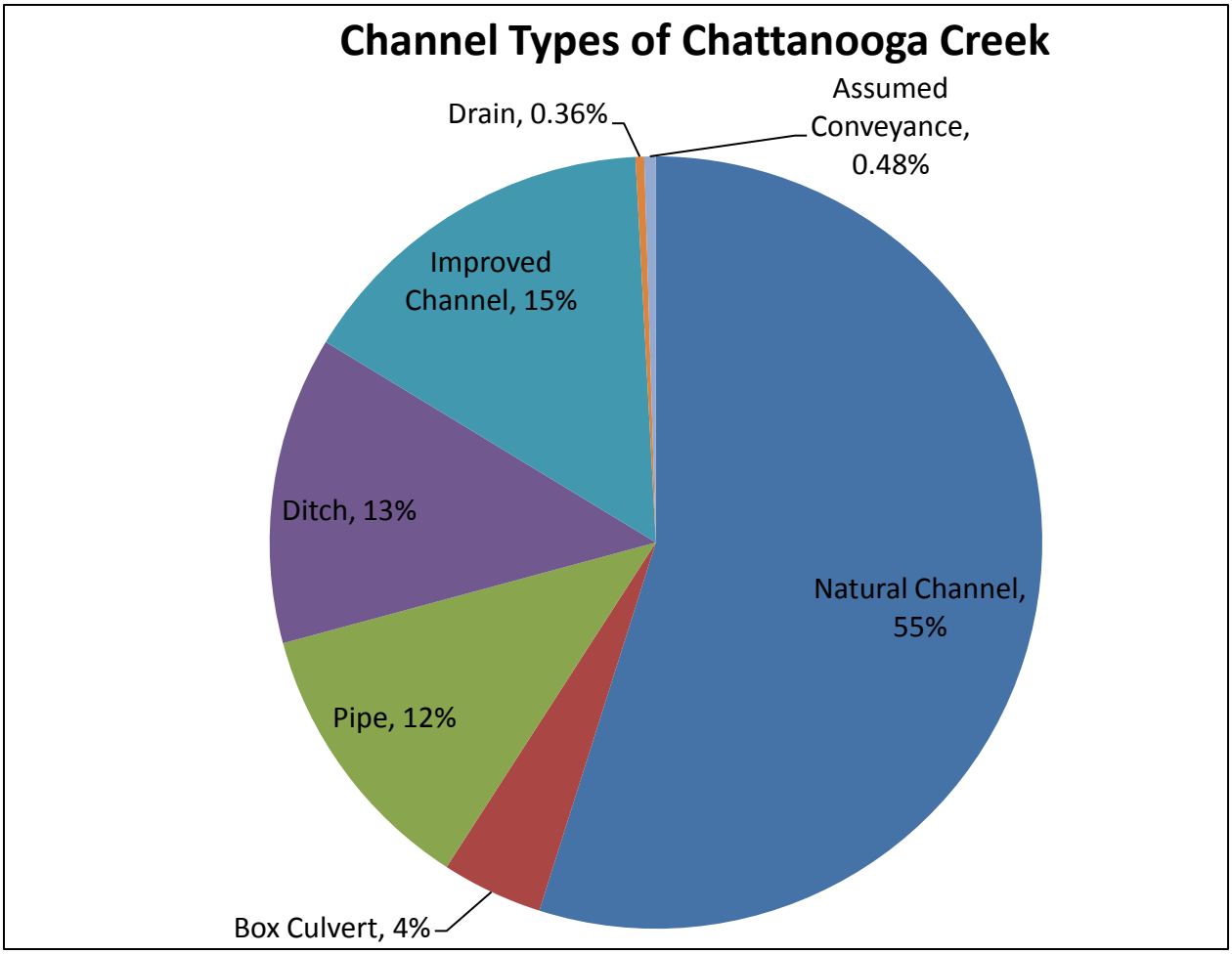

Figure 3 Channel Types, by percentage

III. Chattanooga Creek Watershed Background

The Chattanooga Creek Watershed is home to one of the oldest suburbs in Chattanooga, dating back to 1878. The area that makes up the Chattanooga Creek watershed was once characterized by thriving industries and desirable neighborhoods. Now, portions of the area are plagued with high crime statistics, high unemployment rates and poverty levels, high infant health risk, and declining property values.

Chattanooga Creek's long history of pollution began in the early 1900's when industries began moving to the area. Dumping of industrial toxic waste became a common practice, even after environmental laws were established. Chattanooga Creek was once considered one of the most polluted creeks in the US.[vi] As a result of historical pollution, many properties are now listed as brownfields or Superfund sites, including a portion of Chattanooga Creek. Cleanup efforts have been made; however, pollution is still a problem and no streams within the watershed meet all of the designated uses.

A. Neighborhoods within Chattanooga Creek Watershed

The Chattanooga Creek is comprised of the South Broad, Alton Park/Piney Woods, St. Elmo, Clifton Hills, and Cedar Hill Neighborhoods, as well as portions of East Lake. Additionally, the boundaries of the watershed extend west to encompass Lookout Mountain, and south into North Georgia; however, these areas are not within Chattanooga city limits. In the heart of the watershed, and adjacent to Chattanooga Creek, is a purely industrial section. The industrial section was a big part of the thriving economy before the 70's and also a big part of the pollution today.

In the mid-twentieth century, South Broad was an important travel corridor as it connected Lookout Mountain, Alton Park, and St. Elmo to downtown. The area was predominately commercial developments along Broad Street with residential neighborhoods located just off of Broad Street. The areas along the railroad corridor and the Tennessee River were filled with industries. Historical employers of the area include Chattanooga Medicine Company, Chattem Inc., Combustion Engineering, North American Royalties/Wheland, and car dealerships. In recent years, the area has been on the decline. Approximately 70% of the housing units are Chattanooga Housing Authority sites and the remaining residential properties experience high vacancy rates.[vii]

Alton Park became a popular location for manufacturing because it has many transits available (Chattanooga and Southern Railway), its close proximity to water supply (Chattanooga Creek),

fuel from nearby coal deposits, and close location to downtown Chattanooga. The first of many manufacturing facilities was Chattanooga Cotton Oil Company. Alton Park was incorporated in 1917. Alton Park boasted paved streets, electricity, schools and sewers that came as part of the city's annexation to Hamilton County. Additionally, tax incentives were provided to encourage the growth of a manufacturing economy. Between 1920 to 1950's, Chattanooga Coke & Chemical, Chattanooga Glass Company, Velsicol Chemical Company, and Bunge Foods all called Alton Park home. It was these same manufacturing companies that have heavily contributed to the polluted condition of the area today. When the recession hit in the 1970's, many residents lost their jobs and companies closed or moved out, leaving Alton Park in a deteriorated condition, in which it has yet to bounce back from.[viii]

St. Elmo is recognized as one of the oldest suburbs in Chattanooga. It was founded as a result of an exodus from Chattanooga to Lookout Mountain due to a yellow fever epidemic in 1878. Before the development of its suburb, Native Americans occupied the area, creating extensive trail systems. The current 37th Street and Tennessee Avenue intersection was a major crossroads for the Indians. In 1929, St. Elmo was annexed into the city of Chattanooga. Like many other neighborhoods, it fell into a state of disrepair due to the recession in the 1970s.[ix] The Incline Railway and Chattem Drugs were, and still are, vital companies in the neighborhood. High crime, aging housing stock, and economic issues have all contributed to the decline of the community.[x]

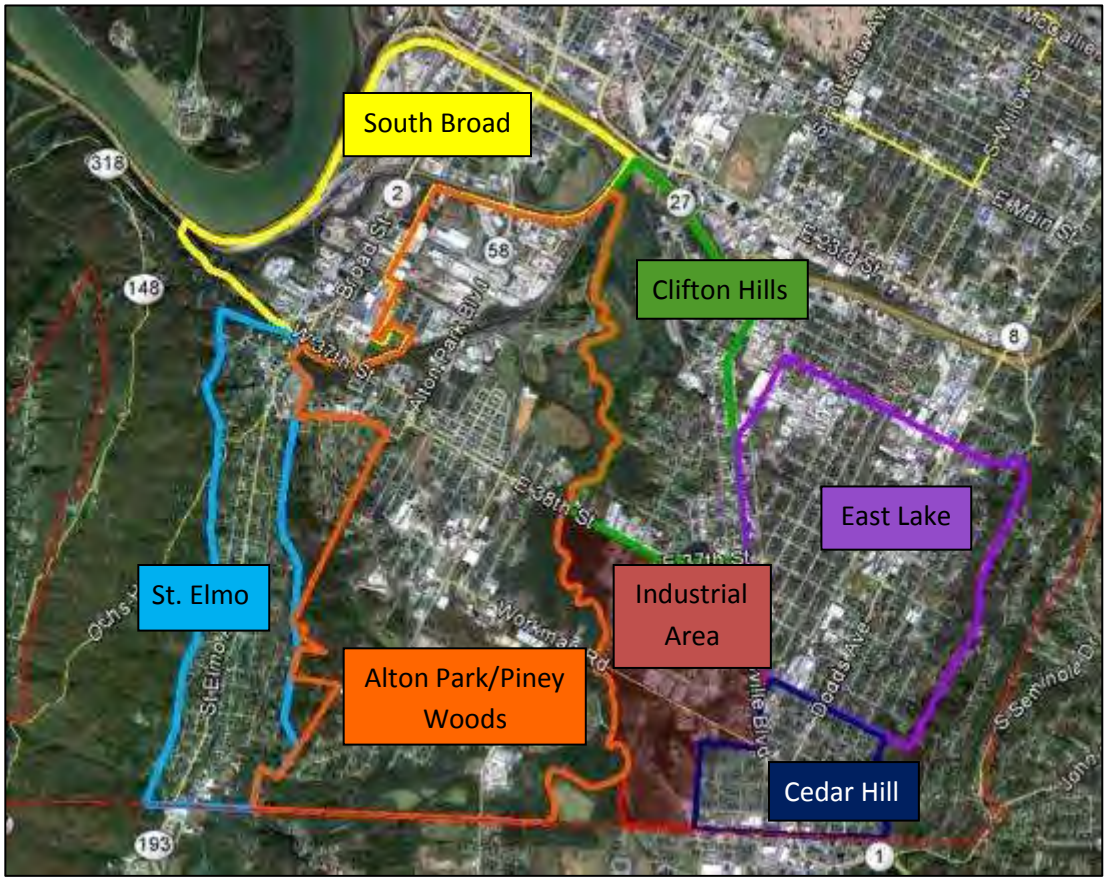

Figure 4 Map of neighborhoods in Chattanooga Creek

B. Demographics

Demographic information was gathered from the US Census Bureau's 2010 Census and the 2011 American Community Survey 1-year Estimates and 5-year Estimates, which provides detailed social, economic, demographic, and housing data for areas with populations greater than 65,000. The data is broken down by Census Tracts, and then compared to city, state, and national data. Five tracts lie within the Chattanooga Creek Watershed. A portion of Census Tract 20 lies outside of the watershed boundaries. The portion within the boundaries is Census Tract 20, Block Group 2, whose population was determined to be 325. This area corresponds to the South Broad neighborhood. Census Tract 18 corresponds to the St. Elmo neighborhood, Tract 19 to Alton Park/Piney Woods, Tract 23 to Clifton Hills and the Industrial Area, and Tract 24 to East Lake and Cedar Hill. Figure 5 shows the boundaries of the Census Tracts.

The entire Chattanooga Creek Watershed's population is approximately 13,533. Compared to the entire city of Chattanooga at 167,674, the watershed makes up around 8% of the City's population. The ratio of males to females is approximately 1:1. The total percentage of citizens 65 and older is 11.5% which is lower than the city, state and US percentages. Additionally, unemployment is more common in the area, with rates ranging from 17-35%, up to three times as high as the national unemployment rate of 10.3%. Tract 18's percentage of residents with a high school diploma or higher is greater than national percentage; however, all other tracts have a lower rate, with Tracts 23 and 24 being much lower than the national percentage.

It can be seen that as the minority population increases, income levels decrease and poverty and unemployment increase. Tract 19 has the highest minority rate of 94% and also has the highest poverty rate of 60% and highest unemployment rate of 35%. However, educational attainment does not correlate. Tract 19 has the third highest percentage of residents with a high school diploma higher. Demographic data can be seen on Table 2. The values in red represent the most undesirable data, such as high poverty and low income.

Census Tracts

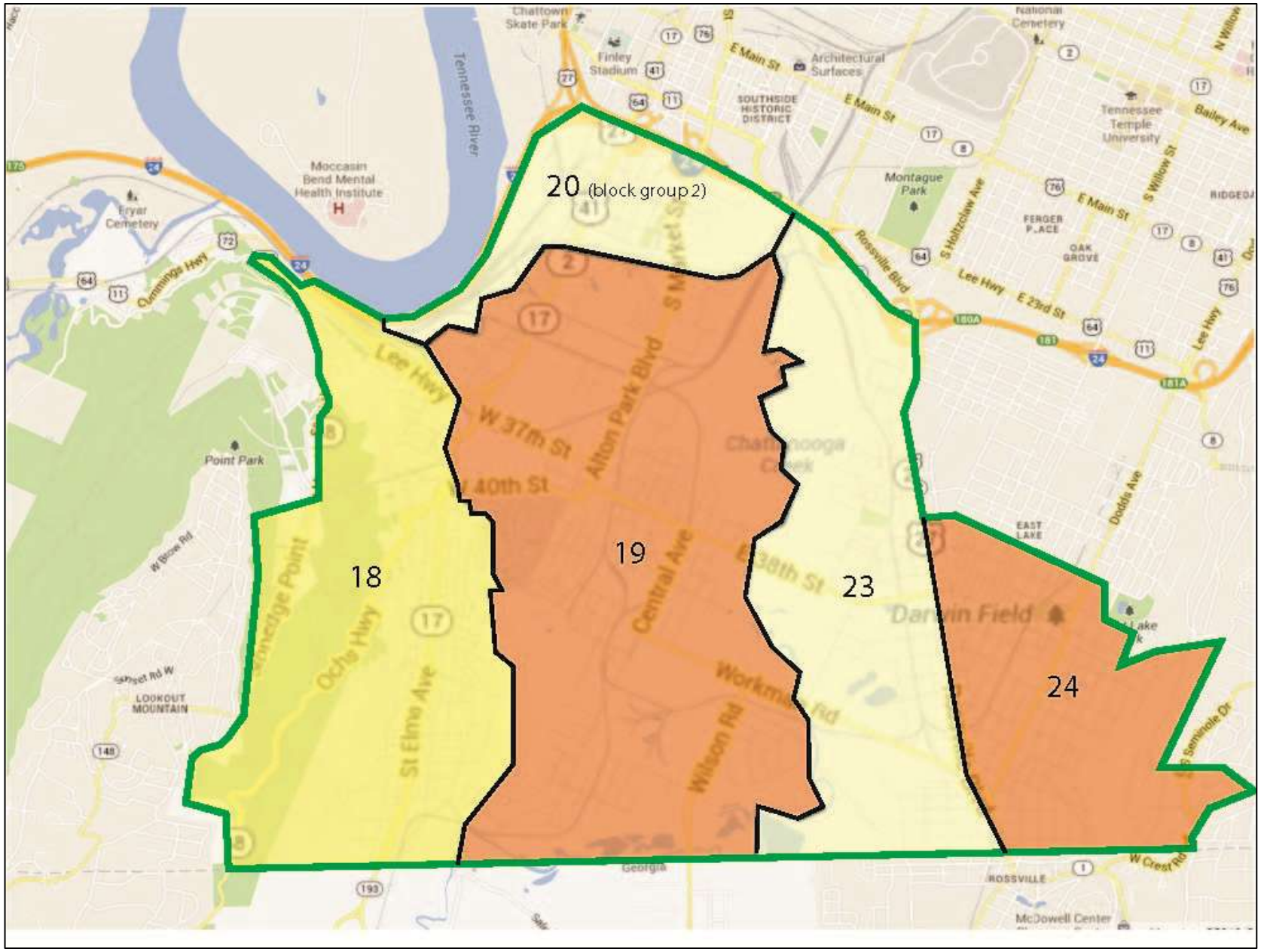

Figure 5 Census Tract Boundaries

Table 2 Demographic Information

	Tract 18	Tract 19	Tract 20*	Tract 23	Tract 24	Chattanooga, TN	Tennessee	United States
Population	2,978	4,595	325	1,164	4,471	167,674	6,346,113	308,747,508
Median Age	35.7	23.7	35.5	34.7	29.0	36.4	38.3	37.3
Percent 65 or older	12.9%	9.7%	12.3%	14.6%	9.0%	15.0%	13.7%	13.3%
Percent Minority	29%	94%	55%	47%	40%	44.1%	24.4%	36.1%
Median Household Income**	$ 45,438	$14,307	$17,670	$24,500	$23,716	$22,800	$25,243	$30,500
Median Family Income	$49,569	$14,236	$15,526	$34,342	$29,984	$46,069	$52,273	$61,455
Percent of Families below Poverty Level	11.6%	60.0%	54.4%	32.5%	46.8%	22.1%	13.7%	11.7%
Percent of Individuals Unemployed	17.3%	34.9%	18.5%	23.2%	23.2%	15.4%	10.6%	10.3%
Percent High School graduate or higher (age 25+)	89.2%	67.9%	74.4%	45.1%	55.8%	84.1%	84.2%	85.9%
***Values estimated because Tract 20 does not lie completely within the watershed boundaries**								
****A household is defined as all people who occupy a housing unit regardless of relationship**								
Source: 2010 US Census Bureau and 2011 American Community Survey 1-year Estimates and 5-year Estimates								

C. History of Pollution

From 1913-1995, Tennessee Products, later known as Tennessee Coke and Chemical, operated a coal carbonization facility located adjacent to Chattanooga Creek. The by-product produced was coal tar, and was dumped directly into Chattanooga Creek and its floodplain for years. Contaminants discovered from the dumping include a wide variety of PAHs, including chemicals such as benzene, toluene, ethyl benzene, zylene (BTEX), and metals. It has been documented that contaminated surface waters containing significant levels of PAHs, phenols, oil and grease, ammonia, and metals were discharged downstream, where the Creek intersects with the Hamill Road Bridge. Just upstream of the Hamill Road Bridge, a private sewer line used by Tennessee Products and Chattanooga Coke and Gas Company discharged wastewaters directly to the Creek dating back to as early as 1926. As a result of chronic discharge, the sediment, groundwater, and surface waters have been heavily contaminated, as well as wetlands and fisheries downstream. In 1995, EPA declared a 2.5 mile section of Chattanooga Creek a Superfund site as a result of the years of toxic dumping.[iv]

Other historical polluters include Reilly Tar, Velsicol Chemical, and Southern Wood Piedmont. Reilly Tar produced coal tar products from the by-products of Tennessee Products coal carbonization plant between 1921 and 1976. Velsicol Chemical purchased its facility from Tennessee Products in 1963. Benzoyl chloride, benzoic acid, benzyl chloride, benzyl alcohol, benzotrichloride, benzoate esters, benzoguanamine, benzonitrile, benzaldehyde, and sodium benzoate were all chemicals produced at the plant. Southern Wood Piedmont was a wood treatment facility operating from 1925-1988, located adjacent to Chattanooga Creek. Prior to 1940, wastewater from the facility was discharged directly to the Creek. Furthermore, during Superfund cleanup of Chattanooga Creek, a creosote-like material, called non-aqueous phase liquid (NAPL), was found seeping into the creek bed and believed to have come from Southern Wood Piedmont.[xi]

Many other contaminated properties exist within the watershed. The corporations listed below are directly responsible for the significant pollution levels that resulted in Chattanooga Creek being identified as a Superfund site. There are a total of twenty-seven National Superfund sites and fourteen Local Superfund sites in the watershed. Combined, five sites lie within the floodway (one of which is Chattanooga Creek itself), ten lie within the 100-yr floodplain, and four lie within the 500-yr floodplain. With the area's history of flooding, contaminants from these sites can easily be spread into areas not previously contaminated. Tables 3, 4, and 5 on the following pages identify the Superfund sites within the Chattanooga Creek Watershed.

Table 3 National Superfund sites

National Superfund Sites within Chattanooga Creek	Sub Basin	Floodway	100 yr floodplain	500 yr floodplain
Chattem Chemical Warehouse	C0101-06.01			
Chattem Chemicals, Inc	C0101-06.01			
Cofer Site	C0101-32			
Porter Warner Industries	C0103-01			
Ahlstrom Engine Filtration Inc	C0103-01			
Alton Park Rec Center	C0103-01			
Tennessee Products	C0103-01			
Bunge Oils	C0103-01			
ADM Southern Cellulose Products Inc	C0103-01			
Velsicol Chemical Corp	C0103-01			
North American Royalties Inc. -Wheland Automotive Industries	C01-12			
Bromid LLC	C01-12			
Motor Wheel Commercial Vehicle Systems Chattanooga	C01-12			
CE Tubes Inc.	C01-12			
Chattem Inc Annex Warehouse	C01-16			
Quala Systems Inc	C01-26			✔
Caraustar of Chattanooga	C01-28			
Southern Wood Piedmont	C01-30			✔
Steward Advanced Materials	C01-41			
Mitchell Industrial Tire Co., Inc	C01-41		✔	✔
MorFlo Industries Inc	C01-41		✔	✔
ASTEC Inc	C01-41			✔
Taylor Laboratories Inc	DA 14	✔	✔	✔
Chattem Inc Plant 2	DA 2			
BOC Gases	DA 2			✔
Rossville Yarn Inc	DA 7			
Secondary Aluminum Smelters	DA 9		✔	✔

Table 4 Local Superfund sites

Chattanooga Superfund Sites	Sub Basin	Lies within Floodway	Lies within 100 yr Floodplain	Lies within 500 yr Floodplain
Velsicol Residue Hill	C0103-01			
Wheland Foundry	C01-12			
28th St Sludge Ponds	C01-21		✔	✔
Howard High School Landfill	C01-28		✔	✔
Steward	C01-41		✔	✔
Electro-Lite Battery	C01-41		✔	✔
Southern Wood Piedmont	DA 11		✔	✔
36th St. Dump	DA 11		✔	✔
Chattanooga Creek	DA 12	✔	✔	✔
Chattanooga Coke	DA 4			
Piney Woods Playground	DA 9		✔	✔
Hooker Rd Bridge	DA 9	✔	✔	✔
Hooker Rd	DA 9	✔	✔	✔
Hooker Rd	DA 9	✔	✔	✔

Table 5 Superfund sites, local and national, defined by sub-basin

Sub-Basin	Area, acres	Number of Superfund Sites, Local and National
C01-12	35	5
C01-16	41	1
C01-21	43	1
C01-26	42	1
C01-28	204	2
C01-30	168	1
C01-41	204	6
C0101-32	106	1
C0103-01	303	8
C0101-06.01	457	2
DA 2	94	2
DA 4	131	1
DA 7	651	1
DA 9	156	5
DA 11	115	2
DA 12	194	1
DA 14	29	1
Total		41

In addition to industrial pollution to Chattanooga Creek, downtown Chattanooga has one of the approximately 772 combined sewer systems throughout the United States. In instances of heavy rainfall, combined sewers can become overwhelmed; resulting in partially treated, but not disinfected, wastewater to be discharged from one of the several combined sewer overflow (CSO) outfalls. Although the area within the Chattanooga Creek Watershed does not have a combined sewer system, both the Williams Street CSO outfall and the Central Avenue CSO outfall discharge directly to Chattanooga Creek, which is already listed by TDEC as impaired for *E. coli* and low dissolved oxygen. A recently issued consent decree will require the City to develop a Long-Term Control Plan to that will help manage the CSO discharges.[xii]

Lastly, not only are large corporations to blame for the pollution, some small businesses and community members contribute as well. Dumping has been common practice in the isolated areas along the Chattanooga Creek corridor. During the Superfund cleanup, 25 tons of old tires were removed. In July 2011, another 600 were removed by a volunteer team at Hooker Road and Chattanooga Creek. Just weeks later, more tires had been dumped. In addition to tires, household items can be found, such as TVs, dressers, garbage, and clothing.[xiii]

Figure 6 Tire removal from Chattanooga Creek

IV. Land Use

Land use is divided into nine categories: residential, vacant, industrial, recreation, commercial, institutional, transportation, utilities, and agriculture. The leading land use types of the watershed are residential properties at 31%, vacant properties at 26%, and industrial properties at 13%. Each of the nine categories is then broken down into 38 sub-categories, which can be seen in Figure 7. Although recreation makes up a relatively large portion of the watershed, 93% of the recreational properties are confined to Lookout Mountain, leaving only 7% of the parks and green spaces for the rest of the neighborhoods within the watershed. The nine land use categories can be seen in Figure 6 below.

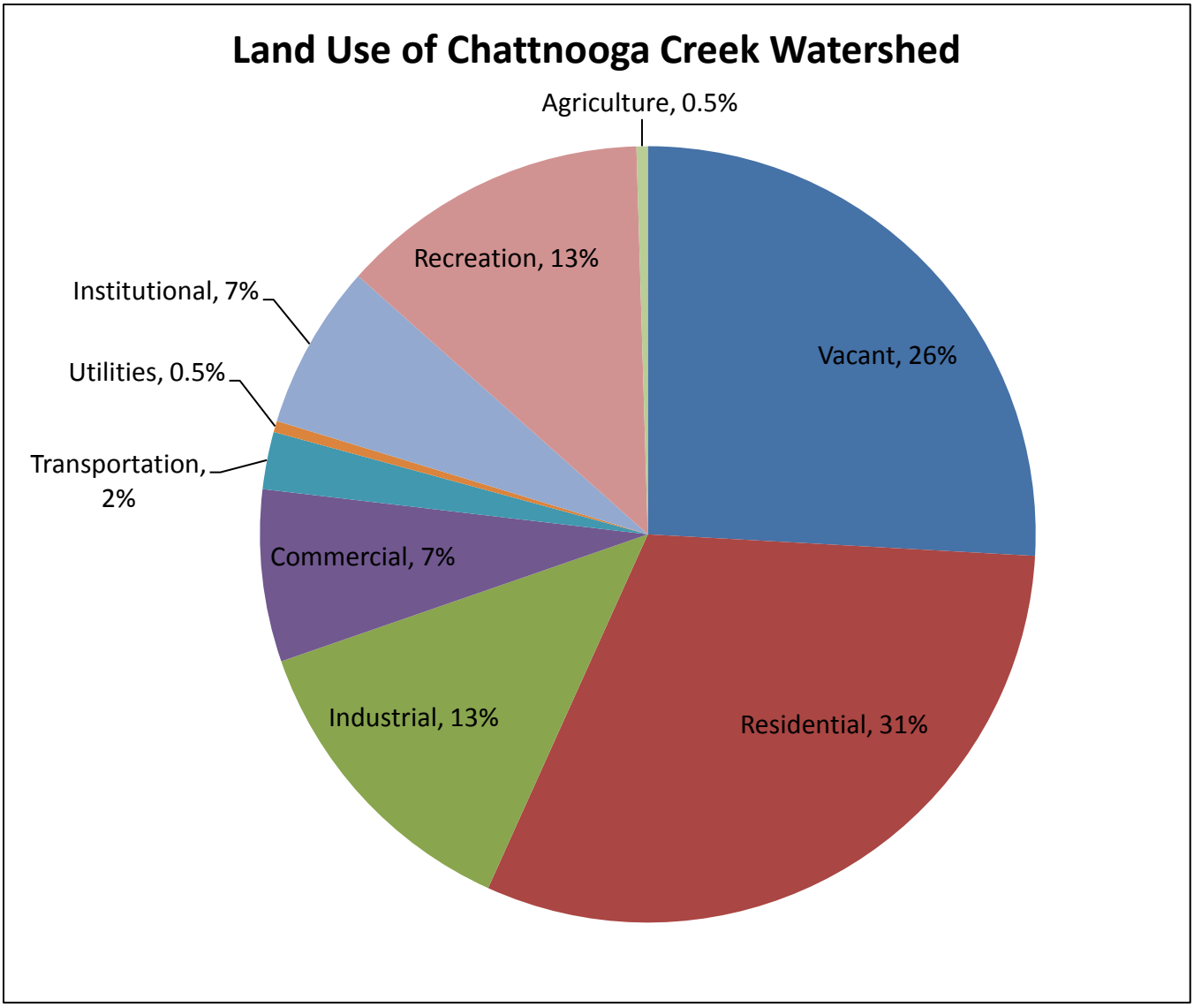

Figure 7 Breakdown of land uses, by percentage

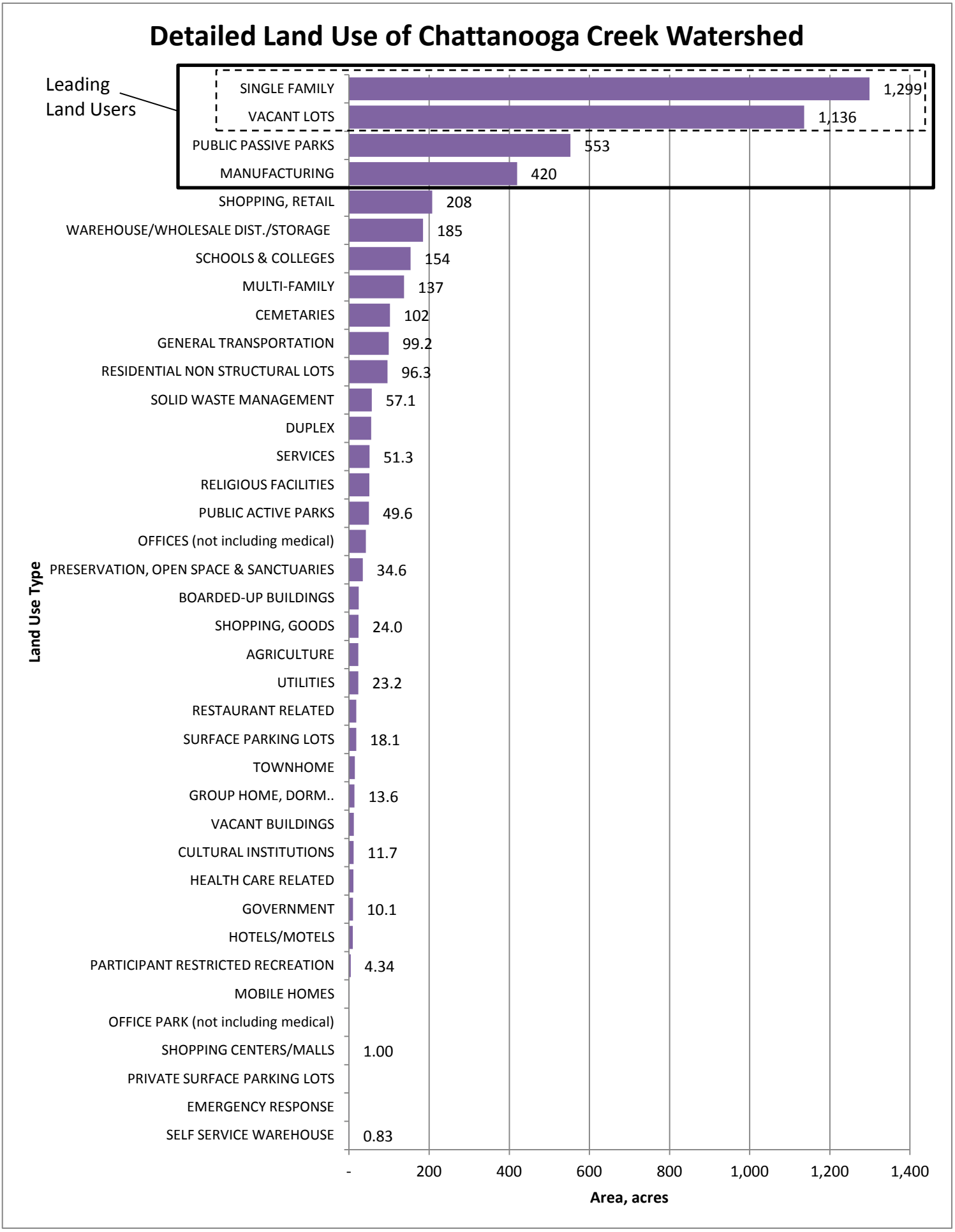

Figure 8 38 sub-categories of land uses

A. Residential

The majority of land use within Chattanooga Creek Watershed is comprised of residential properties. Residential properties are defined as single family houses, duplexes, multi-family houses (3 or more units), group homes (dormitories, retirement homes, etc), mobile homes, attached townhomes, and mobile home parks.

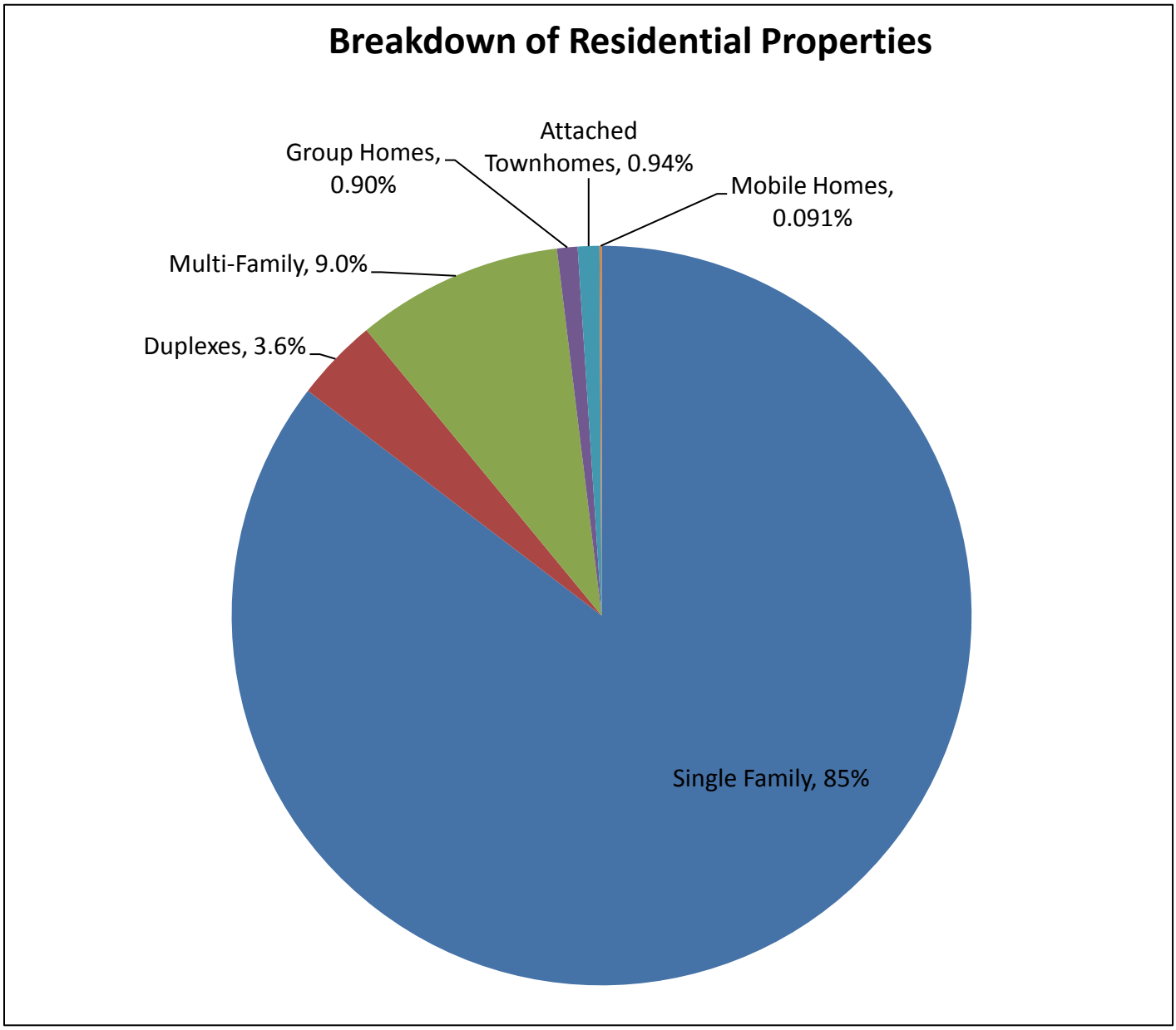

Figure 9 Residential property types by percentage

B. Vacant

The next leader in land use is vacant properties. This category consists of vacant lots, vacant buildings, residential non-structural lots, and boarded-up buildings. One of the contributors to vacant properties is the industrial facilities that have closed down and left properties vacant, many of which are brownfields. Vacant properties project a declining economy as well as further reduce existing property values. When a property is designated as a brownfield, remediation efforts must be completed before the property can take on a new use.

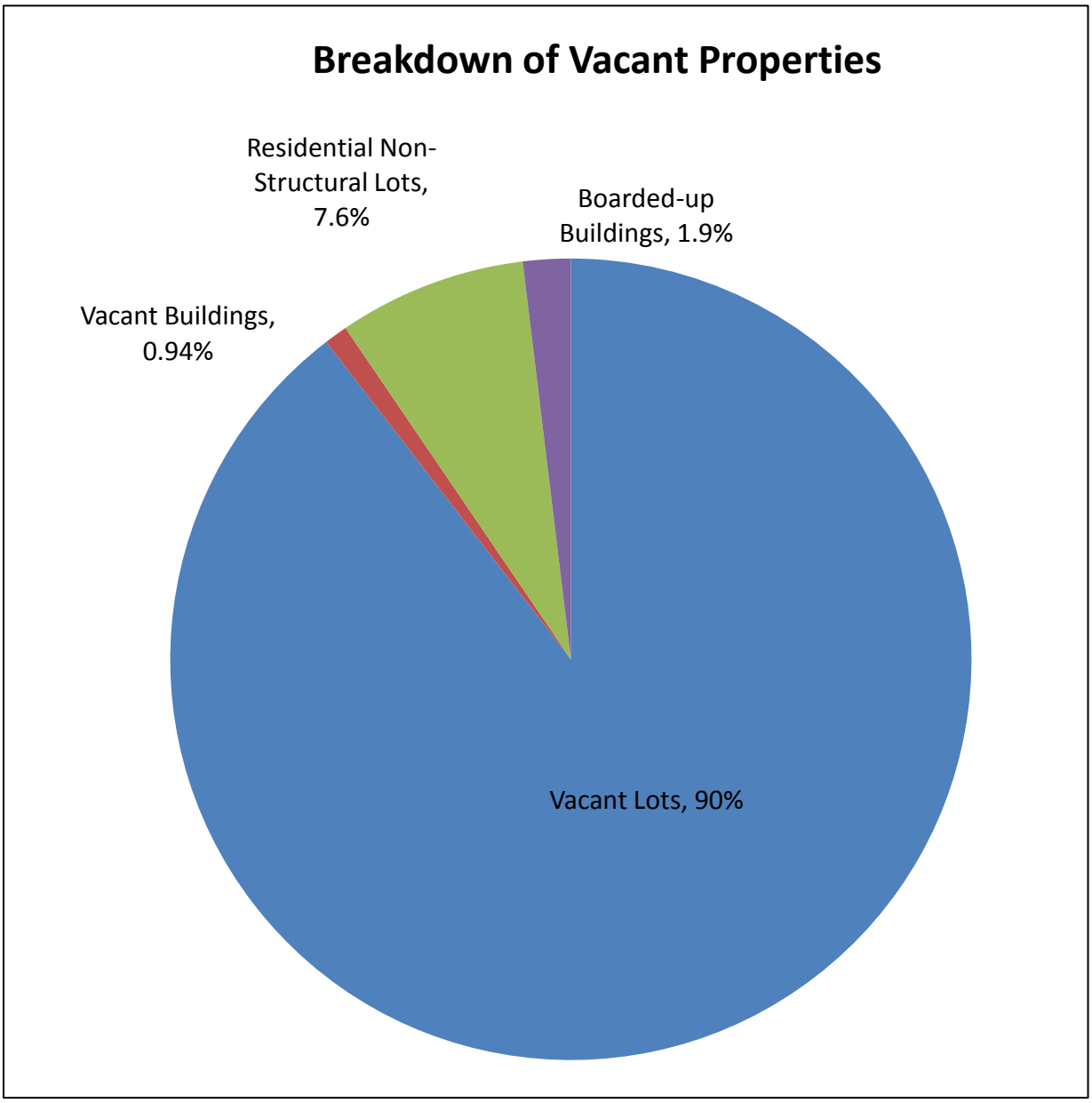

Figure 10 Vacant property types by percentage

C. Recreational

Recreational properties are broken down as Public Passive Parks; Public Active Parks, such as baseball fields and playgrounds; Participant Restricted Recreation, such as YMCA, private golf courses, and private recreation facilities; and lastly preservations, open spaces, and sanctuaries. For the Chattanooga Creek Watershed, recreational properties are somewhat falsely represented. Within the watershed, there is a total 641 acres of recreational properties with 93% concentrated on Lookout Mountain, leaving only 43 acres of parks and open spaces for the remaining neighborhoods. Not only do these neighborhoods not have their own recreational properties, the properties located on Lookout Mountain are not easily accessible. Table 6 shows a list of parks within our study boundaries as defined by Chattanooga's Department of Parks and Recreation.

Table 6 Parks in Chattanooga Creek Watershed

Park Name	Features	Address
Alton Park	Playground, swings, ball field, tennis courts	100 West 45th St.
Boulevard Park	Ultimate Frisbee Park	4701 Divine Ave.
Caruthers Park	Walking Trail, playground, ball field, picnic area	3300 Brannon Ave.
Church Street Park	Swing set, horse shoes	3701 Church St.
Clifton Hills Park	Open green space	2801 Clifton Terrace
Fredrick Park	Open green space	916 West 38th St.
Harris Johnson Park	Playground, trail	41 West 28th St.
Pringle Park	Playground	2613 Long St.
Roy Nelms park	Open green space	1609 West 41st St.
South Chattanooga Recreation Center	Walking track, tennis, ball fields, rec center	1151 West 40th St.
St. Elmo Park	Walking path, playground	4909 St. Elmo Ave.

D. Industrial

Industry once and still is a big part of the Chattanooga Creek Watershed. Many of the industrial properties are listed on the National Priorities List (NPL) as Superfund sites. The EPA defines a Superfund site as "an uncontrolled or abandoned place where hazardous waste is located, possibly affecting local ecosystems or people."[xiv] Industrial properties are defined as manufacturing facilities, warehouses (including wholesale distributors and storage facilities), self-service warehouses and mini warehouses, and solid waste management facilities.

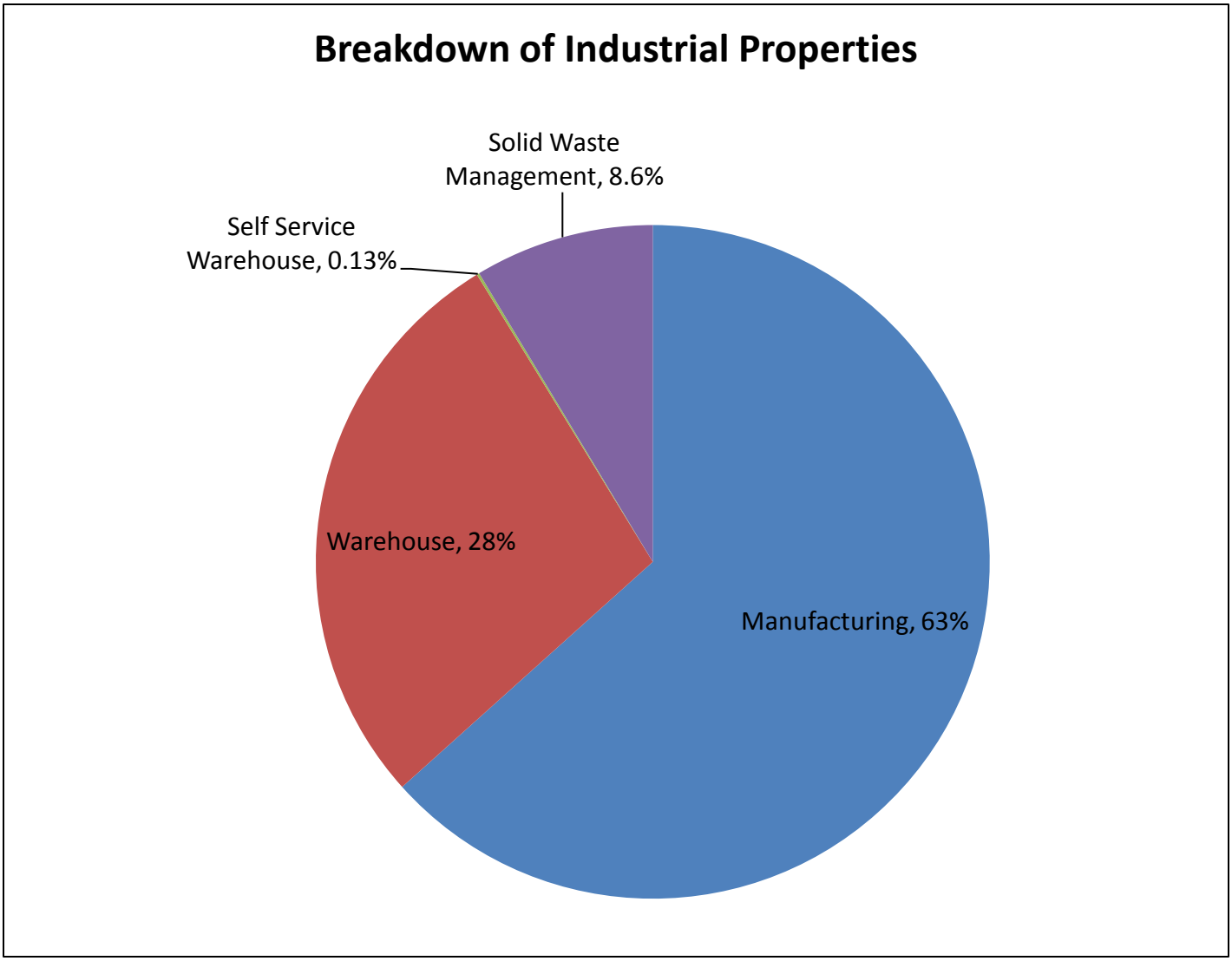

Figure 11 Industrial property types by percentage

V. Watershed Conditions

A. Water Quantity

It is important to manage the volume of water that drains an area. Increased stormwater volumes can cause flooding, which then results in stream bank erosion and spreading of contaminated sediments from polluted areas, and create dangerous conditions for people and their homes. Large volumes of stormwater put an excess strain on the sewer and stormwater infrastructure. Once the maximum volume of stormwater and sewage in a pipe has been exceeded, combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) occur. When a drainage issue arises, residents can file a service request through Chattanooga's 311. Over the past five years, 300 service requests were filed within the Chattanooga Creek Watershed. Sub-basin C0104-02 had the most reoccurring requests as well as the greatest overall number. Of the 59 requests in sub-basin C0104-02, approximately 60% were located on 12th and 13th Avenues. The table below shows the ten sub-basins with the highest drainage complaints *per acre*.

Table 7 Ten sub-basins with highest drainage complaints per area

Sub-basin Name	Acres	Drainage Complaints	Drainage complaints per acre
C0104-05	3.5	3	0.858
C0104-10	20.1	9	0.447
C0104-13	4.0	1	0.250
DA 8	130.6	30	0.230
C0104-03	55.5	11	0.198
C0104-02	312.8	59	0.189
C01-48	98.8	11	0.111
DA 6	191.8	21	0.110
C0104-04	56.0	6	0.107
C01-33	112.9	12	0.106

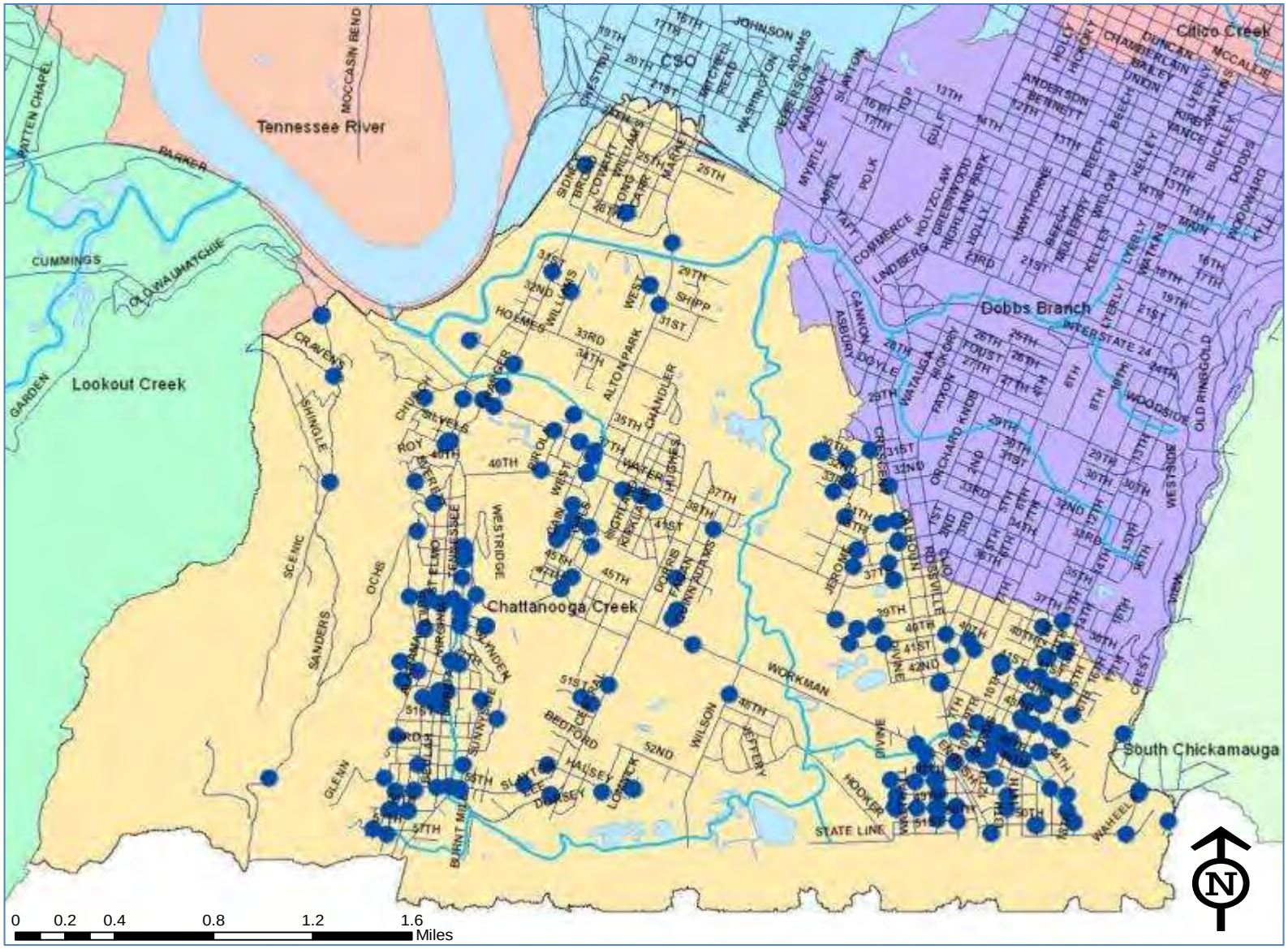

Figure 12 Location of drainage complaints in Chattanooga Creek Watershed

B. Water Quality

The water quality of a stream is determined by several different sampling and monitoring methods. Water quality data is used to determine if the stream is meeting its designated uses. TMDLs are developed as a method to improve water quality by focusing on types and causes of specific pollutants. Grab samples were collected as part of the National Pollutant Discharge Elimination System (NPDES) permit requirements in 2009 for Chattanooga Creek. There is no more recently collected data recorded. An automated sampler is located just outside of the watershed border in Dobbs Branch. The data collected in Dobbs Branch would represent the quality of the water entering into Chattanooga Creek but not of the Creek itself.

1. Chattanooga Creek Designated Uses

Every body of water in the United States has a designated use. If it is determined that a stream is not meeting its designated use, it is placed on the 303(d) list for impaired waters. Section 305(b) of the Clean Water Act requires all states to submit a report for EPA approval every two years regarding the health of all its bodies of water.[i] Chattanooga Creek's designated uses are for fish and aquatic life, industrial water supply, irrigation, livestock watering and wildlife, and recreation. However, Chattanooga Creek, and all of its tributaries, are listed on the 303(d) list for impaired waters.[ii]

Table 8 Designated Uses for Chattanooga Creek and its tributaries

Stream	Description	Use Classifications
Lookout Creek	Mile 0.0 to GA/TN state line	*Fish and aquatic life, Industrial Water Supply, Recreation, Livestock Watering, Irrigation*
Black Creek	Mile 0.0 to origin	*Fish and aquatic life, Recreation, Livestock Watering, Irrigation*
Chattanooga Creek	Mile 0.0 to GA/TN state line	*Fish and aquatic life, Industrial Water Supply, Recreation, Livestock Watering, Irrigation*
Citico Creek	Mile 0.0 to origin	*Fish and aquatic life, Recreation, Livestock Watering, Irrigation*
South Chickamauga Creek	Mile 0.0 to GA/TN state line	*Fish and aquatic life, Industrial Water Supply, Recreation, Livestock Watering, Irrigation*
Friar Branch	Mile 0.0 to origin	*Fish and aquatic life, Recreation, Livestock Watering, Irrigation*
Mackey Branch	Mile 0.0 to origin	*Fish and aquatic life, Recreation, Livestock Watering, Irrigation*
North Chickamauga Creek	Mile 0.0 to 13.2	*Fish and aquatic life, Recreation, Livestock Watering, Irrigation*
Wolftever Creek	Mile 0.0 to origin	*Fish and aquatic life, Recreation, Livestock Watering, Irrigation*

Table 9 Impacted waters from report to EPA, 303(d) list Year 2010

Waterbody ID	Impacted Waterbody	Miles	Cause	Impacted Use	TMDL Priority	TMDL Status	Pollutant Source
TN60200011244-0200	Unnamed Trib to Chatt Crk	1.4	*E. coli* Other Anthropogenic Habitat Alterations	Recreation -- Fish and Aquatic Life	NA -- NA	Completed -- Completed	Combined Sewer Overflows -- Municipal High Density Area
TN60200011244-0300	McFarland Springs Branch	1.2	Unknown Toxicity *E. coli*	Fish and Aquatic Life Recreation	L NA	Needed Completed	Source in Other State Source in Other State
TN60200011244-0400	Gillespie Springs Branch	1.9	*E. coli* Other Anthropogenic Habitat Alterations	Recreation -- Fish and Aquatic Life	M -- NA	Needed -- Completed	Discharges from MS4 area -- Municipal High Density Area
TN60200011244-1000	Chattanooga Creek	8.4	PCBs Dioxins Low Dissolved Oxygen *E. coli* Other Anthropogenic Habitat Alterations Oil and Grease	Recreation Recreation Fish and Aquatic Life Recreation -- Fish and Aquatic Life Fish and Aquatic Life	NA NA L NA -- NA L	Needed Needed Needed Completed -- Completed Needed	Contaminated Sediment Contaminated Sediment Combined Sewer Overflows Combined Sewer Overflows -- Municipal High Density Area Discharges from MS4 area Spills
TN60200011244-2000	Chattanooga Creek	3.5	*E. coli*	Recreation	NA	Completed	Source in Other State

http://www.tn.gov/environment/wpc/publications/pdf/2010_303d_final.pdf

TMDL Priorities

Medium (M): Tools are available to produce the TMDL, but the stream is not in a watershed being studied in the next two years. TMDL will be produced in the next five years

Low (L): Tools are not currently available to produce the TMDL and the stream is not in the watershed being studied in the next two years. TMDL will be produced in the next twelve years

Not Applicable (NA): 4a-A TMDL has already been completed, submitted to EPA, and approved by EPA
4b-A TMDL is not needed because a different type of control strategy is in place which will bring about compliance with the criterion in a reasonable amount of time
4c-The impact to the stream is not being caused by a pollutant

2. Combined Sewer Overflow Outfalls

During periods of heavy rain, the lines in downtown Chattanooga's combined sewer system reach capacity and cannot carry the entire volume of stormwater and sewage to Moccasin Bend for treatment. In cases of heavy rain the system is designed to overflow into storage basins. CSO storage basins are also designed to overflow once they reach capacity and are released to the Tennessee River and its tributaries. The wastewater released at these outfalls is primarily treated, meaning the large solids are filtered out and the smaller solids are allowed to settle to the bottom. The Central Avenue and Williams Street outfalls both empty directly to Chattanooga Creek, contributing to the already high levels of *E. coli* and low dissolved oxygen levels. Total, there are eight CSO treatment facilities within the Chattanooga city limits.

- ***Central Avenue (outfall to Chattanooga Creek)***
- ***Williams Street (outfall to Chattanooga Creek)***
- Carter Street
- 19th Street
- Martin Luther King
- Ross Landing
- Tremont Street
- Citico Avenue

Figure 13 Central Avenue and Williams Stream CSO Treatment Facilities

3. Water Quality Sampling

In Chattanooga Creek, thirteen sample locations were defined to test for temperature, pH, conductivity, dissolved oxygen (DO), *E. coli*, and total suspended solids (TSS). Data was collected on 5 days during a 21 day period from October 6 - October 26 2009. All data was collected from base flow conditions. The sampling location, Chatt-12, has no recorded data because it was dry on each of the 5 sampling days. The data in Table 10 represents the averages from the 5 days, except for *E. coli*, where the data is represented as the geometric mean. There is no recorded data beyond 2009.

Table 10 Sampling Data

Sample Locations	Address	Temp	pH	Conductivity	DO	*E. coli*	TSS
		Celsius	--	µmhos/cm	mg/L	col/100 ml	mg/L
Chatt-01	Calhoun & 42nd	17.8	7.26	426	9.7	1163	2.4
Chatt-02	4011 12th Ave.	18.0	7.73	383	9.3	557	3.5
Chatt-03	10th Ave between 44th and 45th	17.9	7.71	486	8.9	493	5.2
Chatt-04	46th & 49th	17.9	7.79	491	9.4	360	3.2
Chatt-05	E 46th St. @ Walthall Ave	19.0	7.56	517	7.7	425	3.0
Chatt-06	E 47th St. @ Walthall Ave	19.3	7.12	486	8.1	1085	10.4
Chatt-07	Chattanooga Creek @ Hooker Rd	17.9	6.76	545	6.2	3892	4.6
Chatt-08	Wilson Rd. Bridge	14.1	6.05	297	7.3	452	10.2
Chatt-09	Ohls & W. 42nd St.	17.2	6.79	483	8.0	345	26.0
Chatt-10	5508 Tennessee Ave.	16.6	7.08	302	8.9	500	4.5
Chatt-11	St. Elmo Ave. @ Virginia Ave.	17.0	7.45	247	8.7	97	10.7
Chatt-12	4008 St. Elmo Ave. **DRY**	na	na	na	na	na	na
Chatt-13	Chattanooga Creek & Broad St.	15.4	7.23	245	5.8	995	9.8

TDEC has defined water quality standards depending on the waterbody's designated use. Allowable limits are defined for each of the uses.[xv]

a) Temperature

According to TDEC, the maximum allowable temperature for all designated uses is 30.5°C. The average temperature for all sample locations meets this criterion. Additionally, each individual sample collected throughout the 5 day period is below the maximum temperature.

b) pH

For all designated uses, the acceptable pH range for streams is 6.0-9.0. All samples collected were within this range.

c) Conductivity

The EPA states that all rivers in the US generally have a conductivity between 50-1500 µmhos/cm. Industrial waters can be as high as 10,000 µmhos/cm. The conductivity range for Chattanooga Creek is 160-630 µmhos/cm, with the average ranging from 245-545 µmhos/cm.

d) Dissolved Oxygen

For the designated use of fish and aquatic life, the dissolved oxygen levels should not be below 5.0 mg/L. For all other uses, TDEC states, dissolved oxygen should be "present at levels great enough to prevent odors of decomposition." All samples collected within Chattanooga Creek were greater than 5.0 mg/L. Dissolved oxygen levels also correlate to water temperatures; as temperatures rise, dissolved oxygen decreases. EPA's Water Quality Assessment Report lists oxygen depletion or low levels of dissolved oxygen as a cause of impairment for 2010 reporting year for the section of Chattanooga Creek from the Tennessee River to Hooker Road.

e) E. coli

For impaired waterbodies, the maximum geometric mean for an *E. coli* group is 126 col/100 ml and for an individual sample the maximum is 941 col/100 ml. The geometric mean for all groups, with the exception of sample location Chatt-11, are above the limit (Table 10, above). Table 11, on the following page, shows the individual *E. coli* sample results. The values in red indicate samples above the maximum of 941 col/100 ml. October 13, 2009, sample location #7 recorded an *E. coli* level of 99,300 col/100ml. There was no recorded SSO or CSO event that occurred in the area around this date.

f) Total Suspended Solids

There is no quantitative limit for total suspended solids. The water quality criteria states there shall be no visible solids and no TSS in amounts that will affect fish and aquatic life.

Table 11 E. coli levels for each of the sample locations

Individual E. coli Samples (col/100 ml)					
	10/6/2009	10/8/2009	10/13/2009	10/19/2009	10/26/2009
Chatt-01	2,020	1,360	875	540	1,640
Chatt-02	1,660	675	375	490	260
Chatt-03	965	730	775	205	260
Chatt-04	740	725	1,120	100	100
Chatt-05	545	1,400	425	100	430
Chatt-06	2,860	1,980	730	370	985
Chatt-07	1,240	1,230	99,300	1,060	5,560
Chatt-08	670	1,310	925	155	150
Chatt-09	730	740	100	50	1,820
Chatt-10	1,000	1,100	1,320	50	430
Chatt-11	1	260	100	425	790
Chatt-13	1,310	2,130	1,160	805	375

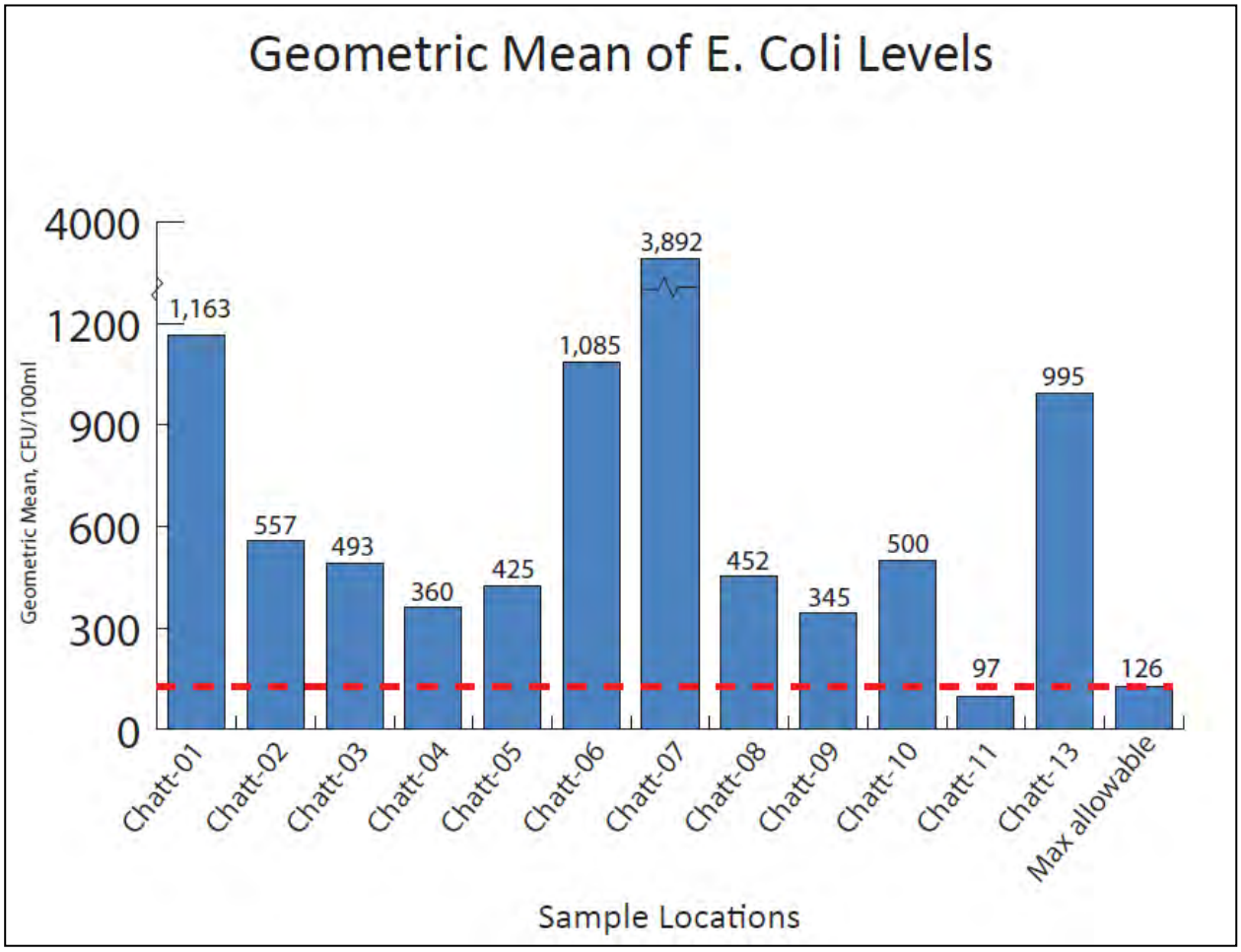

Figure 14 Geometric mean of E.coli samples

C. Basin Illicit Discharge Potential Score (IDP)

A rating system was developed to determine the Illicit Discharge Potential (IDP) for each sub-basin. The criteria for determining this score included the number of illicit discharges that occurred in a 2.5 year period between January 2010-July 2012, age of sanitary infrastructure, percent of impervious cover, and number of sanitary sewer overflows between January 2010 and July 2012. Table 12 below shows the criteria for determining the IDP score, 1-3, for each category. Table 13 shows the IDP score for each sub-basin. The rows highlighted in red indicated the 11 basins with IDP scores of 1.75 and greater.

Table 12 IDP ranking criteria

Criteria for Determining Score	1	2	3
Number of Illicit Discharges	1-3	4-6	>6
Age of Infrastructure	<25	25-50	>50
Percent Impervious	0<x<10%	10-25%	>25%
Number of SSOs	1-3	4-6	>6

Table 13 IDP scores for each sub-basin

Sub-Basin	Area, Acres	Illicit Discharge Rating	Age of Infrastructure Rating	Percent Impervious Rating	SSO Rating	Raw IDP Score	IDP score	Range
C01-01	101		none	1		1	0.25	0 to 1
C01-02	19		3	3		6	1.5	1 to 2
C01-05	2		none	1		1	0.25	0 to 1
C01-06	2		3	2		5	1.25	1 to 2
C01-08	28		none	2		2	0.5	0 to 1
C01-09	3		3	3		6	1.5	1 to 2
C01-12	35	1	3	3		7	1.75	1 to 2
C01-13	4		3	2		5	1.25	1 to 2
C01-14	3		na	3		3	0.75	0 to 1
C01-16	41	1	2	3		6	1.5	1 to 2
C01-17	24	1	3	3		7	1.75	1 to 2
C01-21	43		2	3		5	1.25	1 to 2
C01-24	22	1	2	2		5	1.25	1 to 2
C01-26	42	1	3	3		7	1.75	1 to 2
C01-28	204		1	2		3	0.75	0 to 1
C01-29	3		2	3		5	1.25	1 to 2
C01-30	168		2	3		5	1.25	1 to 2
C01-33	113		3	2		5	1.25	1 to 2
C01-35	54		3	2	1	6	1.5	1 to 2
C01-38	45		3	3		6	1.5	1 to 2
C01-39	21		3	1		4	1	1 to 2
C01-40	1					0	0	0
C01-41	204		3	3		6	1.5	1 to 2
C0104-01	240	1	3	1	1	6	1.5	1 to 2
C0104-02	313	2	3	2	1	8	2	2 to 3
C0104-03	55	2	3	2		7	1.75	1 to 2
C0104-04	56	1	3	3		7	1.75	1 to 2
C0104-05	3		3	2		5	1.25	1 to 2
C0104-07	4		3	2		5	1.25	1 to 2
C0104-10	20		3	2		5	1.25	1 to 2
C0104-13	4		3	2		5	1.25	1 to 2
C0103-02	11		2	3		5	1.25	1 to 2
C01-42	4			2		2	0.5	0 to 1
C01-44	76		2	1		3	0.75	0 to 1
C01-45	148		2	1		3	0.75	0 to 1
C01-47	3		2			2	0.5	0 to 1
C01-48	99		3	1		4	1	1 to 2
C0107-01	12		3	1		4	1	1 to 2
C0101-01	8			3		3	0.75	0 to 1

Table 13, continued. IDP scores for each sub-basin

Sub-Basin	Area, Acres	Illicit Discharge Rating	Age of Infrastructure Rating	Percent Impervious Rating	SSO Rating	Raw IDP Score	IDP score	Range
C0101-06.02	175		3	2	1	6	1.5	1 to 2
C0101-06.01	457	2	3	1	2	8	2	2 to 3
C0101-18	7	1	2	3		6	1.5	1 to 2
C0101-22	7			3		3	0.75	0 to 1
C0101-25	9		1	3		4	1	1 to 2
C0101-02	1			3		3	0.75	0 to 1
C0101-28	3			3		3	0.75	0 to 1
C0101-32	106	1	3	2		6	1.5	1 to 2
C0101-08.01	6			3		3	0.75	0 to 1
C0101-08.02	3			3		3	0.75	0 to 1
C0103-01	303	1	3	2	2	8	2	2 to 3
C01-43	107		2	2		4	1	1 to 2
DA 1	28		3	3		6	1.5	1 to 2
DA 2	94		3	3	1	7	1.75	1 to 2
DA 3	202		3	1		4	1	1 to 2
DA 4	131	1	3	3	1	8	2	2 to 3
DA 5	1107	2	3	1	1	7	1.75	1 to 2
DA 6	192	2	3	1		6	1.5	1 to 2
DA 7	651		2	1		3	0.75	0 to 1
DA 8	131	1	3	1	1	6	1.5	1 to 2
DA 9	156		2	2	1	5	1.25	1 to 2
DA 10	73		3	1		4	1	1 to 2
DA 11	115		3	1		4	1	1 to 2
DA 12	194		3	1		4	1	1 to 2
DA 13	93		3	2		5	1.25	1 to 2
DA 14	29			3		3	0.75	0 to 1

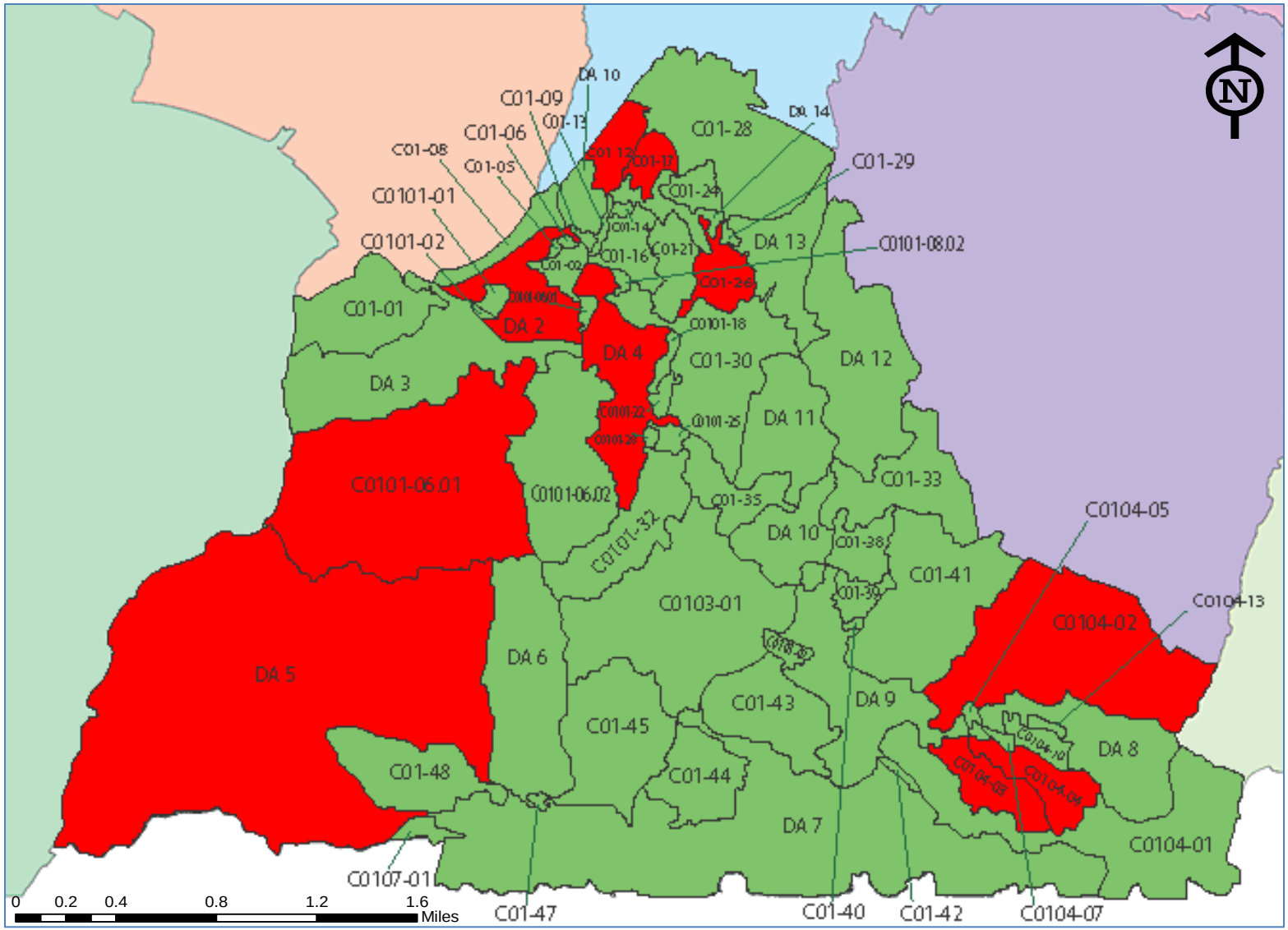

Figure 15 Sub-basins with highest IDP scores shown in red

1. Illicit Discharge Complaints

Illicit discharges between January 2010 and July 2012 were considered for determining the IDP score. The rows highlighted in red in Table 14 show the sub-basins with the greatest illicit discharge complaints *per acre*. The three sub-basins with the greatest discharge complaints per acre are C0101-18, C0104-03, and C01-24, respectively. Whereas, the five sub-basins with the greatest *total* number of discharge complaints are C0104-02, C0104-03, C0101-06.01, DA 5, and DA 6. .

Table 14 Illicit discharge complaints by sub-basin

Sub-Basin	Area, Acres	Number of Illicit Discharge Complaints	Illicit Discharges per Acre
C01-12	35	1	0.029
C01-16	41	1	0.024
C01-17	24	1	0.041
C01-24	22	1	0.045
C01-26	42	1	0.024
C0104-01	240	2	0.008
C0104-02	313	4	0.013
C0104-03	55	4	0.072
C0104-04	56	2	0.036
C0101-06.01	457	4	0.009
C0101-18	7	1	0.134
C0101-32	106	3	0.028
C0103-01	303	1	0.003
DA 4	131	1	0.008
DA 5	1107	4	0.004
DA 6	192	4	0.021
DA 8	131	1	0.008

2. Age of Infrastructure

The majority of sewer lines within the Chattanooga Creek Watershed were installed from 1927-1930, with the oldest dating back to 1889. The material used during this time was clay. In the late 19th century and early 20th century, infiltration and inflow were considered a crucial process in sewer lines, as it "flushed" the sewer system.[xvi] Today, infiltration and inflow (I & I) is

harmful because it leaks contaminated water from the sewer lines into the ground. Additionally, I & I adds rainwater to the sewer line, creating a larger volume of wastewater to be treated at the treatment plant and often causing sanitary sewer overflows when the lines become too overwhelmed. Table 15 shows each sub-basin and the age of the oldest infrastructure identified for the area.

Table 15 Age of stormwater infrastructure by sub-basin

Sub-Basin	Age of Infrastructure
C01-01	none
C01-02	1935
C01-05	none
C01-06	1930
C01-08	none
C01-09	1930
C01-12	1890
C01-13	1930
C01-14	NA
C01-16	1940
C01-17	1910
C01-21	1955
C01-24	1985
C01-26	1929
C01-28	1889
C01-29	1966
C01-30	1971
C01-33	1928
C01-35	1929
C01-38	1928
C01-39	1926
C01-40	none
C01-41	1927
C0104-01	1928
C0104-02	1928
C0104-03	1929
C0104-04	1928
C0104-05	1927
C0104-07	1927
C0104-10	1933
C0104-13	1928
C0103-02	1952
C01-42	none

Sub-Basin	Age of Infrastructure
C01-44	1952
C01-45	1948
C01-47	1983
C01-48	1929
C0107-01	1929
C0101-01	none
C0101-06.02	1929
C0101-06.01	1929
C0101-18	1966
C0101-22	none
C0101-25	2007
C0101-02	none
C0101-28	none
C0101-32	1929
C0101-08.01	NA
C0101-08.02	none
C0103-01	1929
C01-43	1952
DA 1	1910
DA 2	1930
DA 3	1929
DA 4	1929
DA 5	1929
DA 6	1929
DA 7	1952
DA 8	1928
DA 9	1952
DA 10	1929
DA 11	1929
DA 12	1927
DA 13	1929
DA 14	NA

3. Percent Impervious Cover

The amount of impervious cover contributes to the amount of runoff produced for a given area. Any surface that does not allow infiltration is considered impervious, such as buildings, parking lots, sidewalks, and roadways. As imperviousness increases, infiltration decreases. Large amounts of surface runoff can result in increased pollutant loads and a higher risk of flooding. Stream bank erosion and habitat alteration are characteristic indicators of watersheds containing a large amount of impervious cover.

The Impervious Cover Model (ICM) relates the percentage of impervious cover to the water quality of a stream. Depending on the percent of imperviousness, a stream will be classified as sensitive, impacted, non-supporting, or urban drainage. The model can aid in making predictions regarding the future quality of a stream based on its current imperviousness. There has been controversy of the accuracy of the ICM; however, a study in 2008 showed that 72% of the streams analyzed either confirmed or reinforced the ICM.[xvii] Figure 12 on the following page overlays each sub-basin's impervious cover with the Impervious Cover Model to identify predicted stream quality.

4. Number of Sanitary Sewer Overflows (SSOs)

Sanitary sewer overflows were analyzed from January 2010-July 2012 to determine the IDP score. A total of 21 recorded overflows occurred during this period, releasing over 125,310 gallons of wastewater (several incidents did not have a release volume recorded) into Chattanooga Creek and its tributaries. The primary cause of overflow was due to heavy rainfall events and secondary causes due to blockage. SSOs contribute to elevated levels of fecal coliform.

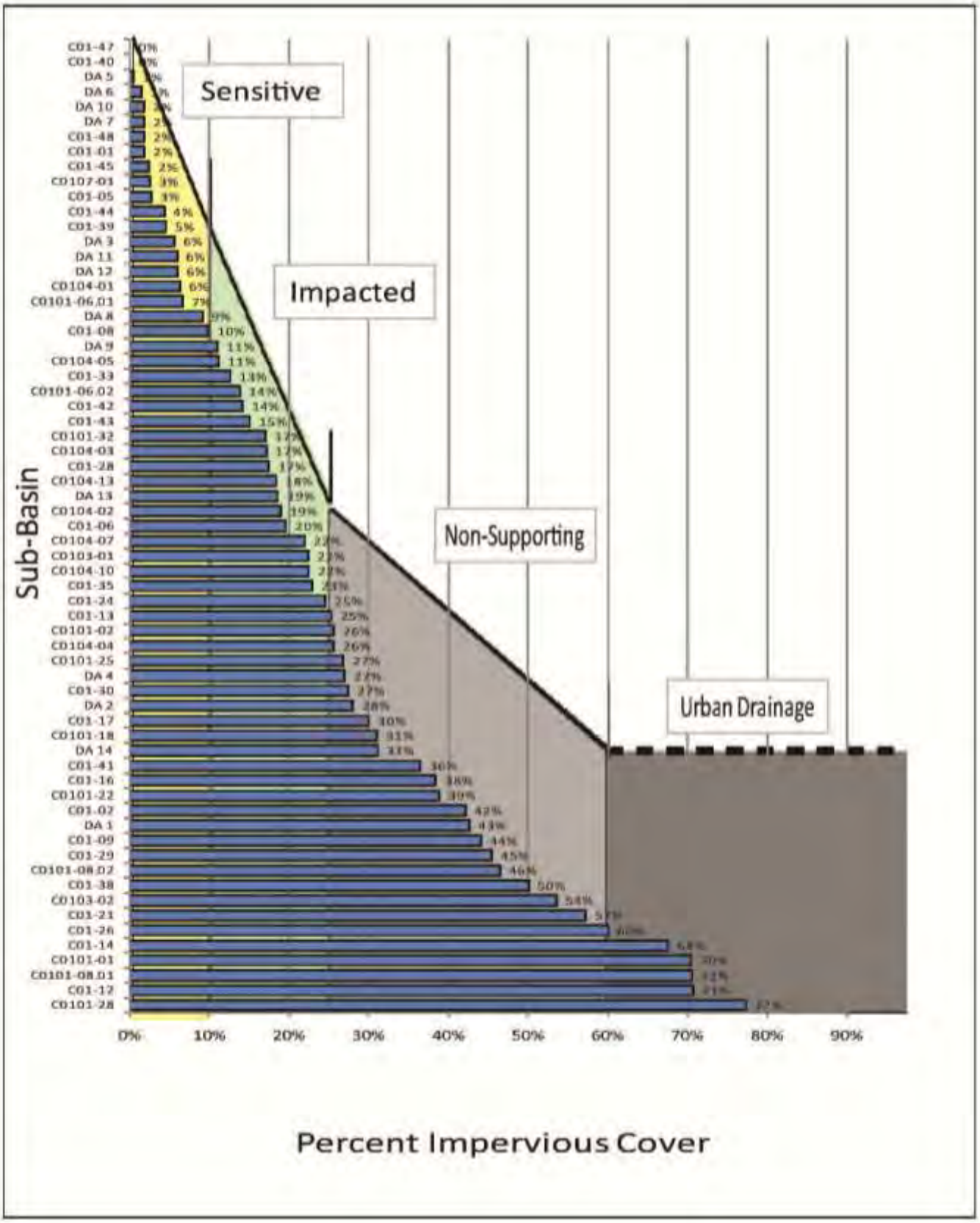

Figure 16 Impervious cover and Impervious Cover Model

VI. Mitigation Activities

A. Chattanooga Creek Superfund Cleanup

In 1995, as a result of years of toxic waste dumping from nearby industrial facilities, a 2.5 mile section of Chattanooga Creek was named a Superfund site and placed on the National Priorities List (NPL). The companies held responsible for the cleanup included the United States Department of Defense (operated Tennessee Products facility during World War II), Mead Corp (owner of former Tennessee Products site), Reilly Tar, and Southern Wood Piedmont.[xviii] Cleanup began in 1997, which included the removal of 25,000 cubic yards of coal tar, 1,150 cubic yards of pesticide contaminated sediment, and 108,000 tons of stabilized sediment. An AquaBlok clay liner was placed along 5,570 linear feet of the stream bed to prevent further contamination. Much more pollution was discovered throughout the cleanup process than originally expected. It took over ten years and cost over $30 million to complete.[xix]

Figure 17 Creosote like material that was found seeping back into stream bed during Superfund Cleanup

B. Consent Decree

In July of 2012, the City of Chattanooga was issued a consent decree requiring the payment of civil penalties and improvements to its sewer system. The settlement will also require the City to develop a Long-Term Control Plan to better manage the CSO discharges at the William Street CSO outfall and the Central Avenue CSO outfall, both of which discharge directly to Chattanooga Creek. Because Chattanooga Creek is already listed as impaired for *E. coli* and low dissolved oxygen, it is extremely important to manage the discharges in efforts to reduce the level of pollutants.

C. Monitoring Program

The City is mandated, through its NPDES MS4 permit, to conduct a variety of monitoring activities, including both analytical and non-analytical assessments. Analytical monitoring consists of homogenous land use and industrial wet-weather sampling, TMDL sampling, "in stream" ambient monitoring and macroinvertebrate sampling. Non-analytical monitoring consists of field screening and stream inspections.

The City utilizes a grid system to identify field screening locations. There are 57 field screening points within the Chattanooga Creek Watershed. Field screening activities include inspection of the site twice, no less than four hours between inspection times, with documentation of physical characteristics associated with the site. Stream inspections are conducted through the Stream Corridor Evaluation (SCORE) program. Chattanooga Creek is listed for siltation and habitat alteration. Key observations from the SCORE program include channel alteration, barriers and blockages, erosion, canopy cover, pipes and outfalls, stream buffers and illicit discharges.

Additional sampling will be conducted in the Chattanooga Creek Watershed and the sampling plan is included in the appendix. *E. coli* and TSS samples will be collected to locate pollutant sources and guide Water Quality Staff toward pollutant reduction strategies.

VII. Stormwater Pollutant Reduction Strategies

A. Pollution Prevention

In an effort to reduce the pollutant loading from stormwater runoff, gross pollutant traps should be installed on at least 50% of all outfalls, starting in the eleven sub-basins with high IDP scores. These traps capture trash and litter that is washed into the stormwater drains, preventing the trash from entering the waterways. Regular maintenance is required in order to remove the traps when they reach capacity.

Figure 18 Storm Water System's Stormx Gross Pollutant Trap

Bandalong Litter Traps are another effective way at removing trash from a stream. The City of Chattanooga has expressed interest in purchasing a litter trap for Chattanooga Creek. The traps are designed to float on the water, capturing litter without blocking flow. They operate continuously without any mechanical assistance. The Litter Trap is ideal for Chattanooga Creek because it only requires 8-10 inches of water for floatation and a stream width of 6 feet. *Storm Water System*'s website states they are an "ideal in-stream solution for floatables where combined sewer overflows are concerned." The Bandalong Litter Trap is capable of removing 20,000 pounds of trash each year.[xx]

Figure 19 Storm Water System's Bandalong Litter Trap

Additionally, efforts will continue to be made towards keeping the creek clean of tires. Dumping tires has been a reoccurring problem in the area and several community cleanup projects have been organized to remove the tires. In order to eliminate tire dumping, cameras will be installed and regular monitoring of the area will be performed.

Figure 20 Tires found in Chattanooga Creek

B. Low Impact Development and Green Infrastructure

All future projects should utilize Low Impact Development (LID) practices and green infrastructure devices for stormwater control and pollution reduction. Rain gardens, pervious pavements, green roofs, and runoff capture and reuse are just a few examples of green infrastructure devices that can be used to reduce runoff. As more green infrastructure devices are installed that manage stormwater on-site, less stormwater will runoff carrying pollutants and less stormwater will enter the sewer system through combined sewer systems or by I & I. Many green infrastructure devices aid in the filtration of stormwater runoff, removing some of the pollutants before they enter the waterways. By reducing the amount of I & I, the result will be fewer number of SSOs and CSOs, thus less *E. coli* contamination. Information regarding LID practices and green infrastructure can be found in the City of Chattanooga's *Resource Rain Manual* - a rainwater management guide.

Figure 21 Examples of Green infrastructure, planter box on the left and green roof on the right.

C. Stream Restoration Projects

Just over half of Chattanooga Creek remains a natural channel. The goal of the Stream Restoration Project should be to replace as much of the "unnatural" channel segments with rock weirs and natural seeding and plantings in order to mimic a natural stream bank. Stream restoration will aid in protecting the stream bank from erosion by slowing the flow velocity with rock weirs and stabilizing the bank with natural plants. Upon the completion of the stream restoration, annual inspections should be conducted, and proper budgeting allocated for maintenance.

D. Pathogen Reduction

The development of a monitoring program is crucial in identifying the causes and sources of fecal contamination. The main goal will be to identify and eliminate possible sources of illicit discharges from private residential lateral service lines. Illicit discharge complaints are received through the City's 311 call service. Upon receiving a complaint, the Water Quality Program has three days to inspect the complaint. If an illicit discharge is confirmed, a Notice of Violation will be issued and the owner will have seven days to come into compliance. Chattanooga City Code 31-4 states it is the responsibility of the property owner, or user of the sewer, to repair and maintain sanitary sewer service lines. If compliance is not met, the owner will be issued to court. If the court order is still not met, the property will be turned into Neighborhood Services to be condemned.

Target neighborhoods will be defined based on the IDP score developed as part of this report. Samples from the major outfalls in these targeted neighborhoods will be collected and analyzed for the presence and concentration of *E. coli*. In order to come into compliance with the City's NPDES permit, the *E. coli* levels in Chattanooga Creek must be reduced by at least 64.7% and by 93.4% in the unnamed tributaries.

E. Education and Community Outreach

In order to truly see successful environmental outcomes, the approach must be holistic. The members of the community must be fully committed to the project. Members of the Chattanooga Creek Watershed community have expressed environmental concern for years. However, all members should be aware of the problems within the watershed and should be educated on why they should care, especially the younger age group. A community audit will be performed to evaluate the resident's watershed awareness in order to develop a strategic plan. From the results, a community education campaign will be launched, involving planning meetings with key neighborhood associations, business owners, and political leaders.

Simultaneously, a media campaign will be launched. Signs identifying the watershed boundaries will be placed so citizens will know when they are entering or exiting a particular watershed. Public service announcements will be used when available and all media outlets will be notified of any upcoming watershed event.

Public-private partnerships are a crucial aspect in leveraging funding for the completion of projects. When opportunities are available that will benefit both private corporations and public communities, the potential for project funding that was not previously available is now possible. Potential opportunities exist with Erlanger, as they have plans of moving a campus to Alton Park; many of the industries, including ADM Southern Cellulose, Bunge Oils, and ACME

Industrial Piping; and utility corporations such as Tennessee Valley Authority, American Water Company, and EPB.

A comprehensive plan will be developed to present at neighborhood association meetings, church meetings, and public hearings. The heads of the following organizations will be contacted in order to initiate discussions:

Neighborhood Association Groups

South Broad Redevelopment Group
Community Association of Historic St. Elmo
Alton Park/Piney Woods Neighborhood Association
Clifton Hills Improvement Committee
East Lake Neighborhood Association
Cedar Hill Improvement League
Villages of Alton Park Homeowners Association

Schools

Howard School
Calvin Donaldson Elementary School
East Lake Elementary
East Lake Academy

Community Centers

Alton Park Community Health Center
South Chattanooga Recreation Center
Bethlehem Center

Faith Communities and Churches

Calvary Chapel Chattanooga
New Covenant Church
Alton Park Church of Christ
First Bible Methodist
New Horizon Baptist Church
Cumberland Presbyterian Church
Carpenter's Cowboy Church

A timeline should be developed to complete the following tasks:

- Develop questionnaire for community audit
- Host meetings with key stakeholders
- Develop public-private partnerships
- Post watershed signs in community
- Distribute community audit
- Formulate an effective outreach strategy
- Enrich partnerships with schools and faith based community
- Finalize curriculum
- Implement community projects such as "adopt a stream" and other cleanup projects
- Initiate mass media campaign
- Evaluate community audit
- Finalize curriculum for school program
- Enhance partnerships with the education community
- Finalize strategic plan based on results of community audit

It is important to address the citizen's concerns for their community in order for the projects to be fully accepted and successful. Citizens should be involved in decisions from day one of the planning process. The City's priority may not be the same as the community's priority; therefore, everyone must be on the same page in deciding what projects and sub-basins are of most importance. Additionally, education regarding watershed characteristics and water quality will be a big factor in this success.

VIII. Regulatory Status

Currently, all streams within the Chattanooga Creek Watershed are listed on the 303(d) list. Seven out of the thirteen causes of impairment have listed TMDLs; however, six are still needed. In order to remove the creek and its tributaries from the list of impaired waters, TMDLs must be developed for all causes of impairment and percent reductions must be met. Through the development of TMDLs, the implementation of monitoring programs and mitigation activities, it is possible for the waters of the Chattanooga Creek Watershed to eventually meet all of its designated uses.

IX. Conclusion

The goal of a Watershed Plan is to promote watershed stewardship. A well-developed plan identifies the key issues within the watershed, develops strategies to address the issues, and implements a strategic plan.

There are a number of issues in Chattanooga Creek that must eventually be addressed. Three priority issues have been identified as the following:

1. Elevated levels of *E. coli* present in the Creek.
2. Habitat Alteration due to anthropogenic activities.
3. Industrial pollution

E. coli is one of the most widespread issues throughout the watershed. *E. coli* levels must be brought to acceptable limits in order to improve water quality. *E. coli* may be reduced through stringent monitoring and enforcement activities. Secondly, the combined sewer system must be to be brought into compliance with federal standards and CSO discharges must be reduced in order to alleviate the *E. coli* loading in Chattanooga Creek.

All future development and redevelopment projects should follow the guidelines set in the *Resource Rain Manual*. By incorporating LID practices and green infrastructure, stormwater runoff will be reduced, thus reducing flooding and the volume of water entering the stormwater system. Effective volume controls may reduce CSOs and SSOs, stream bank erosion will be reduced, and pollutions carried to the Creek by surface runoff will be reduced. Another positive aspect of LID and green infrastructure is the preservation and creation of green spaces, an aspect currently lacking within the Chattanooga Creek Watershed community.

Stream restoration projects will help to recreate natural stream corridors that were previously destroyed. By having more natural vegetation and less rock and mortar, the stream corridor will be brought back as close to their natural state as possible. This will be accomplished by

performing several projects throughout the stream corridor, with the ultimate goal of converting all unnatural channels back to their original state as best possible.

Industrial pollution has plagued the area for decades. Brownfield remediation efforts have been made to clean up many of these sites, as well as the Chattanooga Creek Superfund site cleanup. There have been discussions regarding the placement of parks and open spaces at several of these remediated brownfield sites. Cleanup efforts must continue in order to stop further contamination by the spreading of sediments from these sites.

The City of Chattanooga has performed monitoring and sampling according to the NPDES permit requirements. However, additional monitoring programs are still needed. According to the permit, Dobbs Branch is considered to be a part of the Chattanooga Creek Watershed; however, for the purpose of this plan it is considered its own watershed. Dobbs Branch has various monitoring programs, including an automated sampler. In order to get the most accurate information for Chattanooga Creek, similar programs will need to be implemented in areas along the Chattanooga Creek corridor. These programs will provide historical data on past pollutant levels of Chattanooga Creek. This data will help identify whether pollutants are coming from point or non-point sources. Monitoring programs will also determine the effectiveness of mitigation activities within the watershed.

Another crucial element in the success of the Watershed Plan is the involvement of the community. The community members must be well educated on why pollution is harmful, why environmental stewardship is important, and what they can do help. This will be done by developing an interactive education program, as well as, holding meetings with community stake-holders, neighborhood associations, and community action groups. Without the community's full commitment, the efforts outlined in this plan will not be successful. Improvement of the watershed also relies on effective collaboration between the community and government. In order for the two to work well together, both sides must work together to achieve the goals determined for the watershed.

The top three priority sub-basins have been determined based on IDP score, number of superfund sites and number of industrial sites. They are as follows:

1. C0103-01
   - 8 Superfund sites
   - Cumulative IDP score of 8
   - High industry
   - 303 acres

2. C01-41
   - 6 Superfund sites
   - Cumulative IDP score of 6
   - High industry
   - 204 acres

3. DA 9
   - 4 Superfund sites
   - Cumulative IDP score of 5
   - Extremely high levels of *E. coli* from samples
   - 156 acres

Watershed improvement efforts should begin in these sub-basins and expand to others as progress is made. As each of the watershed issues are addressed, the Chattanooga Creek Watershed will begin seeing water quality improvements. Ultimately, the Creek and its tributaries will meet *all* of its designated uses, as defined by the Tennessee Department of Environment and Conservation and the United States Environmental Protection Agency.

X. Appendix

Supplemental Map 1 Flood Zones: Floodway, 100-yr, 500-yr 59

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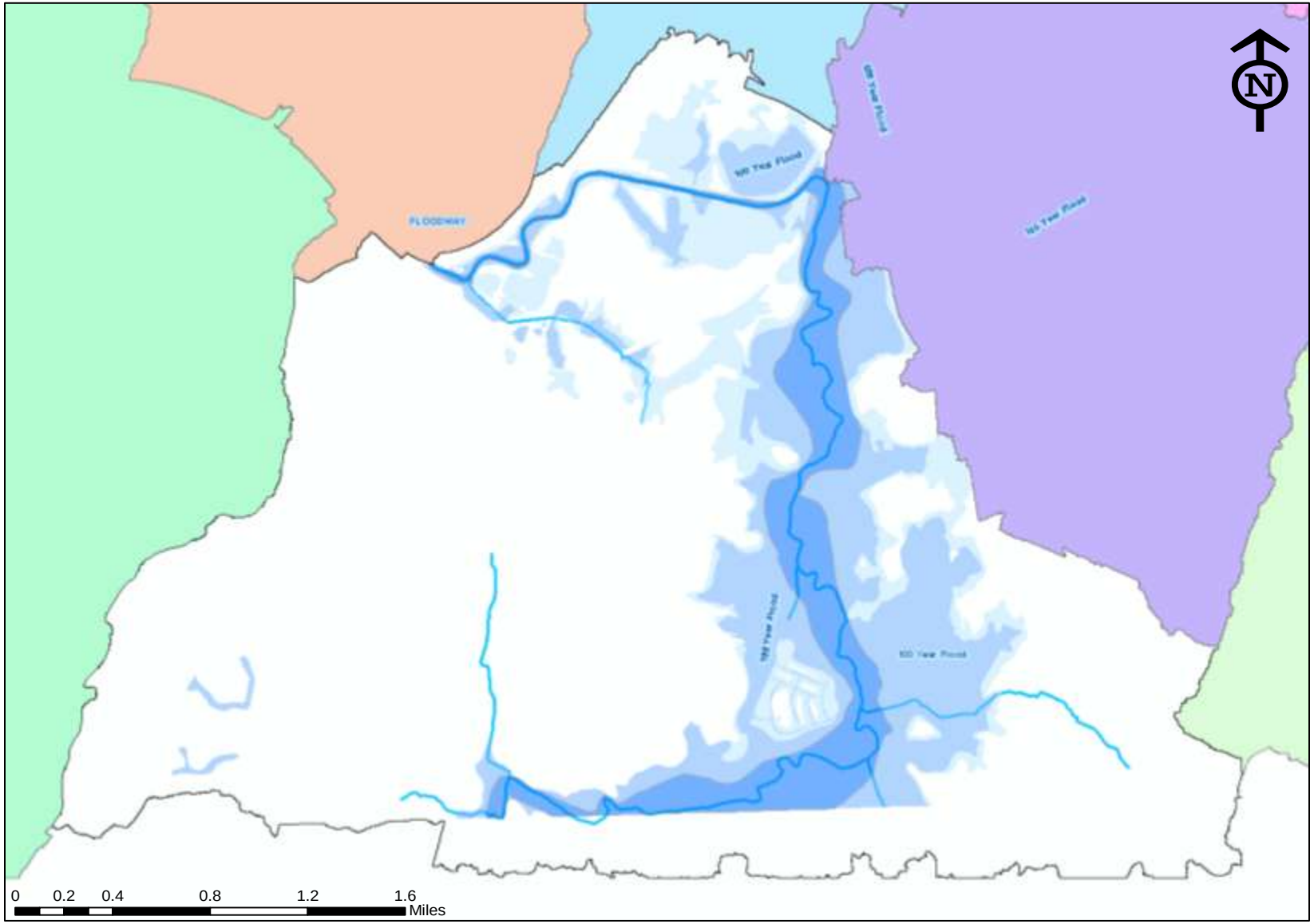
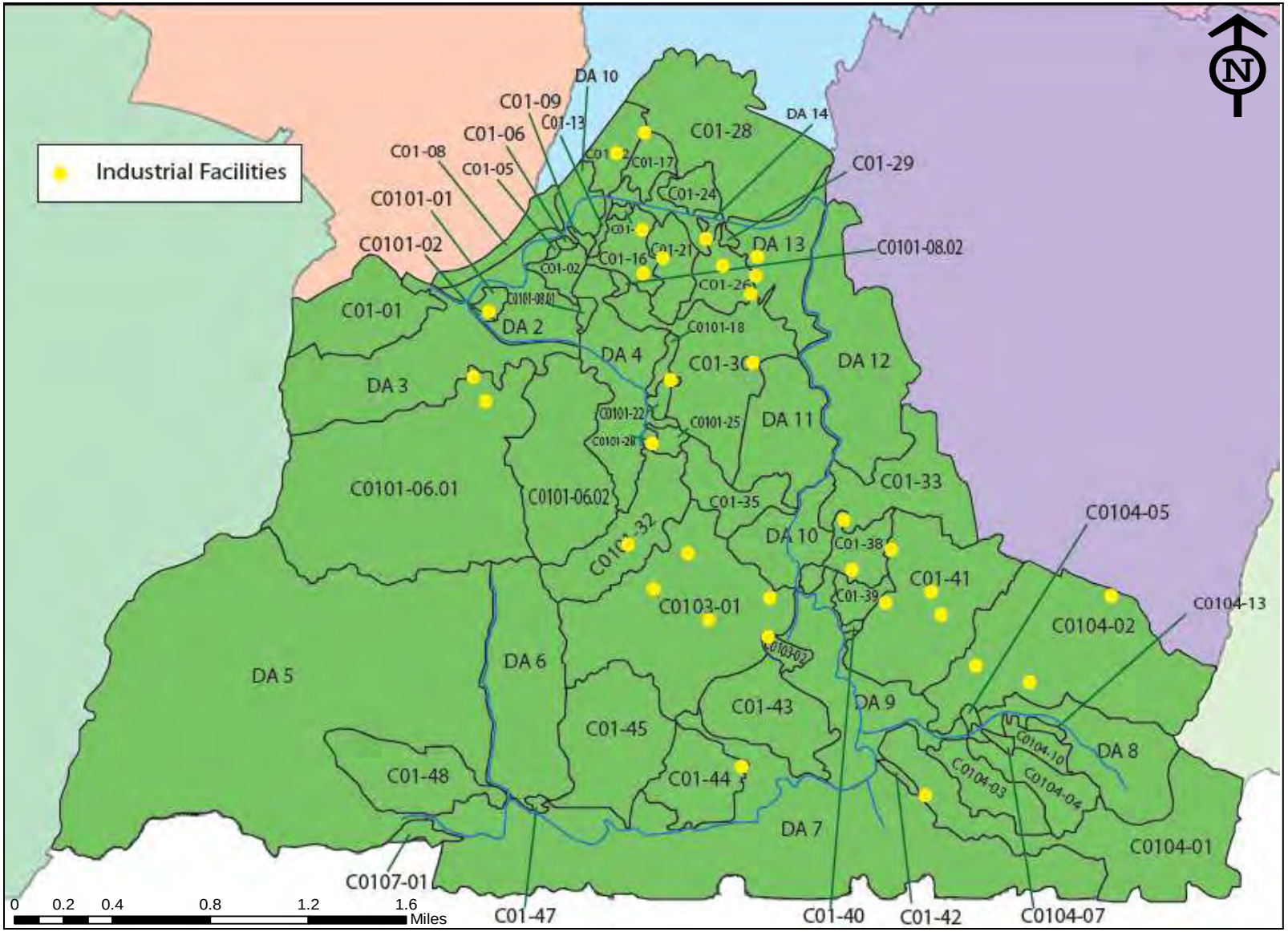
Flood Zones



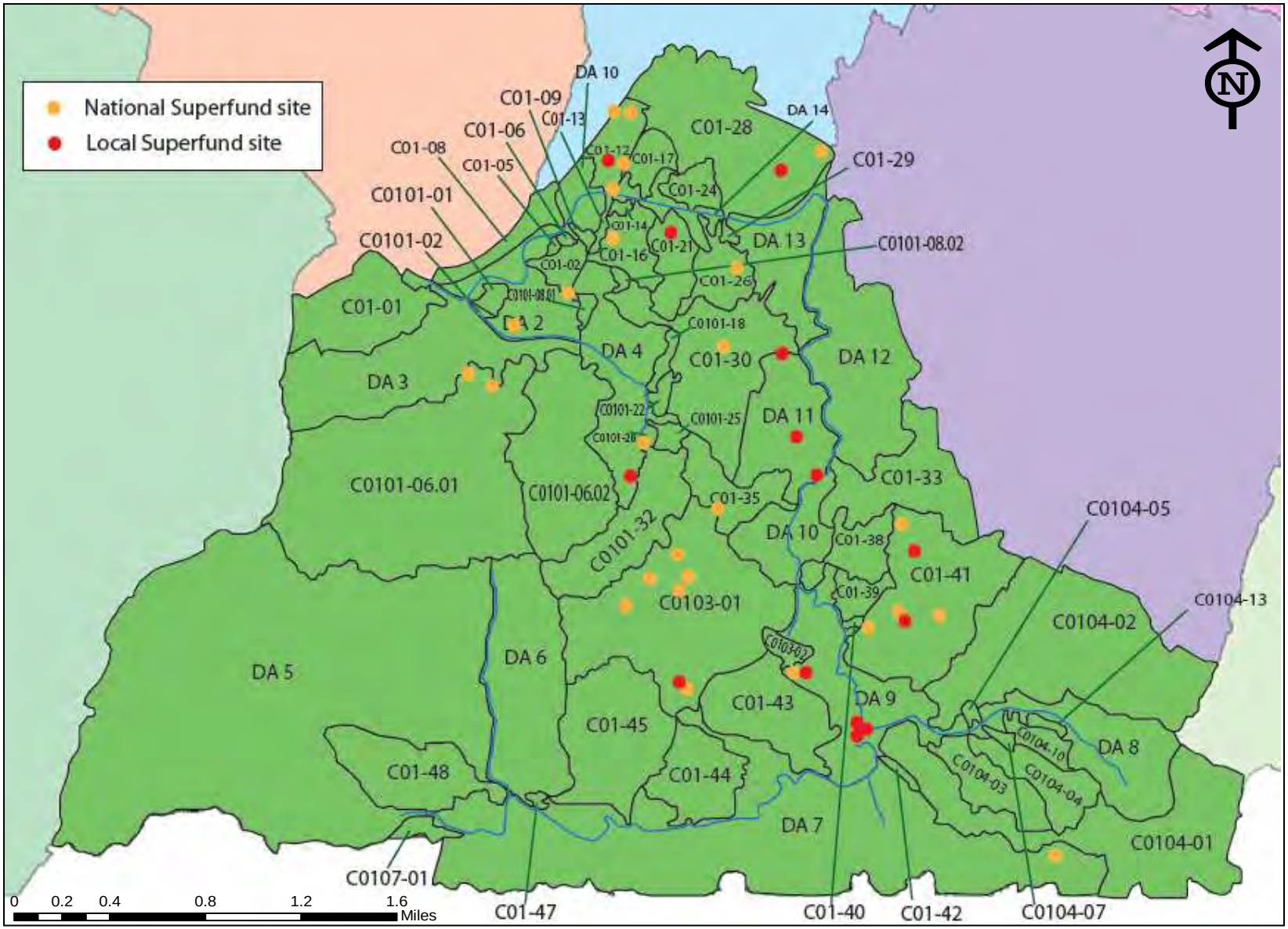
Supplemental Map 1 Flood Zones: Floodway, 100-yr, 500-yr

Locations of Industrial Facilities



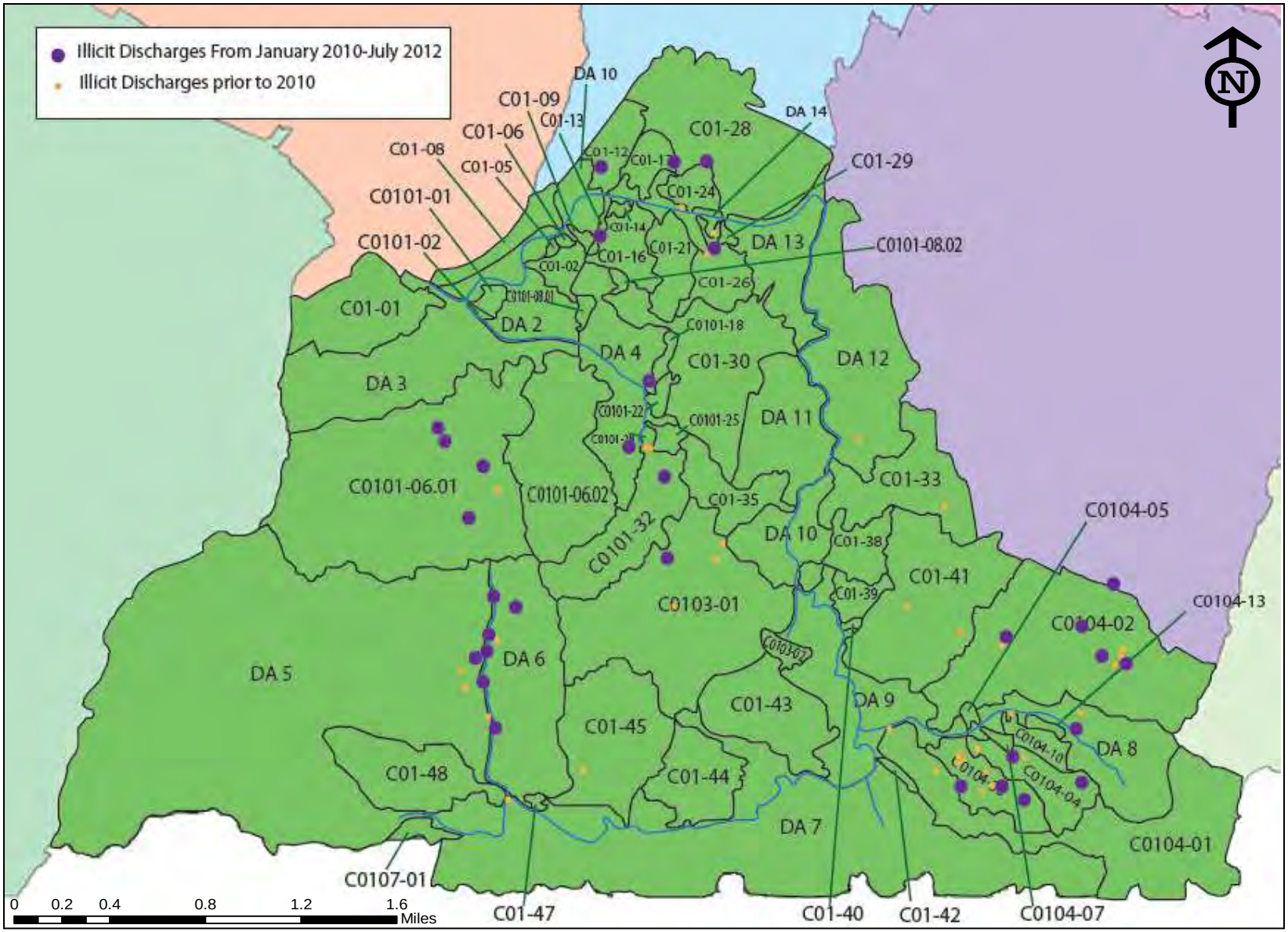
Supplemental Map 2 Industrial Facilities currently in operation

Location of Local and National Superfund Sites



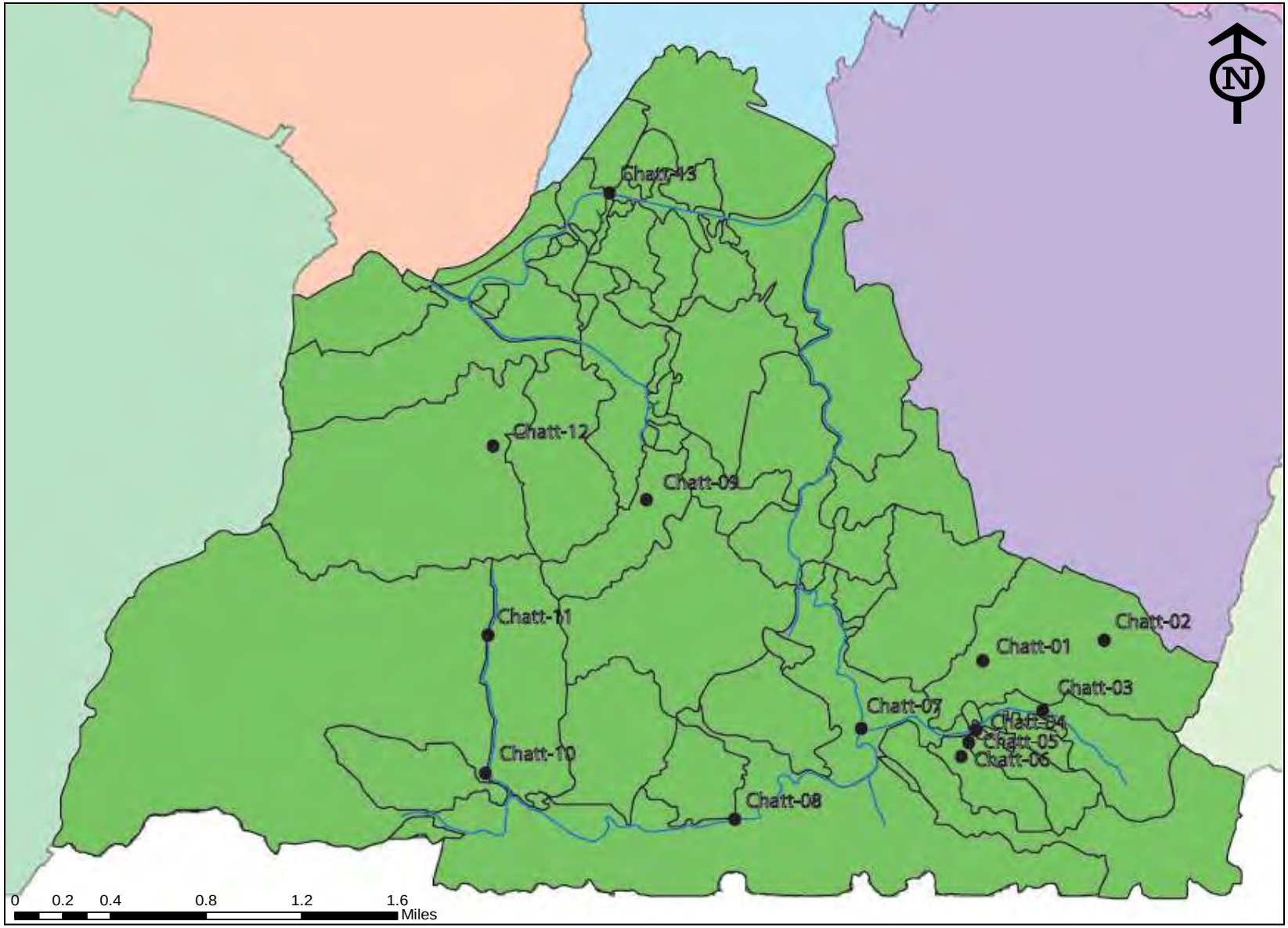
Supplemental Map 3 Superfund Sites

Location of Illicit Discharges



Supplemental Map 4 Locations of Illicit Discharges

Sampling Locations



Supplemental Map 5 13 sampling locations identified.

Monitoring Plan			
WQ Sampling Locations			
Location/Station ID	Location	Frequency	Monitoring Parameters
Chatt-01	Calhoun & 42nd	Annually	pH, dissolved oxygen, conductivity, temperature, *E.coli*, TSS
Chatt-02	4011 12th Ave.		
Chatt-03	10th Ave between 44th and 45th		
Chatt-04	46th & 49th		
Chatt-05	E 46th St. @ Walthall Ave		
Chatt-06	E 47th St. @ Walthall Ave		
Chatt-07	Chattanooga Creek @ Hooker Rd		
Chatt-08	Wilson Rd. Bridge		
Chatt-09	Ohls & W. 42nd St.		
Chatt-10	5508 Tennessee Ave.		
Chatt-11	St. Elmo Ave. @ Virginia Ave.		
Chatt-12	4008 St. Elmo Ave. **DRY**		
Chatt-13	Chattanooga Creek & Broad St.		
Outfall C0104-02	Sub-basin C0104-02		
Outfall C0101-06.01	Sub-basin C0101-06.01		
Outfall C0103-01	Sub-basin C0103-01		
Outfall C0101-09	Sub-basin DA-4		
TMDL Sampling Sites			
Location/Station ID	Location	Frequency	Monitoring Parameters
CHATT000.9HM	Chattanooga Creek @ RR bridge and rendering plant	Monthly	pH, dissolved oxygen, conductivity, temperature, E.coli, TSS
CHATT007.9HM	5200 Clock Wilson Rd. @ bridge		
CHATT1T0.1HM	Hooker Rd		
Hot Spots			
Location/Station ID	Location	Frequency	Monitoring Parameters
Hot Area 2	Northern portion of watershed	Annually	pH, dissolved oxygen, conductivity, temperature, E.coli,
Hot Area 3	Eastern portion of watershed		
Field Screening			
Location/Station ID	Location	Frequency	Monitoring Parameters
37 Locations	One per quarter-mile or half-mile grid, depending on land use	on-going	When flowing: pH, dissolved oxygen, conductivity, temperature, chlorine, ammonia, detergents, phenols, copper, phosphate, and hydrogen sulfide.
SCORE			
Location/Station ID	Location	Frequency	Monitoring Parameters
All stream segments	Throughout Chattanooga Creek Watershed	on-going	Non-analytical: landuse, buffer, canopy, flow conditions, channel alterations, channel dimensions

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