

# Upper West Fork Stones River

## Visual Stream Assessment

## Watershed Characterization



Spring 2012

Murfreesboro Water and Sewer

MURFREESBORO  
**STORMWATER**  
PROGRAM  
improving the quality of local streams

# Upper West Fork Stones River - Watershed Characterization

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Visual Stream Assessment

May and June 2012 – Haley, Upham, & Ross

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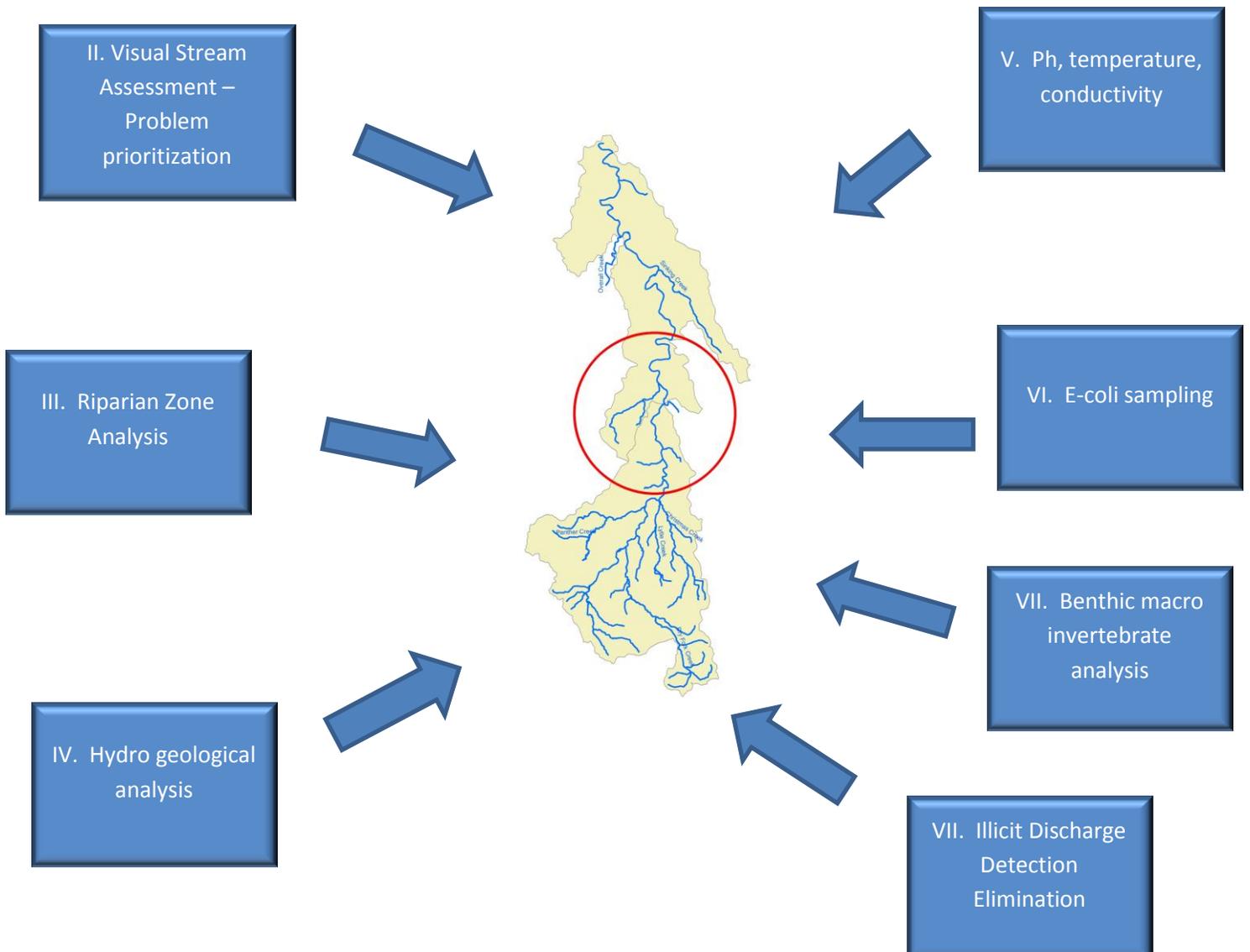
Including:

- Riparian Buffer Analysis
- Ph, temperature, and conductivity readings
- Hydro geological analysis
- E-coli spring samples
- Illicit Discharge Detection Elimination Screening (2011)
- Benthic macro invertebrate sampling

# I. Introduction

The city of Murfreesboro is required to partake in various activities in order to comply with the NPDES Permit for Discharges. This document is intended to describe these activities as well as provide a management plan for the Upper West Fork Stones River Watershed which includes all tributaries within the Murfreesboro Urban Growth Boundary. The management plan will take a comprehensive approach to characterizing the UWFSR watershed in hopes of locating possible pollutant sources, prioritizing documented problems, targeting areas of education and most of all improving water quality in the City of Murfreesboro.

## Sections



## About the Watershed

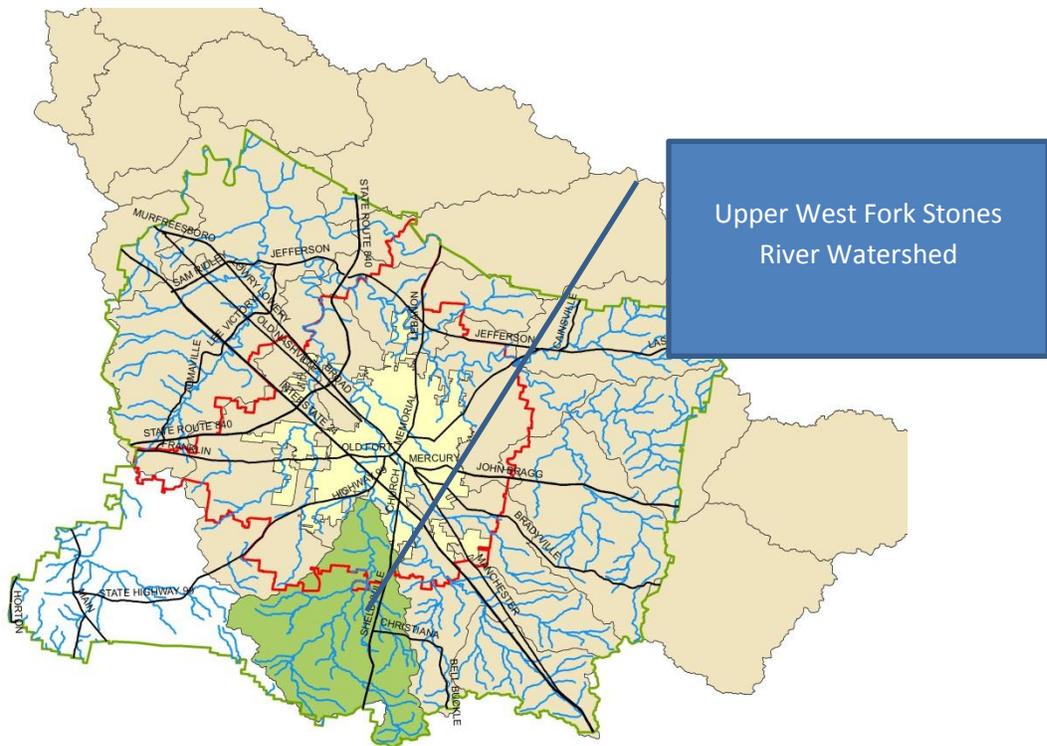
The Upper West Fork Stones River watershed (051302030205) is part of the larger Stones River Watershed. While the entire HUC 12 sub watershed encompasses 38,230 acres only an estimated 5,942 acres are inside the Murfreesboro urban growth boundary. The West Fork Stones River begins as a series of springs in the southern part of the county and has a diverse ecology making it an eco-reference stream. Some of the named tributaries are Panther Creek, Lytle Creek, and Christmas Creek. A large portion of the watershed is agricultural while subdivisions and residential areas are scattered throughout the watershed urban growth is slowly extending into the watershed with changing infrastructure and developments. Much of the sub watershed like the rest of the Stones River flows across the karstic Ridly Limestone. Sinking portions of stream and large springs are common due to the prevalence of complex limestone conduits making pollutant sources difficult to track. The river was even observed to disappear briefly near Barfield Crescent Park. This report will attempt to describe existing water quality issues and find ways to correct these problems as well as prevent further issues in this changing watershed.

Total Watershed:

38, 230 acres

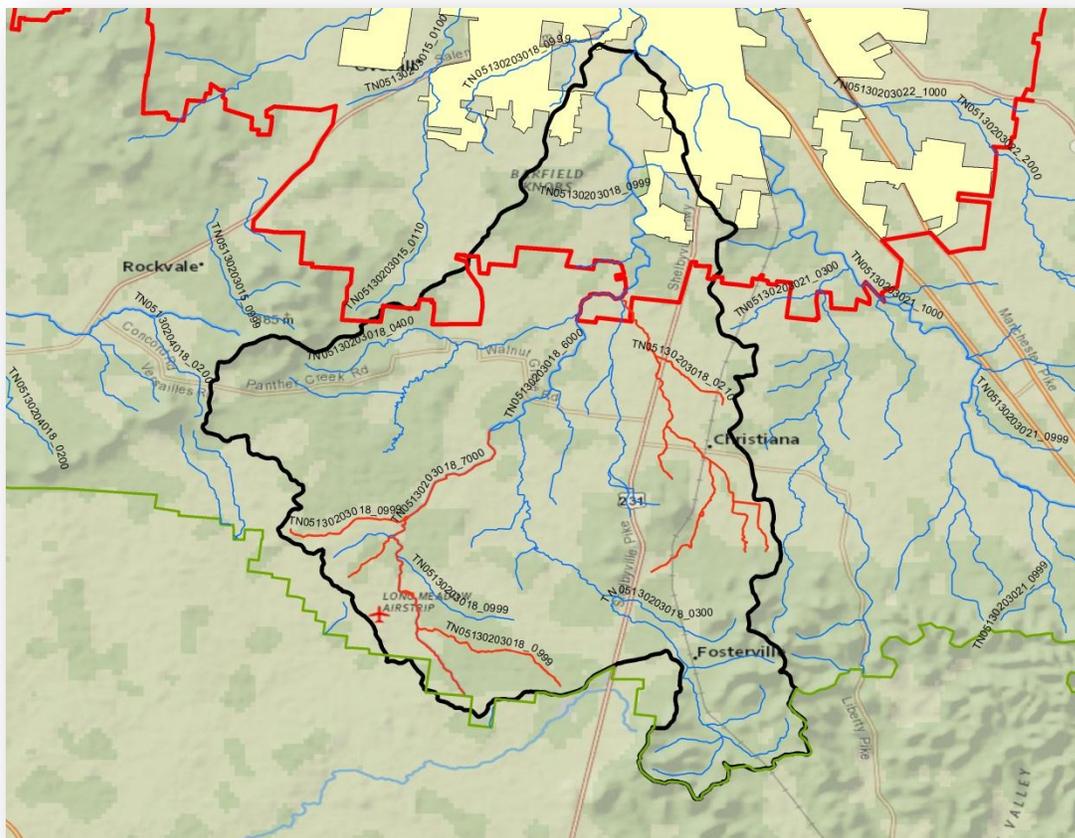
Within UGB:

5,942 acres



## Impairment:

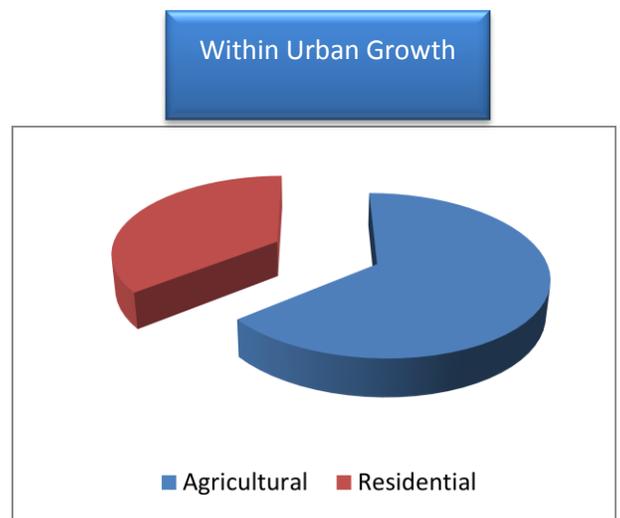
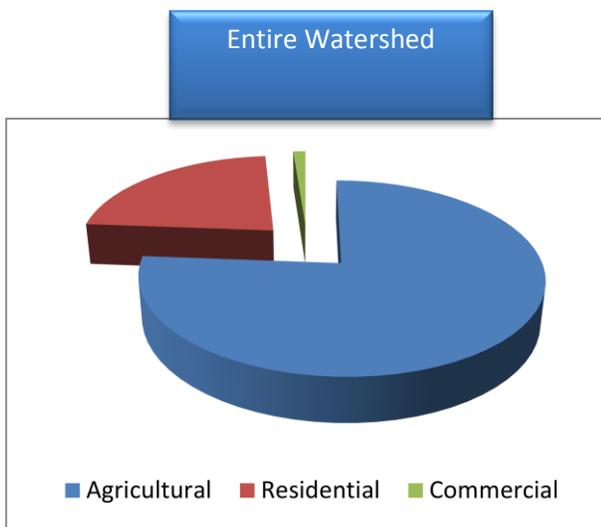
The Upper West Fork Stones River watershed has a couple of segments currently listed on the 303d list. Almost all of these stream segments are outside of the urban growth boundary and are due to mostly an agricultural use. The entire Stones River Watershed will be assessed by the Tennessee Department of Environment and Conservation during the year of this report (2012). One of the objectives of this report is to document problems so that they can be corrected and keep downstream segments off of the 303d and fully supporting its use. The visual stream assessment section (II) will detail problems found such as erosion, invasive plant species, and other issues.



Stream Name	Entity ID	Impairment	Source
Christmas Creek	TN05130203018 – 0210	E-coli	Pasture grazing
West Fork Stones	TN05130203018 - 7000	Low dissolved oxygen	Pasture grazing/ access

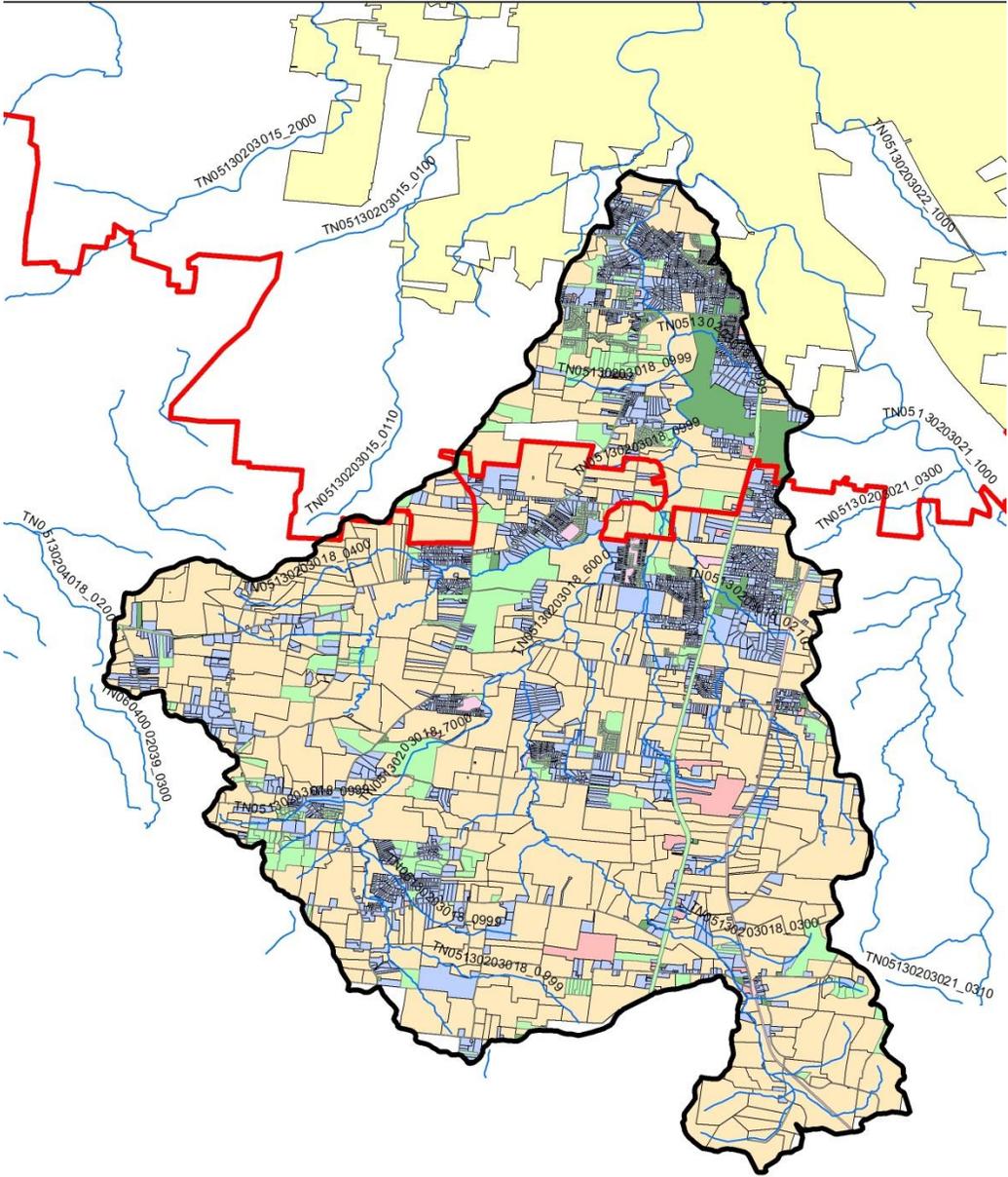
**Land use:**

Most of the Upper West Fork Stones River watershed is an agricultural or farm use. As expected the concentration of residential acreage increases once inside the Murfreesboro Urban Growth but agricultural still maintains an edge. With growth land use will change and water quality issues will also change according to land use. *All calculations based on parcel data provided by Rutherford County.*



Land use	Acres	Percentage of watershed
<b>Entire watershed</b>	38,230	
<b>Agricultural</b>	24,842	64%
<b>Residential</b>	7,599	19%
<b>Commercial</b>	471	1%
<b>Within Urban Growth</b>	5,942	
<b>Agricultural</b>	2,713.9	45%
<b>Residential</b>	1,496	25%

# Land Use of the Upper West Fork Stones River

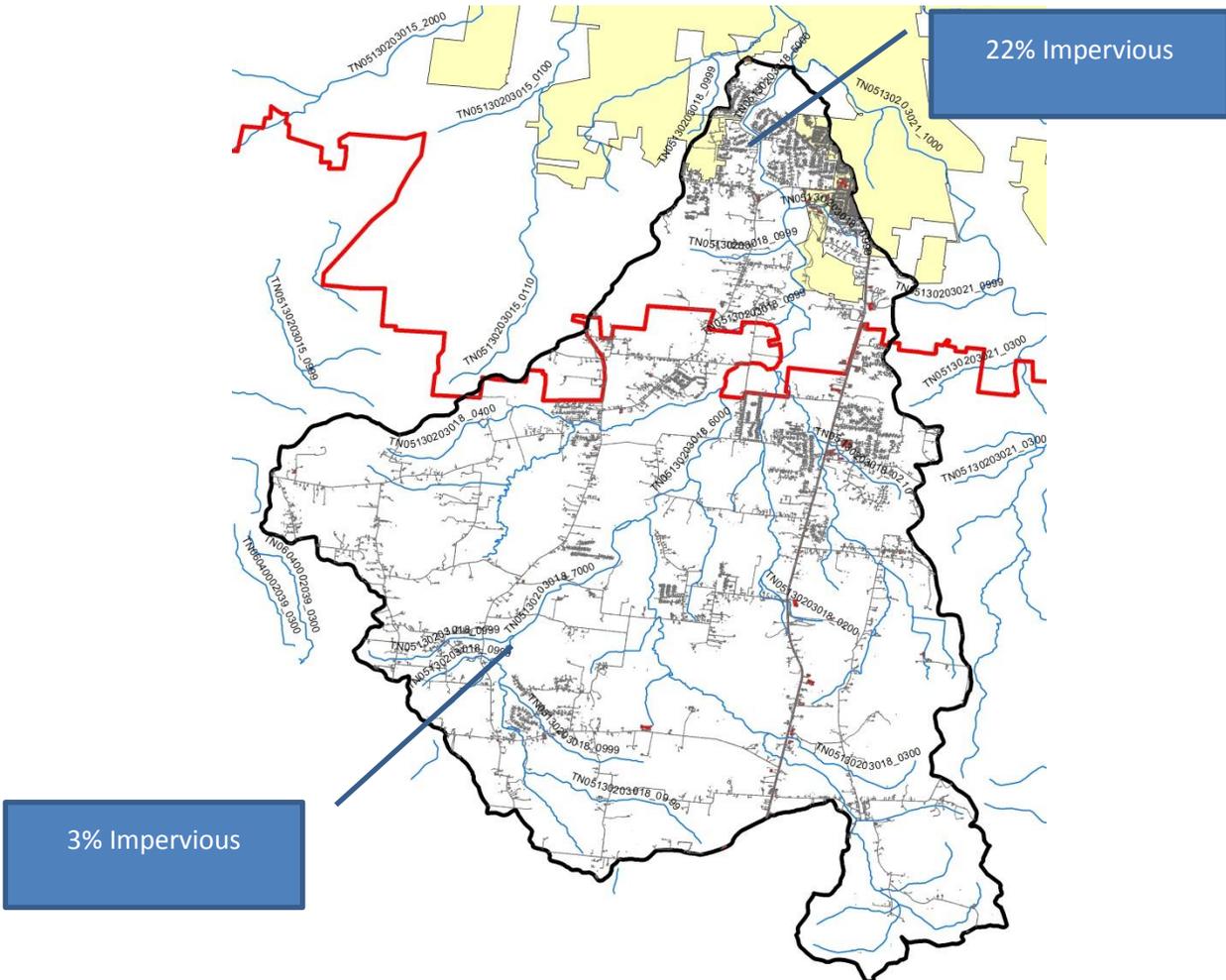


Tan = Agricultural or Farm, Blue = Residential, Red = Commercial

## Imperviousness

The Upper West Fork Stones River is dominated by mainly agricultural use and does not have much residential or commercial use. This allows for generally low impervious values throughout the watershed. It is important to note that some soil types can become nearly impervious with high curve numbers when little vegetation is present and certain land uses.

Upper West Fork Stones River Watershed	Within Urban Growth Boundary
3% - Impervious	22% - Impervious



The following sections of this report are intended to further characterize the Upper West Fork Stones River and describe activities that the Murfreesboro Stormwater program is involved in that analyze and improve water quality.

- II. Visual Stream Assessment and Problem Prioritization
- III. Riparian Zone Analysis
- IV. Hydro Geological Analysis
- V. Ph, Conductivity, and Temperature
- VI. E-coli Sampling
- VII. Benthic Macro Invertebrate Study
- VIII. Illicit Discharge Detection Elimination

## II. Visual Stream Assessment 2012



April and May 2012

## Introduction

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In order to comply with rule 5.2 (Non-analytical monitoring) of the NPDES General Permit for Discharges and evaluate the sub watersheds in Murfreesboro, the Murfreesboro Stormwater Program conducted a visual stream assessment in the Upper West Fork Stones River Watershed. The assessment was done using a modified version of the Maryland Protocol.

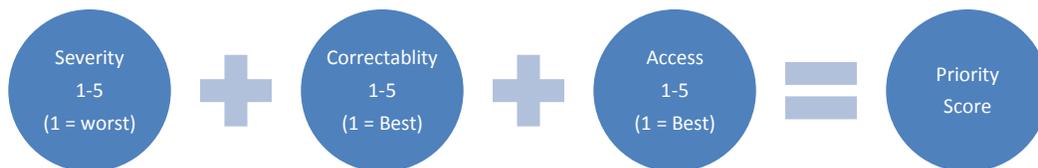


The watershed was broken into sectors and problems were GPS'd with a handheld GPS unit and given an ID number based on the sector the problem was located in. Since a majority of the Upper West Fork Stones River is outside of the Murfreesboro Urban Growth boundary, the department assessed downstream to Medical Center Parkway where a previous assessment began. Each problem GPS'd was photographed and described in the following report based on parameters describing problem.

## Prioritizing Problems

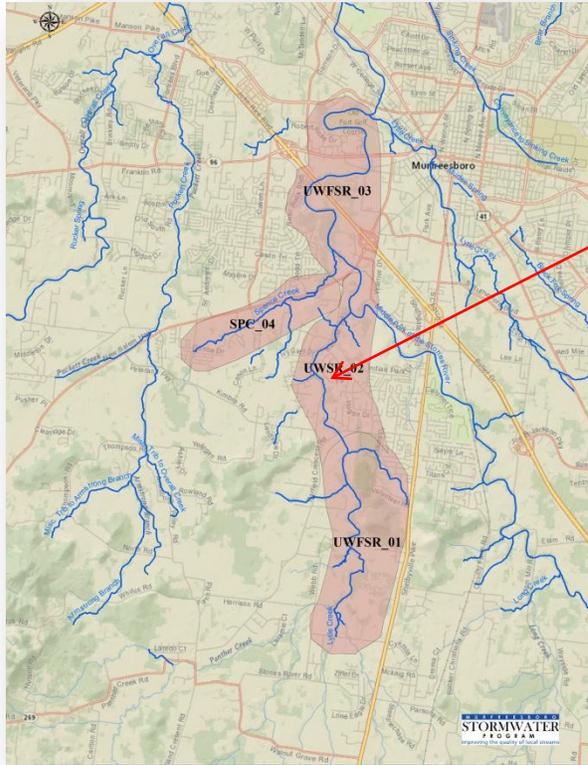
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The protocol modified for this assessment is designed to accurately assess a stream and its riparian zone while documenting problems. Once a problem is observed its ability to correct and access as well its severity is noted. The sum of these parameters will give the problem a priority score. At the end of this section will be a priority ranking chart. This chart will provide a list of all problems observed and order the problems by the best opportunity. *See Appendix 1 for complete description of parameters.*



# Upper West Fork Stones River Watershed – Watershed Characterization

## - Example of Problem



**“UWFSR0202 – Inadequate Buffer”**

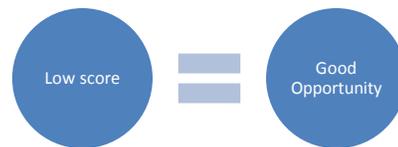
“UWFSR02” = Sector, “02” = number of point with sector

**Severity = 1** – “A section of stream with trees on both sides of the stream, but on one side the stream buffer is less than 50 ft wide”

**Correctability = 1** – Small reach on residential property where a no mow zone and trees could be planted easily

**Access = 1** – Easily accessible both by car and foot.

**Priority Score = 3**



Low scores are easy opportunities that can be corrected by education, volunteer groups, and small projects. High scores may indicate large project potential.

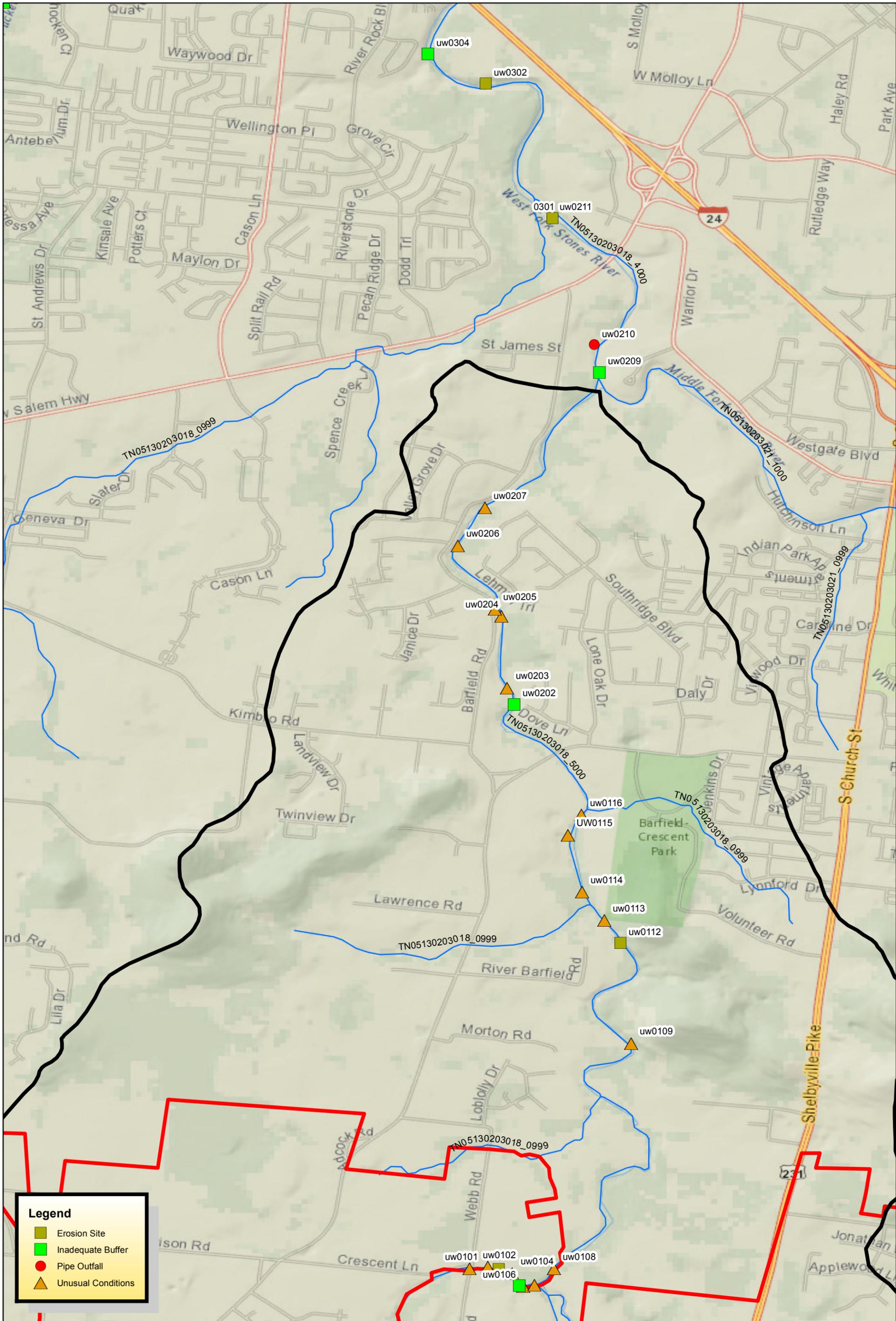
**Summary and Conclusions**

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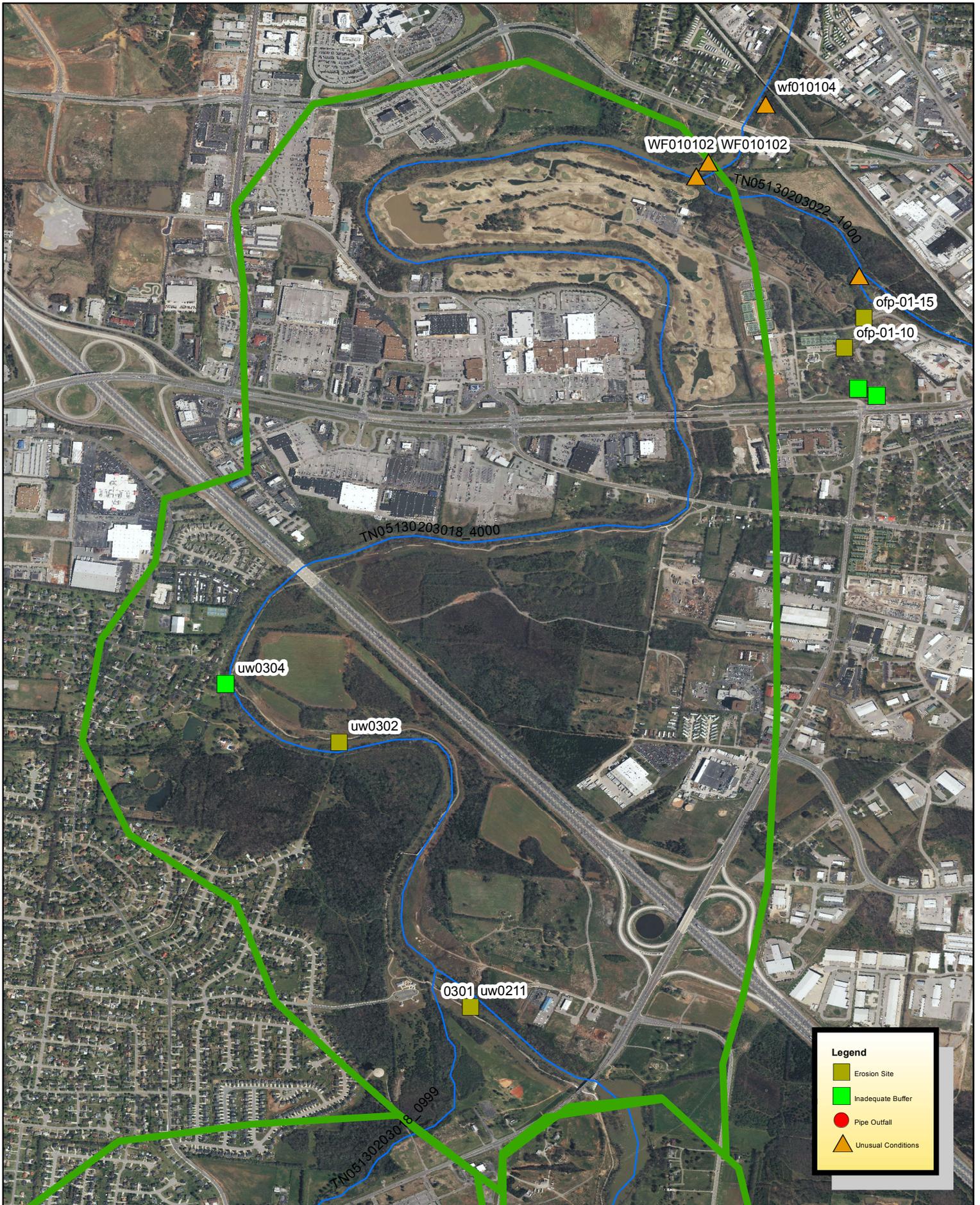
After completing the Visual Stream Assessment segment of the Upper Stones River Watershed Characterization it was observed that a good portion of the stream and its riparian corridor remains healthy. This in part is due to a significant part of the stream being either undeveloped or bordered by park land or green space which will be detailed further in the “Riparian Analysis” of this study.

Priority Scores

Map ID	Description	Severity	Correctability	Accessibility	Priority Score
uw0202	Inadequate Buffer	5	1	1	7
uw0209	Inadequate Buffer	4	2	1	7
uw0304	Inadequate Buffer	5	1	1	7
uw0101	Old Ford	3	4	2	9
uw0102	Algae Inundation				
uw0108	Possible Cattle Crossing	5	1	2	8
uw0116	Parrot Feather	4	2	3	9
uw0113	Poles across				
uw0114	Poles across				
uw0203	Pipeline				
uw0204	Debris at bridge	4	1	1	6
uw0207	Rock Line	3	4	4	11
uw0103	Erosion Site	4	1	2	7
uw0112	Erosion Site	3	4	1	8
uw0301	Erosion Site	1	4	2	7
uw0302	Erosion Site	4	3	5	12



# Upper West Fork Stones River Visual Stream Assessment Sites



Upper West Fork Stones River  
VSA Panel 02

## UW0101 Old Road Crossing



- 4/23/2012
- 86°25'40.618"W,  
35°44'59.148"N
- Josh Upham and Bruce Ross
- Severity = 3
- Correctability = 4
- Accessibility = 2
- Old road crossing with breaches that allow fish passage.

## UW0102 Algae Inundation



- 4/23/2012
- 86°25'35.735"W,  
35°44'59.148"N
- Josh Upham and Bruce Ross
- Large patches of algae.

## UW0103 Bank Erosion



- 4/23/2012
- 86°25'33.037"W,  
35°44'59.148"N
- Josh Upham and Bruce Ross
- Severity = 4
- Correctability = 1
- Accessibility = 2
- Left Bank
- Lack of vegetative cover

## UW0104 Dipping Strata



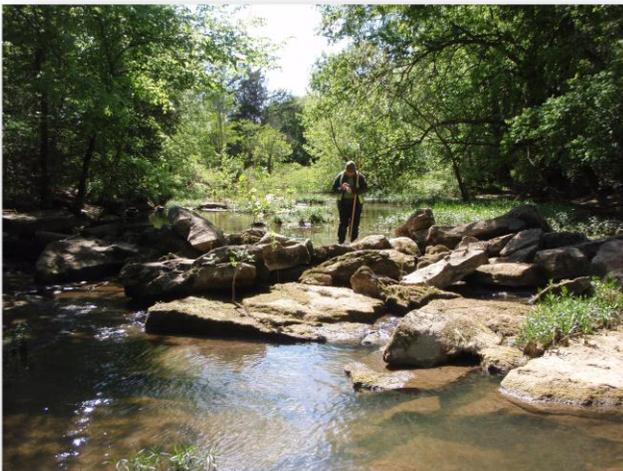
- 4/23/2012
- 86°25'29.246"W,  
35°44'57.927"N
- Josh Upham and Bruce Ross
- Possible synclinal axis.

## UW0106 Inadequate Buffer



- 4/23/2012
- 86°25'27.529"W,  
35°44'54.963"N
- Josh Upham and Bruce Ross
- Severity = 2
- Correctability = 2
- Accessibility = 4
- Left Bank
- Lack of vegetative cover,  
possible cattle crossing

## UW0107 Rock Wall



- 4/23/2012
- 86°25'23.661"W,  
35°44'55.223"N
- Josh Upham and Bruce Ross
- Severity = 3
- Correctability = 4
- Accessibility = 5
- Rock pile across stream

## UW0108 Possible Cattle Crossing



- 4/23/2012
- 86°25'1.414"W,
- 35°46'24.6"N
- Josh Upham and Bruce Ross
- Severity = 5
- Correctability = 1
- Accessibility = 2
- Both banks
- Possible cattle crossing could be corrected with vegetation and ending cattle access.

## UW0109 Sinking Segment



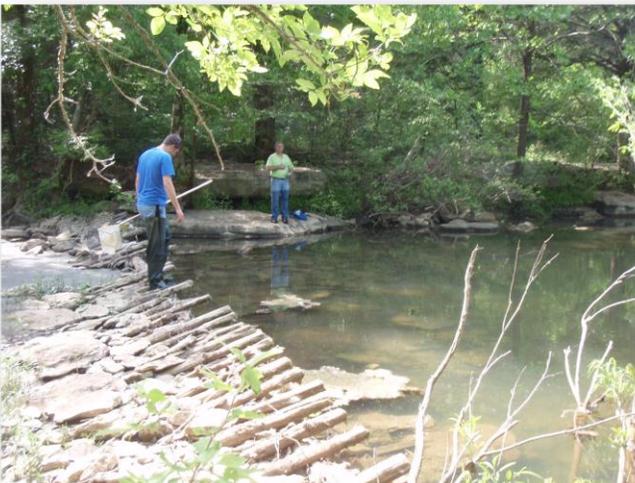
- 4/24/2012
- 86°24'58.845"W,  
35°45'56.332"N
- Josh Upham and Bruce Ross
- Severity = NA
- Correctability = NA
- Accessibility = NA
- River sinks completely, relatively dry conditions but plenty of flow upstream. May emerge at spring downstream.

## UW0112 Erosion Site



- 4/24/2012
- 86°25'1.414"W,
- 35°46'22.03"N
- Josh Upham and Bruce Ross
- Severity = 3
- Correctability = 4
- Accessibility = 1
- Left Bank
- Minor erosion in natural meander.

## UW0113 & 14 poles in stream



- 4/24/2012
- 1 - 86°25'5.8"W,  
35°46'28.915"N
- 2 - 86°25'11.497"W  
35°46'37.331"N
- Josh Upham and Bruce Ross
- Severity = 4
- Correctability = 2
- Accessibility = 3
- Poles in stream may be remnants of old fence. Should be relatively easy to remove.

## UW0115 Large Spring

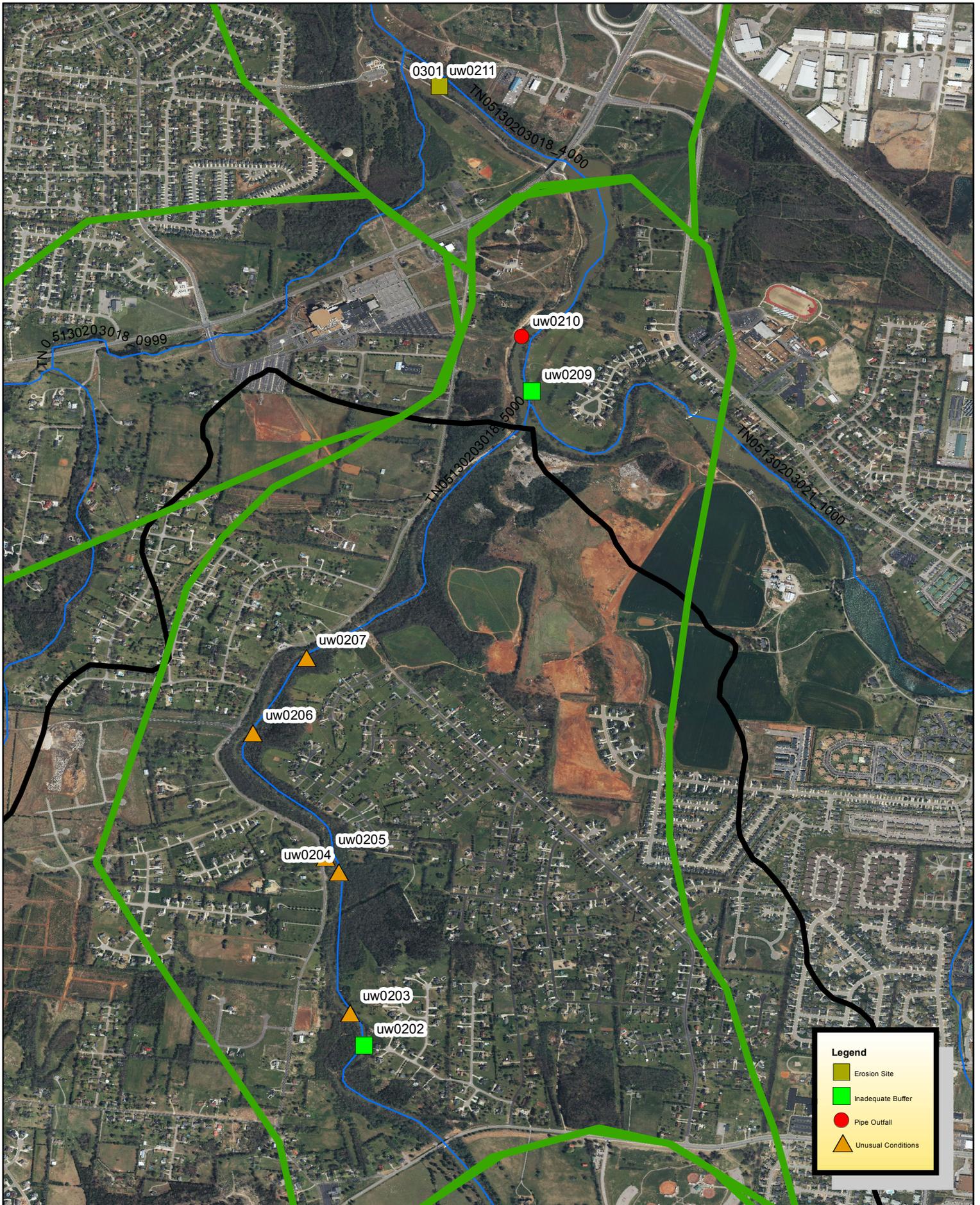


- 4/24/2012
- 86°25'15.758"W,
- 35°46'51.101"N
- Josh Upham and Bruce Ross
- Severity = NA
- Correctability = NA
- Accessibility = NA
- Large spring may be the resurgence of the WFSR

## UW0116 Parrot Feather



- 4/24/2012
- 86°25'11.575"W  
35°46'56.133"N
- Josh Upham and Bruce Ross
- Severity = NA
- Correctability = NA
- Accessibility = NA
- Parrot Feather covering much of the river.



Upper West Fork Stones River  
VSA Panel 02

## UW0202 INADEQUATE BUFFER



- 5/1/2012
- 86°25'28.845"W,
- 35°47'24.504"N
- Josh Upham and Bruce Ross
- Severity = 5
- Correctability = 1
- Accessibility = 1
- Mowing to the bank on the right side. Need to establish no mow zones.

## UW0203 Pipeline



- 5/1/2012
- 86°25'30.695"W  
35°47'28.77"N
- Josh Upham and Bruce Ross
- Severity = NA
- Correctability = NA
- Accessibility = NA

## UW0206 Large Spring



- 5/1/2012
- 86°25'43.269"W,
- 35°48'5.467"N
- Josh Upham and Bruce Ross
- Severity = NA
- Correctability = NA
- Accessibilty = NA
- Large spring despite low flow in river. Possible large recharge basin.

## UW0207 Rock line



- 5/1/2012
- 86°25'36.309"W
- 35°48'15.104"N
- Josh Upham and Bruce Ross
- Severity = 3
- Correctability = 4
- Accessibility = 4
- Line of boulders crossing stream.

## UW0209 Inadequate Buffer



- 5/4/2012
- 86°25'7.456"W,
- 35°48'49.69"N
- Josh Upham and Bruce Ross
- Severity = 4
- Correctability = 2
- Accessibility = 1
- Several properties along the right bank on Sterling Lake are mowing to the bank. Good place to establish now mow zone with view sheds.

## UW0210 Pipe Outfall



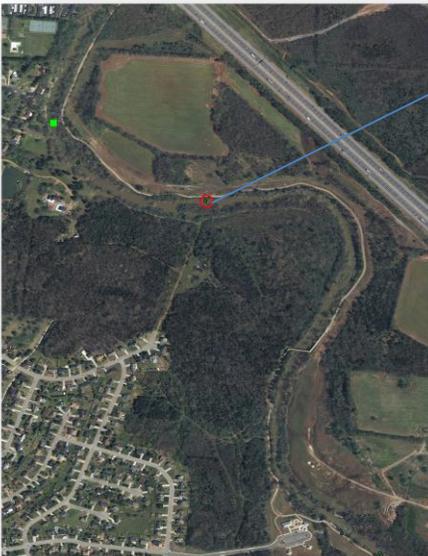
- 5/4/2012
- 86°25'8.206"W  
35°48'57.292"N
- Josh Upham and Bruce Ross
- Severity = NA
- Correctability = NA
- Accessibility = NA
- Pipe outfall.

### UW0301 Erosion Site



- 5/4/2012
- 86°25'18.995"W,
- 35°49'29.677"N
- Josh Upham and Bruce Ross
- Severity = 1
- Correctability = 4
- Accessibilty = 2
- Large erosion site on left bank that continues an estimate 2,500 ft. Stabilization project being planned

### UW0302 Erosion Site



- 5/10/2012
- 86°25'36.128"W
- 35°50'4.096"N
- Josh Upham and Bruce Ross
- Severity = 2
- Correctability = 3
- Accessibility = 5
- Small erosion site on the right bank below greenway trail.

## UW0304 Inadequate Buffer



- 5/10/2012
- 86°25'50.94"W,
- 35°50'11.493"N
- Josh Upham and Bruce Ross
- Severity = 5
- Correctability = 1
- Accessibilty = 1
- Area being mowed to the bank of about 300 ft with sporadic trees,

### III. Riparian Zone Analysis



June 2012

# Upper West Fork Stones River Watershed – Watershed Characterization

## Introduction

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The riparian zone is the area of vegetation on either side of a stream. This area is an important part of the stream which can be managed effectively through education and outreach. The objective of the Riparian Zone Analysis is to target locations in the Upper West Fork Stones River Watershed where there is inadequate riparian zone vegetation.

### Methods of detecting inadequate Buffer:

- Visual Stream Assessment (Locating areas with GPS – generating a shapefile)
- Aerial photography

### Symptoms of Inadequate of Buffer



## Correcting an Inadequate Buffer

The Stormwater Program has many ways that it helps to correct inadequate buffer depending on the type of land the riparian corridor is located on.



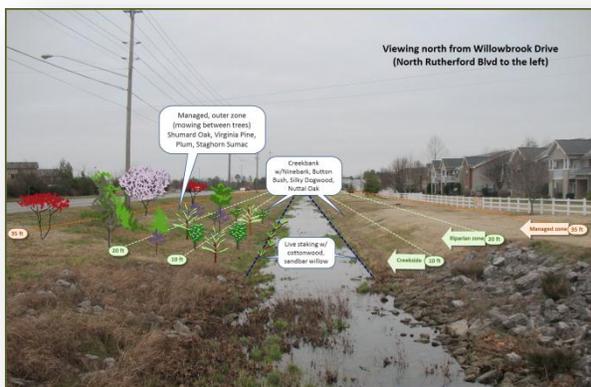
**1. Public education and outreach** – Once areas of inadequate buffer are identified in the watershed, a mailing list can be developed so brochures containing riparian management tips for residents can be mailed.

**2. Tree give away and public outreach events** – the stormwater program encourages landowners along Murfreesboro streams to

pick up trees at its annual Tree Day event. All parcels belonging to residents who picked up trees are recorded and compared to original inadequate parcels.



**3. Habitat restoration areas** – where it is possible the city participates in habitat restoration projects. In these areas native trees and shrubs are planted and a “no mow” zone is established to help restore the stream’s riparian zone.



## Upper West Fork Stones River Watershed – Watershed Characterization

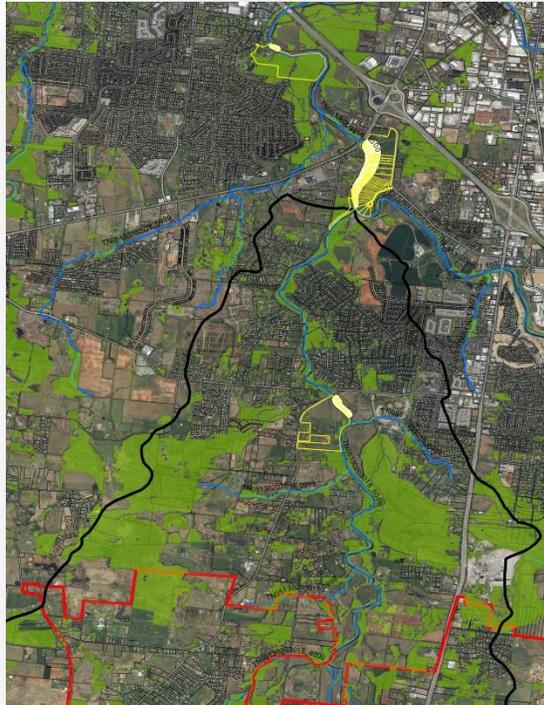
### Findings

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Overall very little areas of inadequate buffer were found in the watershed (only parts within the urban growth boundary). This is in part due to amount of stream bank that is within city parks and greenways. Of an estimate 64,468 ft. of streambank 8,845 ft is inadequate falling in mainly residential areas where a buffer could be easily established.

Total length of  
streambank:  
64,468 ft

Inadequate  
streambank:  
8,845 ft 13.7%



### Past or Planned Projects

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- West Fork Stones River Tree Planting with the Cumberland River Compact 2010 (Hwy 99 to Cason Trail trailhead)
- “Church Outside the Walls” Tree Planting 2010 – (Between Hwy 99 and Molloy Ln)
- Planned bank restoration West Fork Stones River – river left between Hwy 99 and Cason Trail trailhead (2012)

## IV. Hydro Geology



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improving the quality of local streams

June 2012

Introduction

The entire Upper West Fork Stones River watershed is located within the Central Basin province of Tennessee. The watershed for the most part is within a karst terrain where losing and gaining segments of stream can be noted depending on which geologic strata the stream is traveling across. Understanding the underlining geology is extremely important in being able to track pollutants as well as stream flow. In Rutherford county rock strata is gently folded forming synclines and anticlines or crests and troughs. In addition to the folded strata 6 rock formations can be found in the watershed. The Murfreesboro and Ridley Limestone formations are capable of contain large conduits and aquifers while

the Pierce and Ridley Confining unit are generally impermeable and are where many of the large springs can be found when exposed by a down cutting of a stream. As an example a sinkhole with a wet weather conveyance flowing to it may receive all run off from a large area of land. The water will then travel through conduits formed along NW or NE trending joints in the rock strata that are slightly tilted until the water reaches an impermeable unit at the bottom of a trough.



Opm – Peirce, Olb – Lebanon, Hashed – Losing Segments, all other Ridley Limestone, green - sinkholes

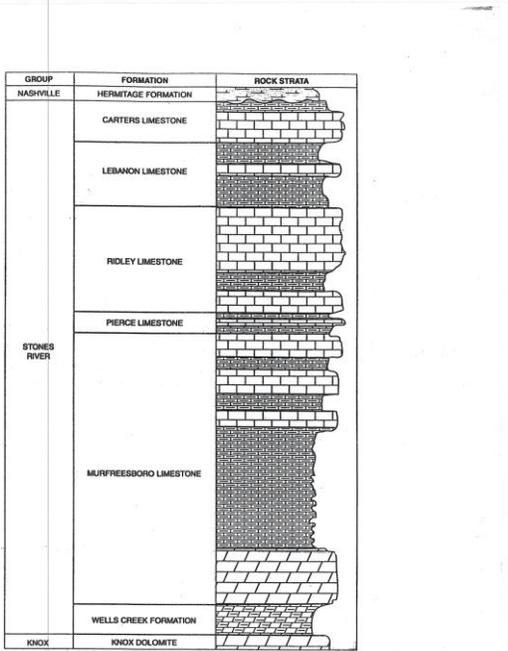
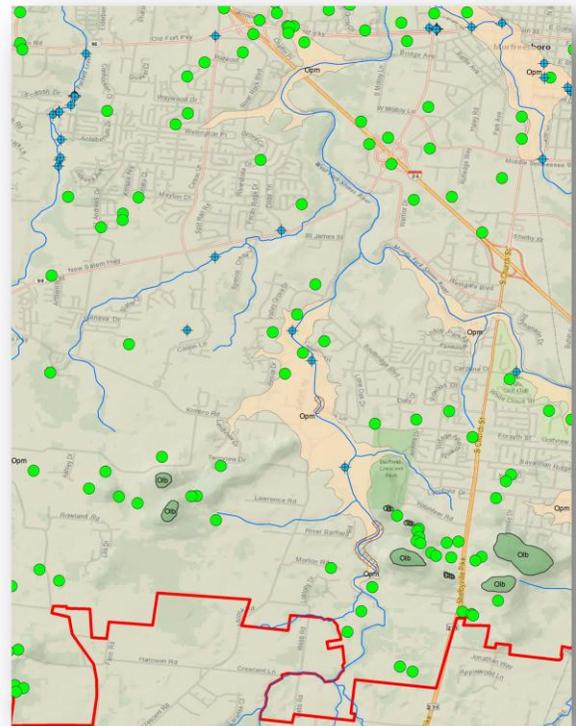


Figure 2. Stratigraphic column of the study area (from Farmer and Hollyday, 1999).



## Findings

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A benefit of conducting visual stream assessments and other studies in a watershed is that it allows for every foot of a stream bank to be seen. This along with probe readings of dramatically lower temperatures and high conductivity readings can help to locate springs. Once springs are located, they can be sampled to identify possible contamination and eventually dye traced to delineate recharge basins and define location of large synclines.

### 2 Major Springs Located or Observed

Several seeps were noted and two major springs were located. Both of these springs contribute significant portions of flow to the West Fork evident by the lack of flow in the segments upstream from each spring. It recommended that dye traces be conducted to these springs because of the suspected vast recharge basins to each spring most of which is within the urban growth boundary of Murfreesboro.



#### Century Farm Spring

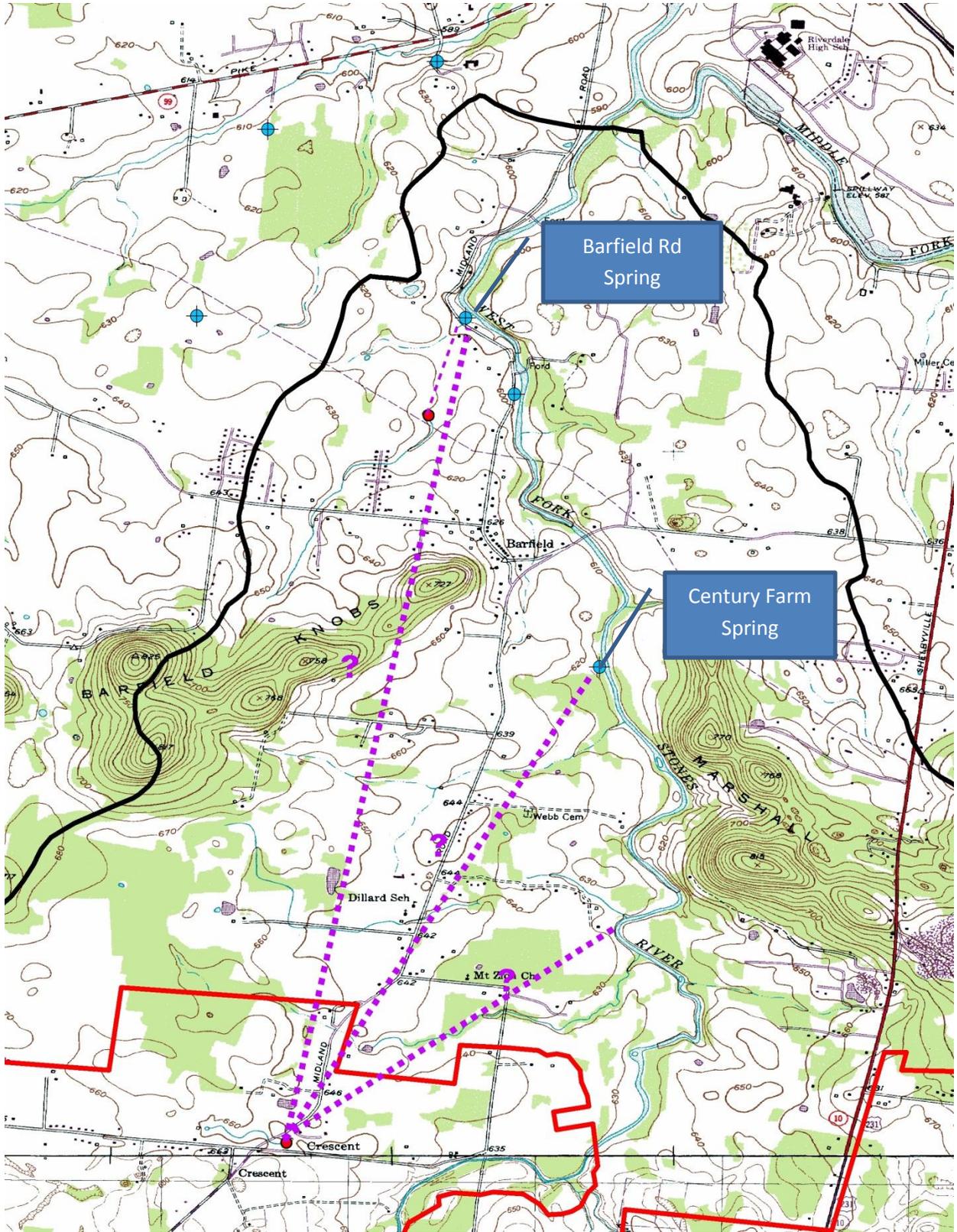
- 86°25'15.556"W, 35°46'51.2"N
- 2,700 ft downstream of dam below Barfield Crescent Rd
- Unmapped spring
- Possible resurgence of the West Fork from it's sinking point up stream
- Karst window/ sinking stream to SW near Crescent Ln and Barfield Crescent Rd



#### West Fork Spring (Barfield Rd Spring)

- 86°25'44.191"W, 35°48'5.488"N
- Previously published by Larry Matthews
- More than doubles river flow - spring at or below water level
- Several sinking streams to SW
- Large recharge basin

# Upper West Fork Stones River Watershed – Watershed Characterization



*Upper West Fork Stones River Watershed*

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V. Probe Readings (Ph, Conductivity, and Temperature)

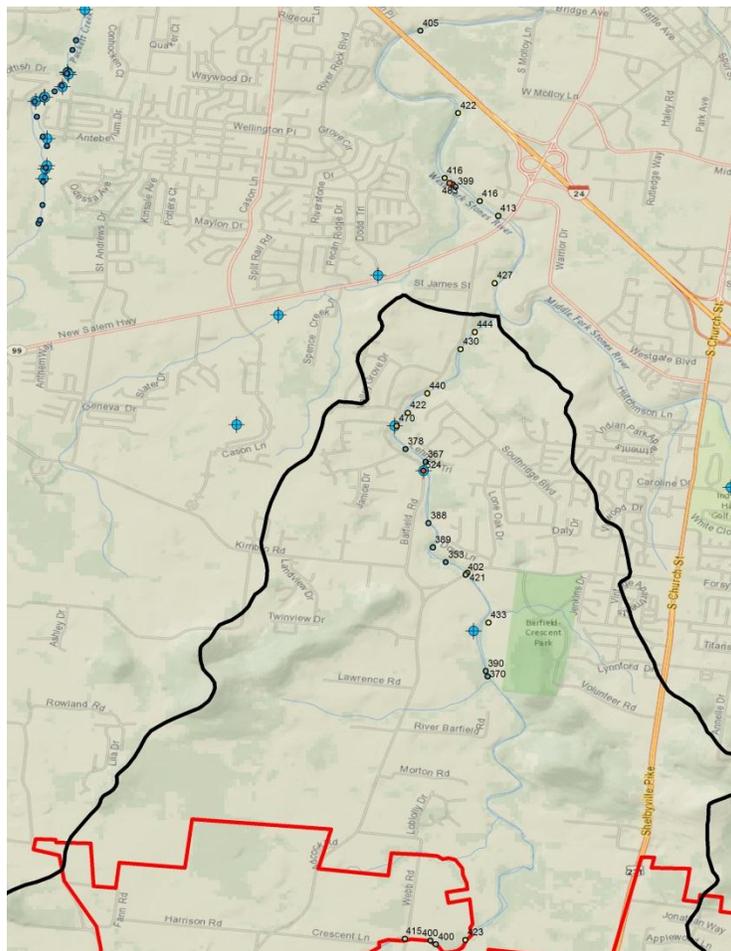
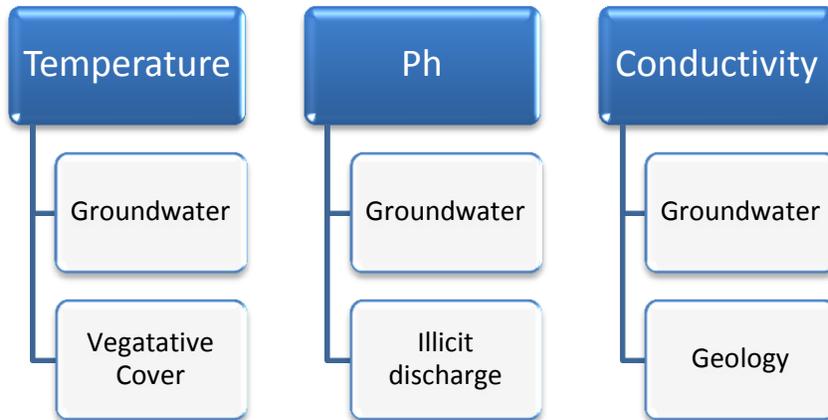


May & June 2012

# Upper West Fork Stones River Watershed – Watershed Characterization

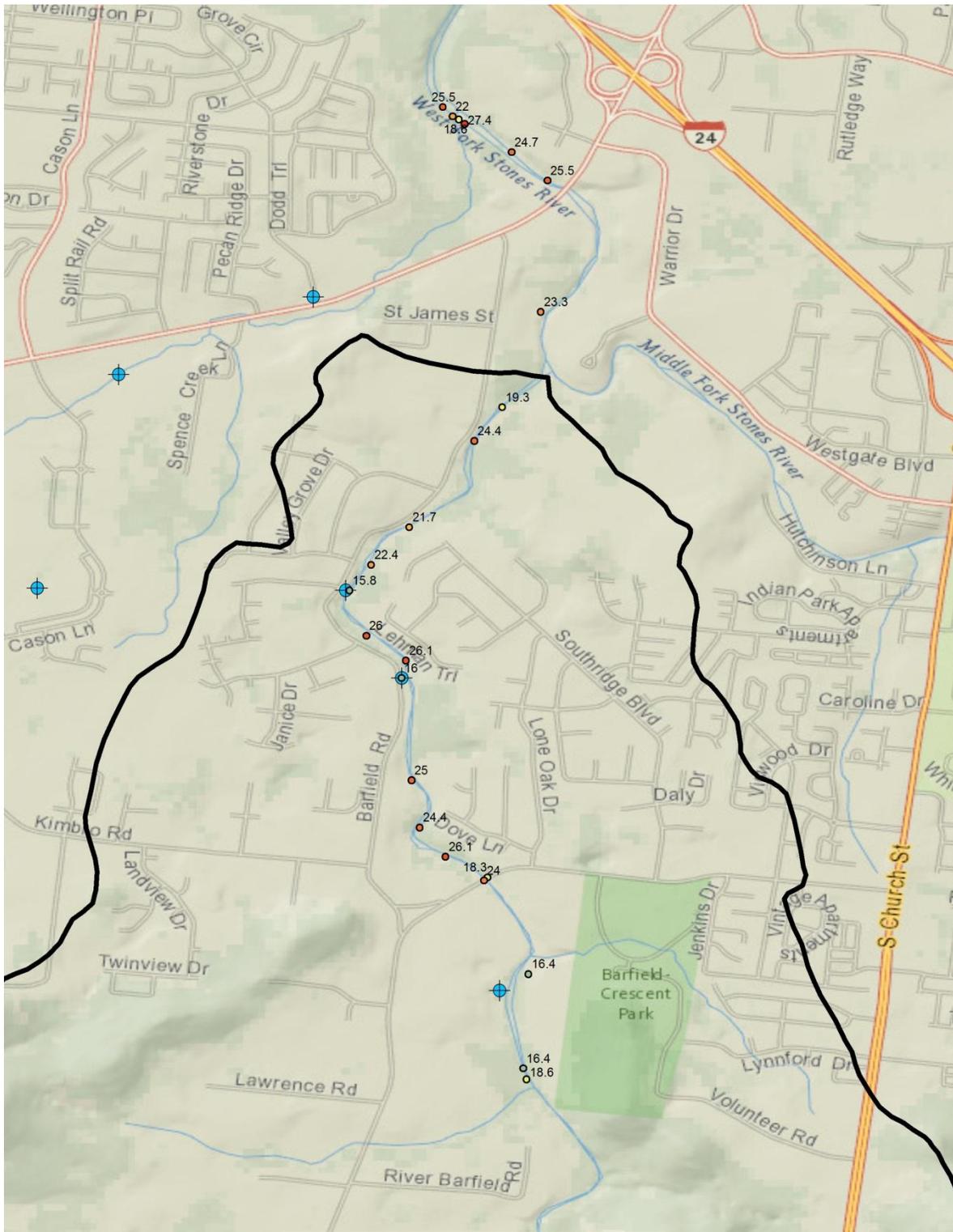
## Introduction

As part of the Upper West Fork Stones River Watershed Characterization the stormwater department uses a probe to detect Ph, conductivity, and temperature. In addition to these readings, flow measurements will be added in future assessments once a flow meter is acquired. The readings are useful in getting different characteristics of the stream.



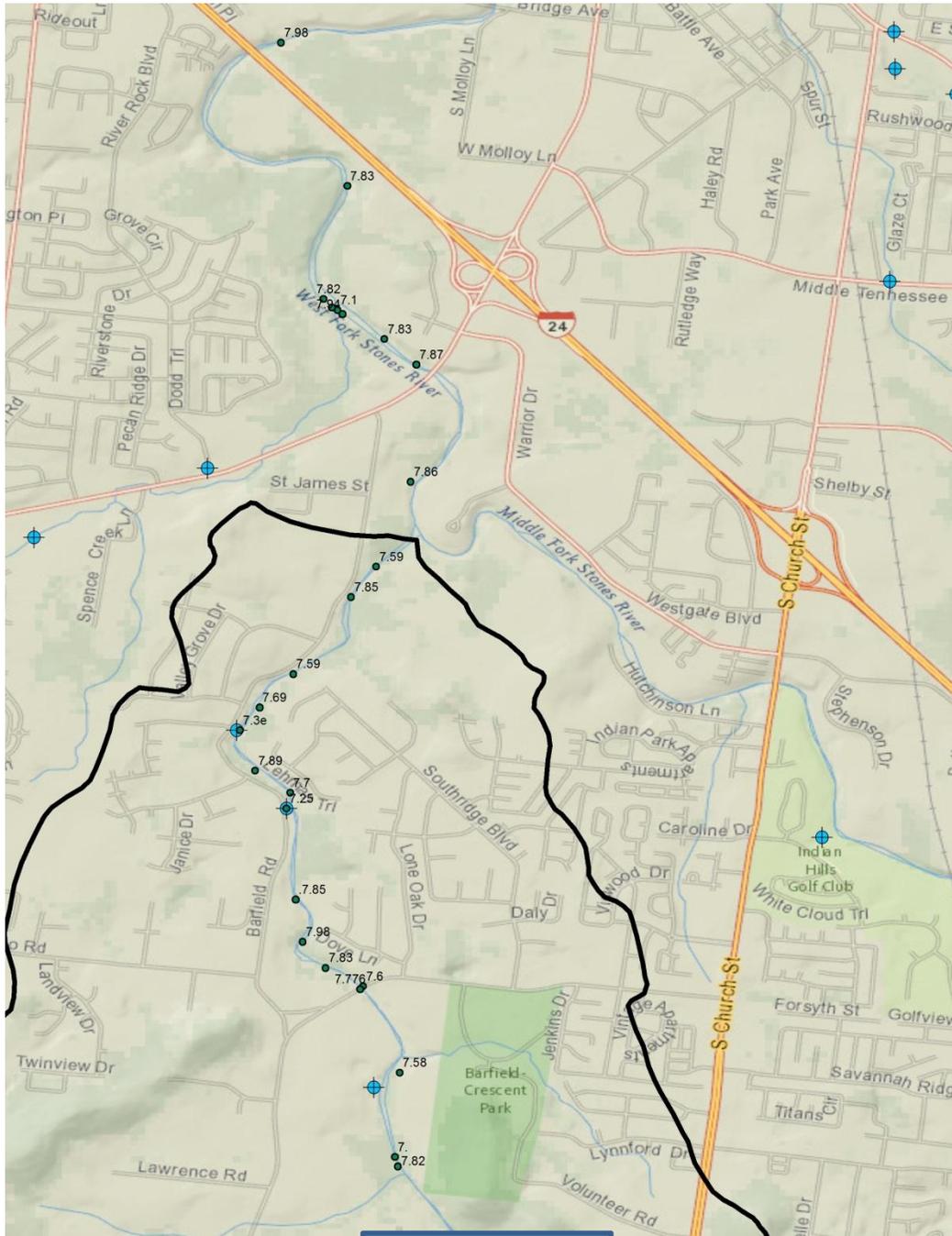
Conductivity

# Upper West Fork Stones River Watershed – Watershed Characterization



Temperature Readings

# Upper West Fork Stones River Watershed – Watershed Characterization



Ph

Upper West Fork Stones River Watershed Characterization

VI. E -coli Sampling

E-coli samples were taken at major springs in the watershed in order to locate any possible pathogen loading. All springs in the watershed displayed a heavy flow rate despite the area being in drought condition at the time of sampling. None of the samples contained a concentration of e-coli more than 20 MPN's indicating that there is no base flow contribution of e-coli.



## VII. Benthic Macro Invertebrate Study



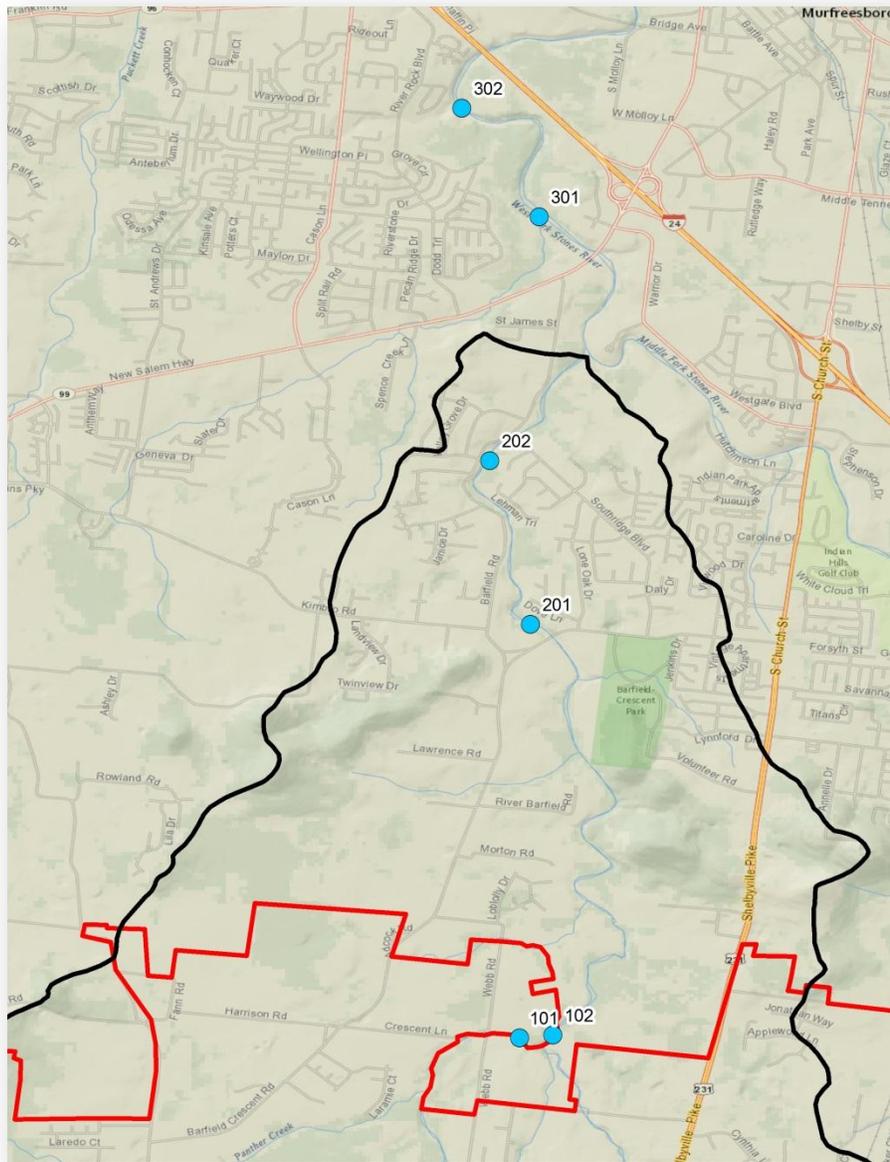
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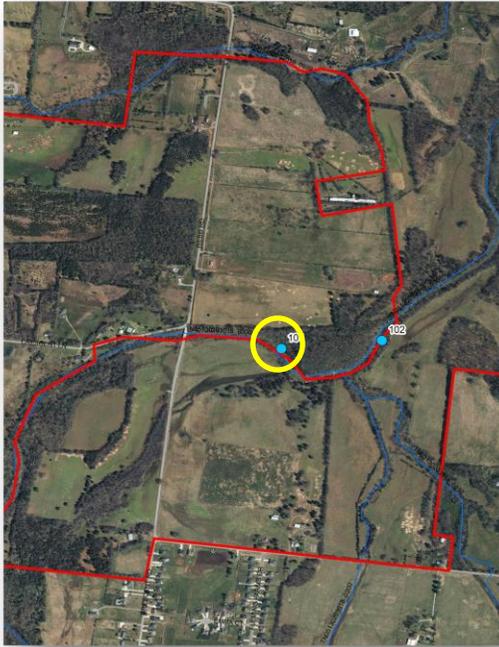
April – June 2012

# Upper West Fork Stones River Watershed – Watershed Characterization

## Introduction

The Murfreesboro Water and Sewer Department, Stormwater Program samples for benthic macro invertebrates as part of its Visual Stream Assessment and Watershed Characterization. At the time of this report no metrics were used to quantify biodiversity but instead general observations of families that were present. The following portion of the report will briefly describe the macro invertebrates found at various stations in the Upper West Fork Stones River Watershed. It is planned to attach a professional analysis using the SQSH method to this characterization in the future which will include all major metrics and scoring criteria.

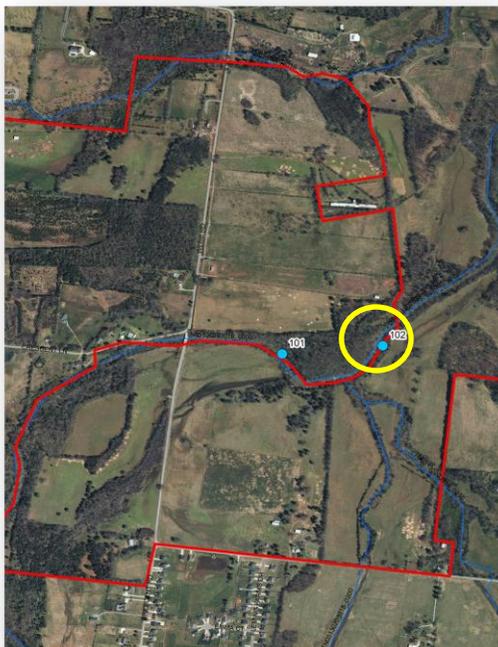




Macro Site 101



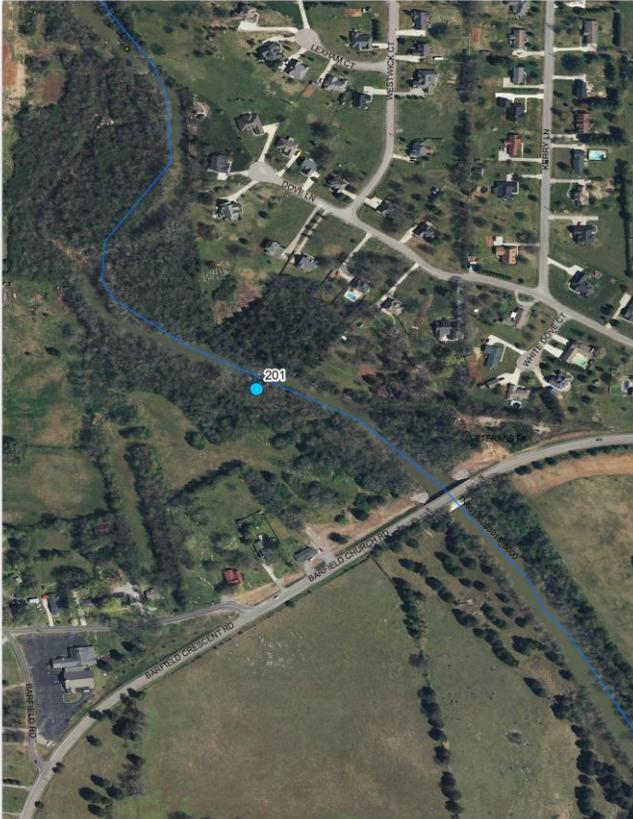
<u>Macrobenthos</u>	<u>Abundance</u>
Gastropoda	Dominant 50 +
Riffle Beetle	Dominant 50 +
Water penny	Dominant 50 +
Halgramite	Common 3-9



Macro Site 102

<u>Macrobenthos</u>	<u>Abundance</u>
Ephemeroptera	Dominant 50 +
Trichoptera Caddisfly	Dominant 50 +
Isopoda	Dominant 50 +
Halgramite	Dominant 50 +
Gastropoda	Dominant 50 +

## Upper West Fork Stones River Watershed – Watershed Characterization



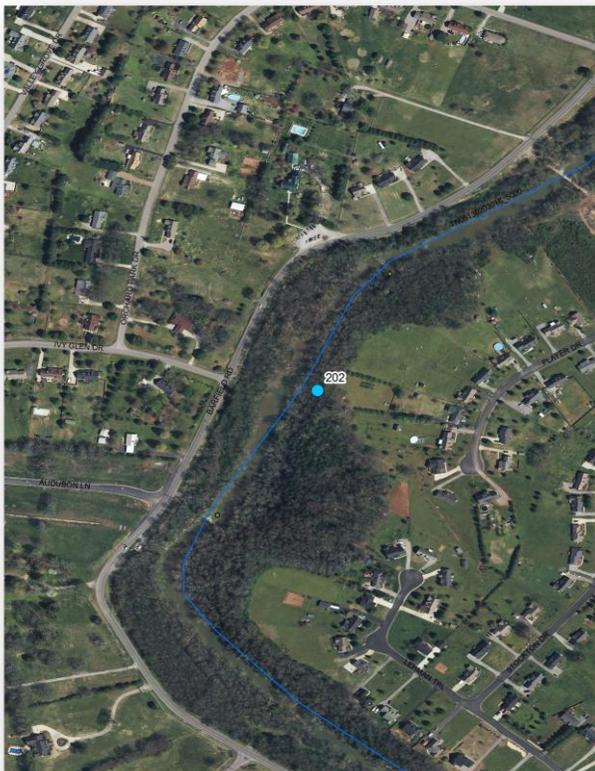
### Macro Site 201



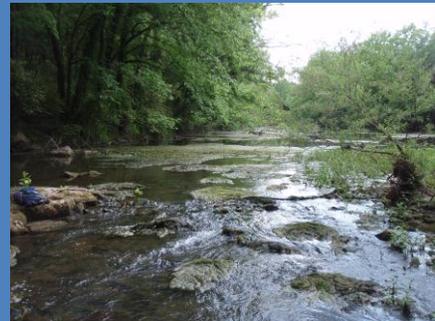
#### Macrobenthos

#### Abundance

Isopoda	Abundant 10 +
Amphipoda	Abundant 10 +
Gastropoda	Abundant 10 +
Plecoptera	Abundant 10 +
Corydalidae	Abundant 10 +
Trichoptera	Abundant 10 +
Coleoptera	



### Macro Site 202



#### Macrobenthos

#### Abundance

Gastropoda	Abundant 10 +
Coleoptera	Abundant 10 +
Ephemeroptera	Abundant 10 +
Trichoptera	Abundant 10 +
Plecoptera	Abundant 10 +

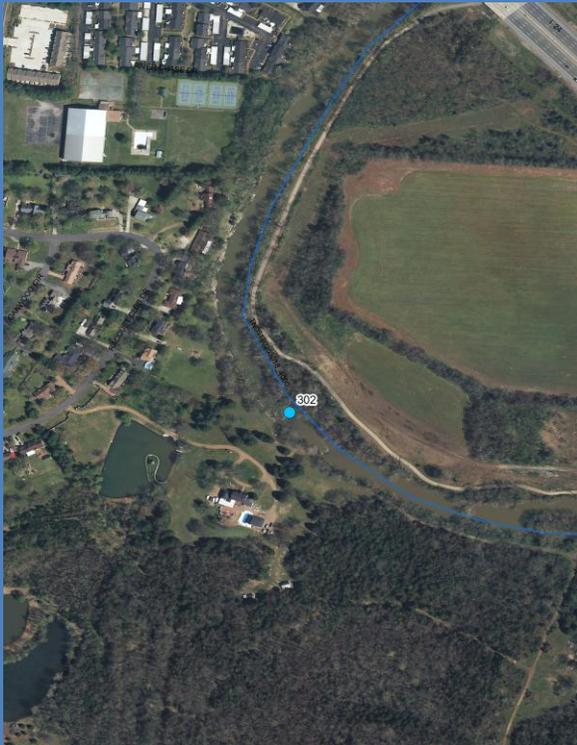
## Upper West Fork Stones River Watershed – Watershed Characterization



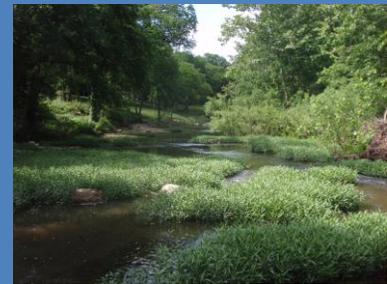
### Macro Site 301



<u>Macrobenthos</u>	<u>Abundance</u>
Ephemeroptera	Abundant 10 +
Trichoptera	Abundant 10 +
Coleoptera	Abundant 10 +
Gastropoda	Abundant 10 +



### Macro Site 302



<u>Macrobenthos</u>	<u>Abundance</u>
Isopoda	Rare 1-3
Gastropoda	Abundant 10 +
Trichoptera	Abundant 10 +
Coleoptera	Abundant 10 +

## 2011 Dry Weather Screening and Illicit Discharge Detection Elimination (West Fork Stones River Watershed)

The city of Murfreesboro is required to detect and eliminate possible illicit discharges under the MS4 Permit rule 4.2.3. The Murfreesboro Water and Sewer Department screens outfalls along a selected stream and junction boxes in “hot spots” yearly in dry weather



conditions to help detect possible illicit discharges. In October of 2011, outfalls on the West Fork Stones River were screened for illicit discharges.

Photographs were taken of all outfall structures screened in addition to the individual structure’s condition and dimensions. The stormwater program also derived “hot spots” which are locations of intense commercial or industrial activities. 8 junction boxes were screened within these hot spots in 2011. All junction boxes and outfalls were screened during dry weather where

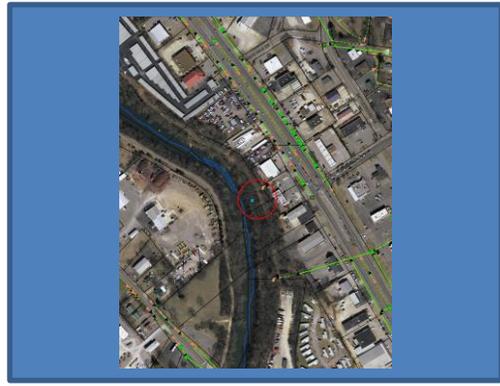
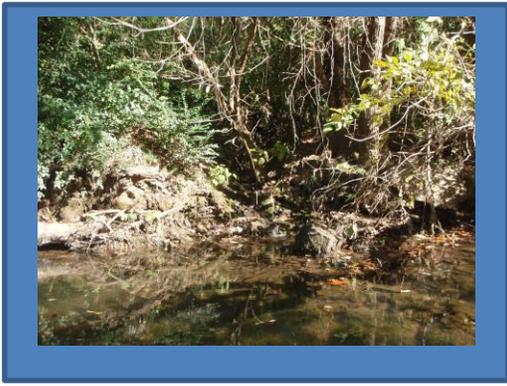
more than 72 hours had passed without precipitation. In order to screen outfalls to the West Fork Stones River, 6.03 miles of the river was canoed. This gave an opportunity to screen the river for other possible problems. All outfalls screened were logged into the MS4 Web stormwater program reporting software with general conditions of the outfalls and pictures.

### Results

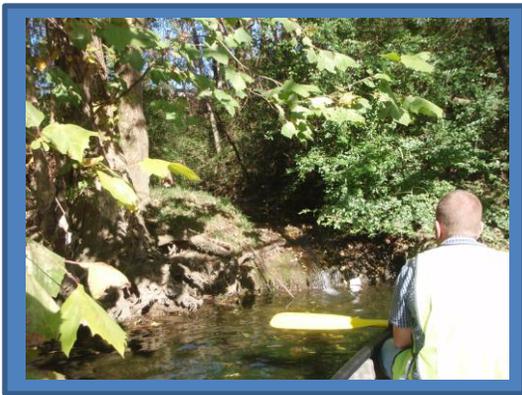
Number of Junction Boxes Screened	Number of Outfalls Screened	Suspected Illicit Discharges or Flows	Illicit Discharges Confirmed
8	31	3	0

### Outfalls with flow

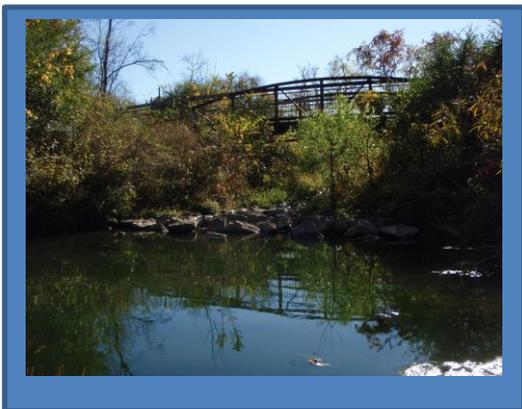
1. Flow emerging from right bank of WFSR looking downstream. Near 1305 NW Broad St. This flow has been monitored in the past and does not seem to be connected to the stormwater system but may be groundwater flow from a perched aquifer. Further research is planned for the possible spring.

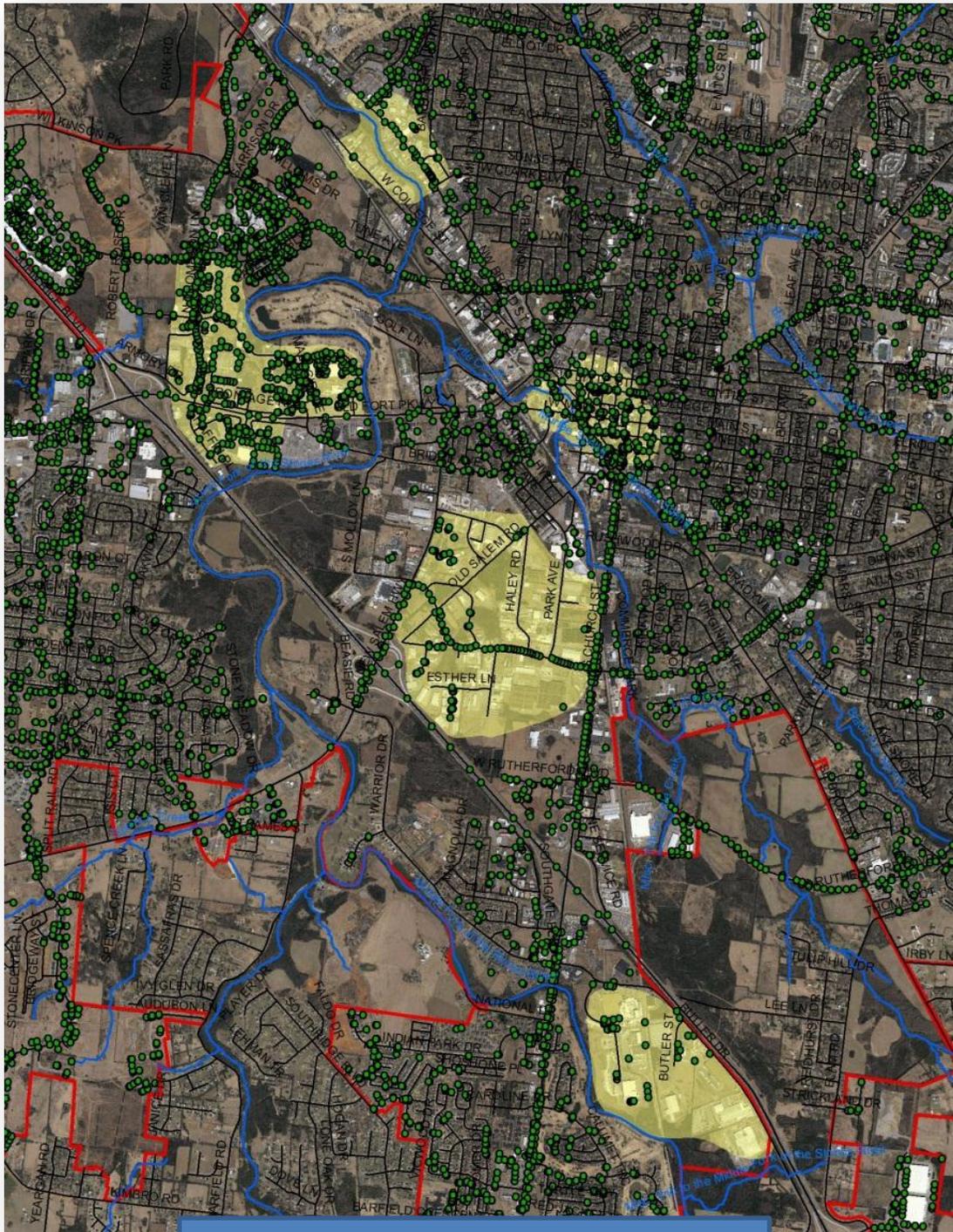


2. Large culvert located approximately 150 ft. off the right bank of the West Fork Stones River near the intersection of NW Broad St and Northfield Blvd. Culvert is thought to be a moderate size spring that has been pipe in conjunction with stormwater infrastructure as indicated on old maps and photography but not confirmed.

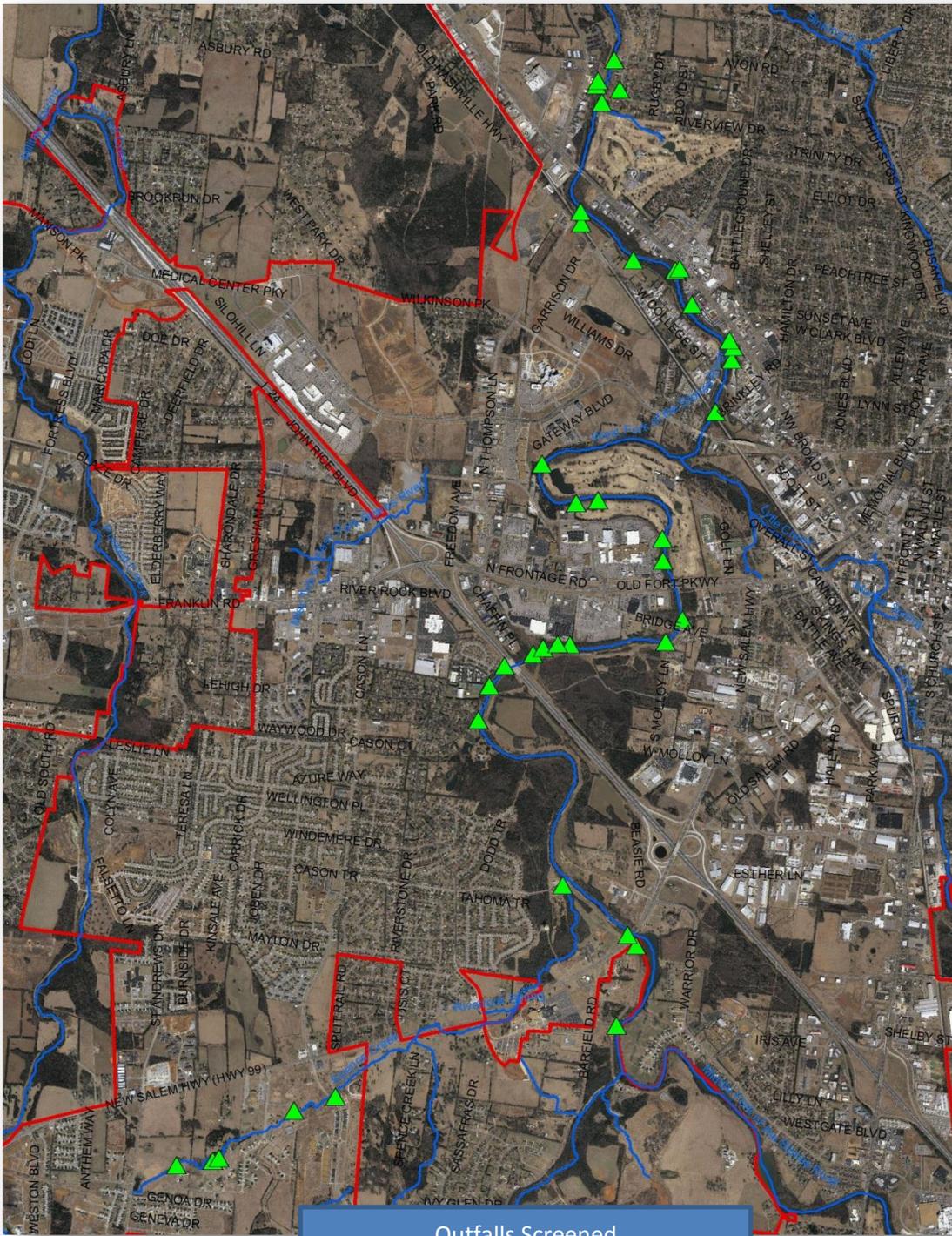


3. Large rip rap ditch and culvert on left bank of the West Fork Stones River near intersection of W. College St. and Hope Way. Flow sampled to have .6 mg/l fluoride and near old dye traces. The flow could be groundwater or loss of water at a nearby lake used for storing re purified water. This area will be continued to be monitored.





Yellow = Hot Spots, Green Dots = Junction Boxes



Outfalls Screened

