



# Missouri Department of Natural Resources

**Cooperative Stream Investigation Project Plan:  
Missouri Department of Natural Resources;  
Missouri Botanical Garden  
Stream Teams 4149 and 5099**

**Deer Creek  
St. Louis County**

**March 2021 – March 2022**

Prepared for:

Missouri Department of Natural Resources  
Division of Environmental Quality  
Water Protection Program  
Water Pollution Control Branch

Prepared by:

Missouri Department of Natural Resources  
Division of Environmental Quality  
Environmental Services Program  
Water Quality Monitoring Section

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## 1.0 Introduction

To assist the Missouri Department of Natural Resources (**Department**), Water Protection Program (**WPP**) and the Missouri Botanical Garden, Deer Creek Watershed Alliance project; Randy Sarver of the Department's Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) initiated a Cooperative Stream Investigation (**CSI**) project to collect total nitrogen, total phosphorus, *E. coli* and chloride samples along with discharge measurements from Deer Creek, St. Louis County, Missouri. The project focus will be in the upper part of the Deer Creek watershed along a 0.9 mile Class C segment of the Water Body Identification (**WBID**) number 4078. In addition, two unnamed Class C reaches that currently have the WBID 3960 will also be monitored. The Missouri Use Designation Dataset (**MUDD**) Version 1.0 includes WBID 3960 as a temporary waterbody code that will be replaced with unique WBIDs in the future.

Designated recreational uses for Deer Creek WBID 4078 are listed as Whole Body Contact – Class B (**WBC-B**) and Secondary Contact Recreation (**SCR**). The Missouri Water Quality Standard (**WQS**) *E. coli* criterion for WBC-B is 206/100 ml Most Probable Number (**MPN**); and SCR is 1134/100 ml MPN. The *E. coli* criterion for the upper segment of WBID 4078 study reach is based on a geometric mean of at least five samples collected during the recreational season (April 1 – October 31).

WBID 4078 is not currently on the impaired waterbody list (**303d list**). However, the downstream WBID 3826 was placed on the United States Environmental Protection Agency (**USEPA**) approved Missouri 303(d) list of impaired waters for impairment by chloride in 2006 and for *E. coli* in 2012. The source of *E. coli* and chloride are listed as Urban Runoff/Storm Sewers.

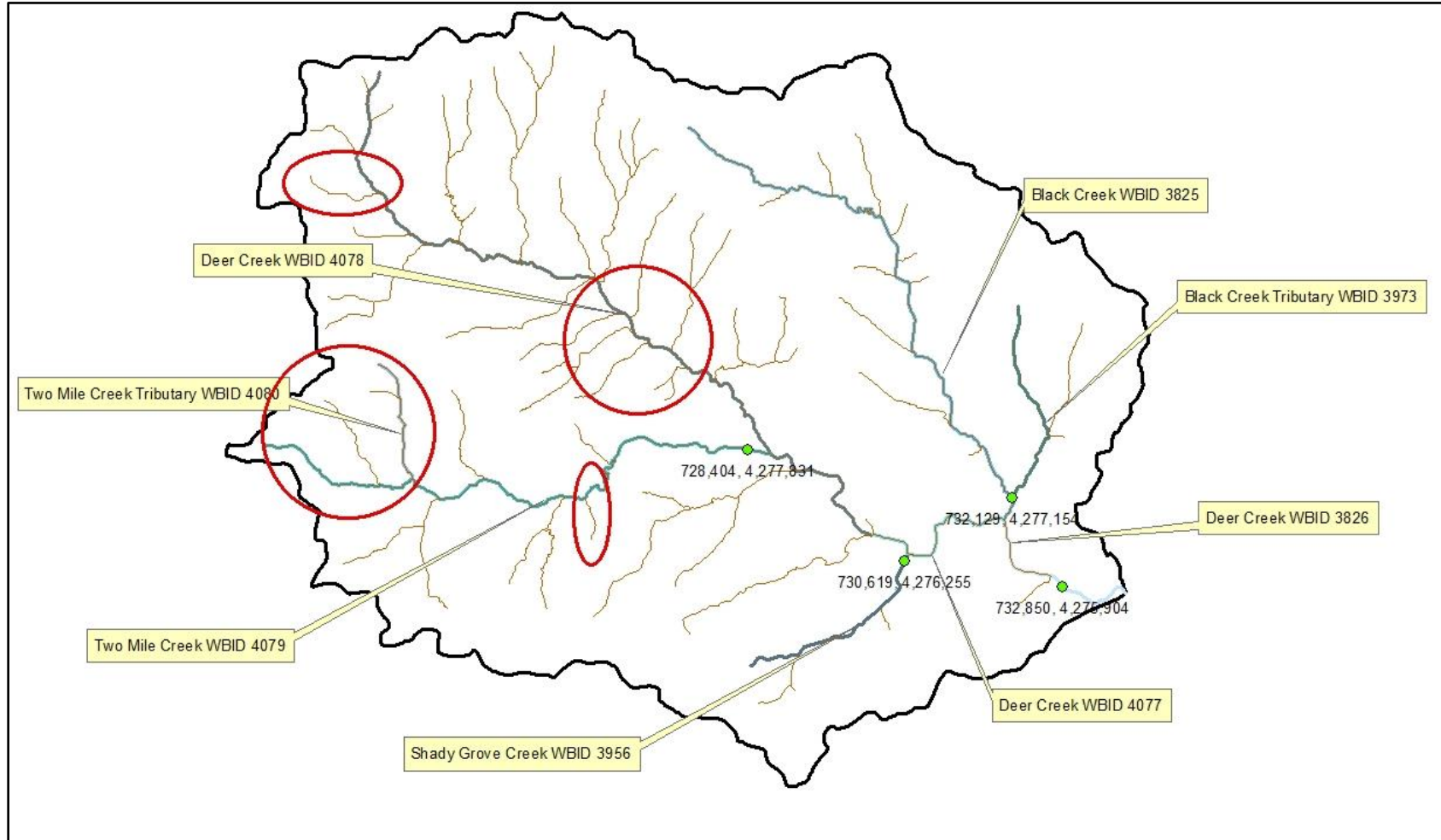
A Total Maximum Daily Load (**TMDL**) for *E. coli* pollution of Deer Creek WBID 3826 was approved in 2019. A chloride TMDL will be completed in the future. TMDLs are developed by the Department in accordance with Section 303(d) of the federal Clean Water Act (**CWA**). Section 303(d) of the CWA and federal regulations in 40 Code of Federal Regulations (**CFR**) Part 131 require TMDL development for waters not meeting designated beneficial uses under technology-based controls for pollutants of concern. The purpose of a TMDL is to determine the maximum amount of a pollutant (the load) that a water body can assimilate without exceeding the Missouri WQS for that pollutant. The TMDL determines the pollutant loading capacity necessary to meet the Missouri WQS established for each water body based on the relationship between pollutant sources and in-stream water quality conditions. The goal of the TMDL program is to restore designated beneficial uses to water bodies. Therefore, identification of sources and implementation of Best Management Practices (**BMP**) to address the sources are critical to watershed restoration.

Historical monitoring results have documented high nutrients, *E. coli* and chloride concentrations in the Deer Creek watershed. Approximately 20% - 60% of the sources of *E. coli* in the watershed are from wildlife and other animals. The St. Louis Metropolitan Sewer District has progressed in reducing sanitary sewer overflows into area creeks and stormwater permits are addressing other human sources of *E. coli*. However, it is not feasible to remove wildlife and animal excrement as a source. Therefore an emphasis on voluntary, plant-based solutions to reduce stormwater runoff is the most effective way to address these additional non-point sources of nutrients and *E. coli* in the watershed and is key to reducing pollutant loads, including *E. coli*, is the reduction of stormwater runoff in the watershed. According to a 2010 USGS study of Metropolitan St. Louis streams, *E. coli* densities and loads typically were many times greater in storm events than at base flow, primarily because loading increased as a result of runoff that contain bacteria contributions from the numerous combined and sanitary sewer overflows within the study area, as well as contributions from nonpoint source runoff. [Occurrence and Sources of Escherichia in Metropolitan St. Louis Streams, October 2004  
<https://pubs.usgs.gov/sir/2010/5150/pdf/sir2010-5150.pdf> ]

To assist in improving water quality, a project through the Missouri Botanical Garden's Deer Creek Watershed Initiative has been funded through the 319 Nonpoint Source Implementation Grant Program. The project was designed in four phases, which include: Phase I (subgrant #G09-NPS-13); Phase II (subgrant #G11-NPS-15); Phase III (subgrant G14-NPS-04); and Phase IV (subgrant G19-NPS-11). All phases implement BMPs that help address the stream bacteria impairment and improve the water quality of Deer Creek.

During the 319 project, maps were developed to help identify high, medium, and low priority planting areas for implementation based on the six criteria of: proximity to floodplain; fragmentation; distance to impervious surface; slope; soil erosion potential; and soil permeability (see Figure 1 for a map of the four priority areas identified for the next three years). Approximately 70-75 stormwater BMPs will be installed through the Deer Creek Watershed Alliance Rainscaping Cost-Share Program during the three-year period 2019 - 2022. BMP implementation will include practices like rain gardens, bioswales, woodland and riparian corridor restoration, permeable pavers, rain barrels, etc. Pre-implementation water quality data will be collected over the next two years (2021 & 2022) in the priority implementation areas to satisfy the monitoring components of the Phase IV 319 Grant (Oct 1, 2019 through September 30, 2022).

**Figure 1**  
**Map of the 2021/2022 Deer Creek Watershed Priority Areas**



## 2.0 Project Objectives

This study will focus on the collection of current water quality data from Deer Creek in St. Louis County, Missouri. Of specific interest are priority areas of Deer Creek and associated tributaries, which have been designated by the ongoing Deer Creek watershed 319 project.

The following objectives have been established for the Deer Creek CSI project:

1. Collect monthly samples for total phosphorus (**TP**) and total nitrogen (**TN**) from March 2021 through March 2022.
2. Collect monthly *E. coli* samples during the recreational season (April 1, 2021 – October 31, 2021).
3. Collect monthly chloride samples during November 2021 through March 2022.
4. Measure stream discharge in association with each sampling event.
5. Send TN, TP, and chloride samples to the Department's ESP for analyses using USEPA approved/accepted standard methods.
6. Analyze temperature, conductivity, and water transparency as field parameters in conjunction with monthly samples. Analyses will use Missouri Stream Team, Volunteer Water Quality Monitoring (**VWQM**) Program procedures.
7. Use resulting nutrient and *E. coli* bacteria data to establish concentrations and loading prior to implementation of BMPs.
8. Use resulting chloride data to assess water quality.

## 3.0 Project Planning

Beginning in May 2020, Mr. Randy Sarver, VWQM Coordinator with the Department, and Ms. Stacy Arnold began e-mail discussion to investigate the possibility of a CSI Project on Deer Creek. Ms. Arnold is a Stream Team, Level 3, VWQM volunteer, a member of Stream Team's 2926 & 4149, serves on the Board of Stream Teams United, and works as the Rainscaping & Deer Creek Watershed Initiative Coordinator for the Missouri Botanical Garden.

On June 30, 2020, Ms. Arnold shared the Deer Creek, Phase IV, Water Quality Monitoring Proposal. Mr. Sarver conducted a phone discussion with Ms. Arnold to discuss the potential CSI project. The conversation mainly focused on the time commitment and objectives of the project. Ms. Arnold continued to express interest in the project and agreed that Stream Team 4149 should have the time needed to participate in the project.

On September 16, 2020, Mr. Sarver proposed the addition of another VWQM volunteer to the project. Mr. Sarver talked to Steve McCarthy, a Stream Team, Level 3, VWQM volunteer that lives close to Deer Creek, about cooperating in the water quality monitoring project. The added man-power would allow more intensive collection of samples in conjunction with measuring stream discharge. Mr. McCarthy agreed to participate in the project.

On September 24, 2020, Mr. Sarver performed field reconnaissance of Deer Creek to look for access to monitoring locations that would be needed to monitor water quality responses to future BMP implementation areas.

On October 21, 2020 Steve McCarthy also performed field reconnaissance of Deer Creek to look for access to monitoring locations. Five locations were found to be satisfactory along the Deer Creek stream segment of interest. Some access locations are on public property, others access locations are on private property and will need landowner permission to access the stream.

On October 27, 2020 a WebEx meeting was held between Mr. Sarver, Ms. Arnold, Mr. McCarthy, and Mrs. Elisa Edge (Department, ESP) to discuss project details and to plan a monitoring schedule.

#### **4.0 Sampling Location**

Sampling will be focused at five locations in the headwaters of Deer Creek. This area has been designated as Deer Creek Priority Area 02 (**DC-02**). See Figure 2 for the actual BMP planning map for priority area DC-02. Three sampling stations are planned for Deer Creek (WBID 4078) and two sampling stations are planned for unnamed tributaries to Deer Creek (WBID 3960). See Figure 3 for a map of the sampling locations.

Site 4078/5.9/0.1 is located on an unnamed tributary to Deer Creek (WBID 3960); approximately 170 meters SW from the end of Mosley Road. The site was established with the goal of acting as a control site, since it is outside the southern edge of the DC-02 BMP implementation area. GIS map derived UTM coordinates are: 723615 Easting and 4280881 Northing.

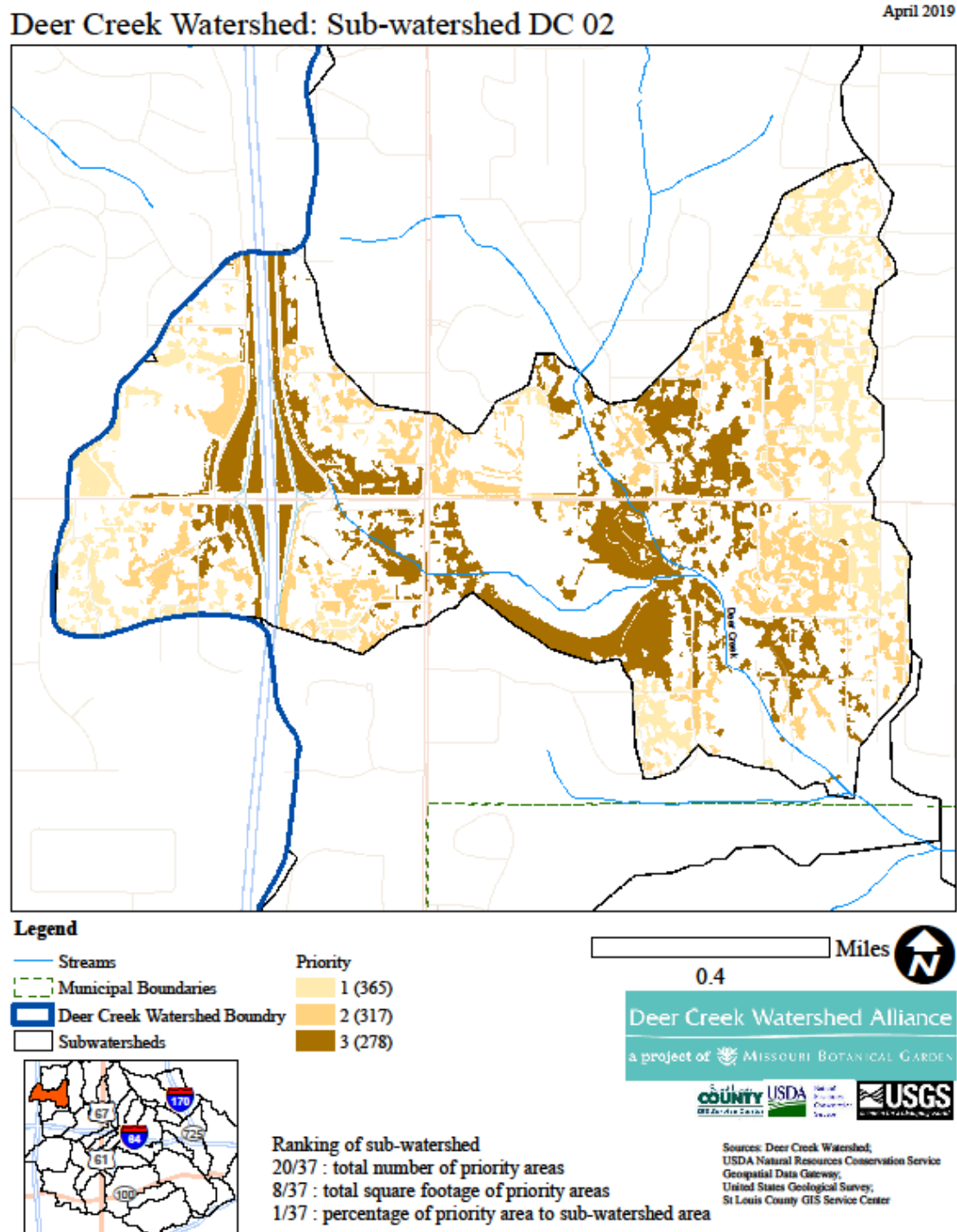
Site 4078/6.0 is located on Deer Creek (WBID 4078); approximately 150 meters SW from the end of Mosley Road. The site was established with the goal of evaluating pollutants leaving DC-02. GIS map derived UTM coordinates are: 723624 Easting and 4280896 Northing.

Site 4078/6.4/0.1 is located on an unnamed tributary to Deer Creek (WBID 3960); approximately 100 meters downstream from the Westchester Lake outfall. The site was established with the goal of evaluating pollutants contributed from Westchester Lake watershed. GIS map derived UTM coordinates are: 723203 Easting and 4281462 Northing.

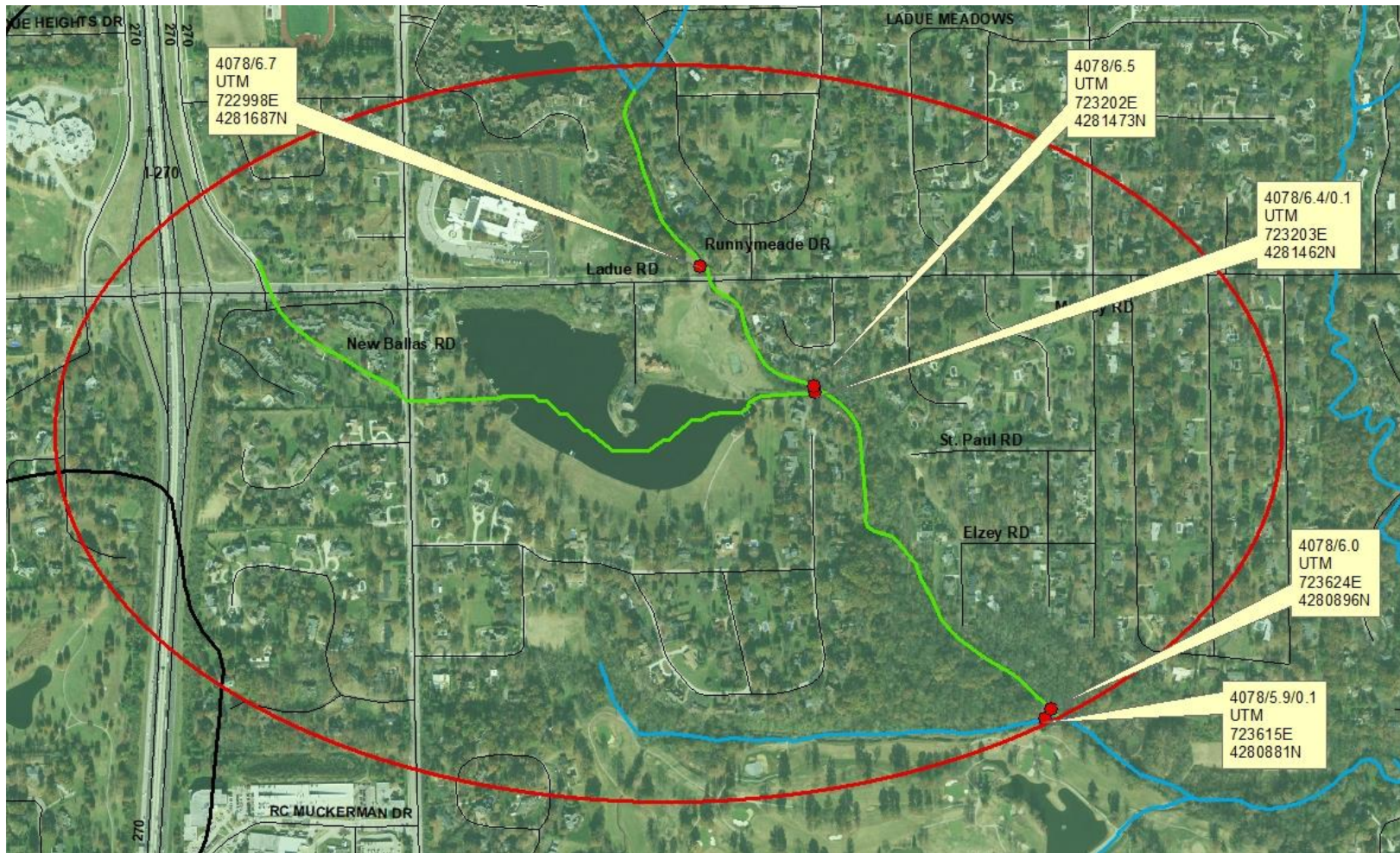
Site 4078/6.5 is located on Deer Creek (WBID 4078); approximately 20 meters upstream from the mouth of the unnamed tributary draining from Westchester Lake. The site was established with the goal of evaluating pollutants from the mid-reach of Deer Creek in DC-02. GIS map derived UTM coordinates are: 723202 Easting and 4281473 Northing.

Site 4078/6.7 is located on Deer Creek (WBID 4078); approximately 75 meters upstream from Ladue Road. The site was established with the goal of evaluating pollutants from the upper-reach of Deer Creek in DC-02. GPS derived UTM coordinates are: 722998 Easting and 4281687 Northing; with 5.0 meter accuracy.

**Figure 2**  
**Map of DC-02 Priority Area**



**Figure 3**  
**Map of Deer Creek Sampling Location**



## 5.0 Sampling Method

Standard method samples for TP, TN, and chloride parameters, will be collected according to standard operating procedures (SOP) MDNR-ESP-001: Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations; and MDNR-ESP-005: General Sampling Consideration Including the Collection of Grab, Composite, and Modified Composites from Streams and Wastewater Flows. Each sample will be accompanied by an appropriate Chain-of-Custody, as detailed in MDNR-ESP-002: Field Sheets and Chain-of-Custody Record. Sample collection and chain-of custody training will be provided to the volunteers by the ESP, VWQM Coordinator.

Discharge will be measured following the SOP MDNR-ESP-113: Flow Measurement in Open Channels, and will be reported on the Chain-of-Custody. Training will be provided to the volunteers by the ESP, VWQM Coordinator.

On the day of collection, nutrient and chloride samples will be delivered to a drop-off location for shipment to the Department's ESP for analyses. A memorandum of understanding has been developed between the Missouri Department of Health and Human Services to facilitate sample shipment to Jefferson City from sites throughout the state. Information concerning the most applicable drop-off location is as follows:

Facility: St. Luke's Hospital  
Address: 232 South Woodsmill Road, Chesterfield  
Phone: (314) 205-6984  
Contact Person: Don Darren  
Location: 2nd Floor Lab  
Pick-up Time: 1:40 p.m.  
Hours of Operation: 7:00 am - 5:30 pm

Also on the day of collection, *E. coli* samples will be relinquished to Mrs. Edge, a Department Environmental Specialist with the ESP, WQMS. Mrs. Edge is housed at Route 66 State Park, has a complete set of IDEXX equipment, and will analyze the samples prior to the 8-hour holding time limit.

## 5.1 Sampling Schedule

Standard method nutrient samples and discharge measurements will be collected monthly from March 2021 – March 2022. Standard method *E. coli* samples will be collected from April 2021 – October 2022. Standard method chloride samples will be collected from November 2021 – March 2022. VWQM field analyses will occur in conjunction with each standard method sample collections. One set of duplicate samples will be randomly collected from one sampling station during each sampling event (see Table 1 –Sample Collection Schedule).

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**Table 1**  
**Sample Collection Schedule (2021 – 2022)**

[illegible]

## 5.2 Stream Team Sampling Responsibilities

- Use appropriate methods to collect and preserve monthly TP, TN, *E. coli* and chloride water samples for standard method analyses.
- Prepare equipment and perform field analyses of temperature, conductivity, and water transparency using VWQM methods. Record the data in the comment field of the Chain-of-Custody.
- Fill out appropriate sample information on the Department's Chain-of-Custody.
- On the same day as collection, and prior to the designated pickup time, drop the nutrient and chloride samples at the courier locations for shipment to the Department's ESP.
- On the same day of collection, deliver the *E. coli* samples to Mrs. Edge within 6 hours of collection.

## 5.3 Department Sampling Responsibilities

- Provide sample containers
- Provide chain-of-custodies for samples.
- Provide training for TP, TN, and chloride sample collection and preservation.
- Provide H<sub>2</sub>SO<sub>4</sub> preservative for TP and TN sample preservation.
- Provide training for performing stream discharge measurements.
- Provide training for proper chain-of-custody use.
- Provide sample labels
- Provide shipping containers for shipping samples.
- Pick up shipped samples at the Health Department Laboratory in Jefferson City.

## 6.0 Stream Flow Measurements

When possible, monthly stream flow measurements will be taken during each sampling event (see Table 1). This will supplement United States Geological Survey (USGS) stream gauge discharge data for Deer Creek. The USGS gauge code for Deer Creek is 07010086 and its location is at the South Big Bend Blvd. Bridge, which is approximately 19.0-20.0 miles downstream from the study reach in WBID 4077. Although stream discharge is not necessary in locating sources of bacteria, it may prove useful in providing additional information for implementation activities or in calculating loading of nutrients, chloride, and *E. coli* concentrations. Flow measurement training will be provided to Ms. Arnold and Mr. McCarthy following the SOP MDNR-ESP-113, Flow Measurements in Open Channels.

## 6.1 Stream Team Flow Measurement Responsibilities

- Provide the flow meter and associated equipment.
- Attend training provided by the ESP, VWQM Program Coordinator.
- Follow Department Standard Operating Procedure for measuring open channel flow.
- Collect discharge measurement in association with water samples.

- Record discharge measurements on the Department's Chain-of-Custody form.

## **6.2 Department Flow Measurement Responsibilities**

- Provide flow measurement training.
- Provide the Department's SOP MDNR-ESP-113.
- Provide flow measurement data collection forms.

## **7.0 Sample Analysis**

Analyses of samples will follow two general approaches. One approach will use USEPA approved/accepted standard methods; the other will use VWQM methods.

### **7.1 Standard Method Nutrient Analyses**

The standard analytical methods used by ESP for TP and TN analyses are:

- Total Phosphorus (USGS I-2650-03 – Modified by ESP)
- Total Nitrogen (USGS I-2650-03 – Modified by ESP)

### **7.2 Standard Method *E. coli* Analyses**

The standard method used by ESP for *E. coli* analysis is:

- The Department's Standard Operating Procedure MDNR-ESP-109, Analysis of *E. coli* and Total Coliforms Using IDEXX Colilert and Quanti-Tray Test Method, based on USEPA methods.

### **7.3 Standard Method Chloride Analyses**

The standard analytical method used by ESP chloride analysis is:

- SM 4500 Cl- G; Mercuric Thiocyanate Flow Injection Analysis.

### **7.4 VWQM Method Analyses**

At the time of sample collection for standard method analyses, water will be analyzed streamside using VWQM Program SOPs. Parameters to be collected include temperature, conductivity, and water transparency. Temperature and conductivity will be analyzed using Hach Pocket Pro model meters; and water transparency will be analyzed using a VWQM water transparency tube. Applicable VWQM Program SOPs can be found at <http://www.mostreamteam.org/training-materials-and-resources.html>.

## **8.0 Data Reporting**

Data generated from CSI projects are collected for specific purposes. In order to meet the objectives of this project, data must be available for assessment purposes. The Deer Creek CSI Project data will be entered and housed in the ESP Laboratory Information Management System (LIMS).

### **8.1 Stream Team Data Reporting Responsibilities**

- Results from discharge measurements will be reported as a field parameter on the appropriate Department Chain-of-Custody.
- Since analyses for temperature, conductivity, and water transparency will utilize VWQM Program procedures, the results will be entered into the comment field of the chain-of-custody.

### **8.2 Department Data Reporting Responsibilities**

- Analytical results for TP, TN, *E. coli*, and chloride will be reported via the ESP LIMS.
- Analytical results for temperature, conductivity, and water transparency will be reported via the ESP LIMS; however, the results will be located as text in the comments field.
- Analysis will be charged to Labor Distribution Profile (**LDPR**) code, Volunteer Monitoring (**FEVLM**) and will automatically be provided to the Project Manager in the WPP. After receipt by the WPP, data will be entered into the Water Quality Assessment (**WQA**) database.
- A final report will be written by the ESP, VWQM Coordinator.

## **9.0 Quality Assurance/Quality Control (QA/QC)**

Accurate and precise data is needed in any monitoring project. As part of quality assurance, one field audit will be conducted by the VWQM Coordinator. Additionally, standard QA/QC procedures incorporated into specific SOPs will be followed during the project and duplicate samples will be collected for two sampling dates (see Table 1 Sample Collection Schedule).

### **9.1 Stream Team QA/QC Responsibilities**

- Follow standard procedures for field analyses, sample collection, and sample preservation.
- Collect duplicate samples for nutrients, chloride, and *E. coli* during each sampling event (see Table 1 – Sampling Collection Schedule).

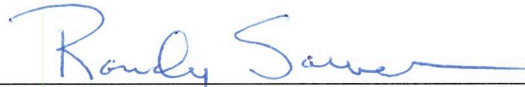
### **9.2 Department QA/QC Responsibilities**

- Review chemical parameter data for values outside QC limits.

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- Review training with volunteers if necessary.
- Make one yearly field audit during the life of the project.
- Update the project plan as necessary.

Submitted by:



Randy Sarver  
Environmental Scientist  
Water Quality Monitoring Unit  
Environmental Services Program

Date:

1.5.2021

Approved by:



Lynn Milberg  
Chief  
Water Quality Monitoring Section  
Environmental Services Program

LM:rsh

- c: Robert Voss, Water Protection Program  
Mike Kruse, Water Protection Program  
Trish Rielly, Soil and Water Conservation Program  
Dorothy Franklin, St. Louis Regional Office