Missouri Department of Natural Resources

Cooperative Stream Investigation Project Plan: Missouri Department of Natural Resources, and Stream Teams 2926, 4149, 5099, 6186, & 2760

Deer Creek Watershed
St. Louis County

April 2025 – October 2025

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
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Table of Contents

1.0 Introduction

To assist the Missouri Department of Natural Resources (**Department**), Water Protection Program (**WPP**), 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, total suspended solids, and *E. coli* samples along with discharge measurements from Deer Creek watershed, St. Louis County, Missouri. The project focus will be in the upper and middle mainstem segments of Deer Creek, as well as near the mouths of eight major tributaries.

The mainstem of Deer Creek has been assigned three Waterbody Identification Numbers (**WBID**). The upper segment (WBID 4078) is 9.2 miles long and has eight major tributaries. Only one of the major tributaries has been assigned a WBID (Two-mile Creek; WBID 4070). The mid-reach segment of Deer Creek (WBID 4077) is 1.6 miles long and has one major tributary that has been assigned a WBID (Shady Grove Creek; WBID 3956). The lower reach segment of Deer Creek (WBID 3826) is 3.7 miles in length and has two major tributaries that have been assigned a WBID (Black Creek; WBID 3825 and Hampton Branch; WBID 3973). Deer Creek also receives seven tributaries that do not have WBIDs and that have been assigned the temporary WBID of 5026. The Missouri Use Designation Dataset (**MUDD)** Version 1.0 includes WBID 5026 as a temporary waterbody code that will be replaced with unique WBIDs in the future.

Designated recreational uses for Deer Creek WBID 4078, Two-mile Creek WBID 4070, Shady Grove Creek WBID 3956, and Black Creek WBID 3825 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 Most Probable Number (**MPN**) per 100 ml. The WQS for SCR is 1134 MPN per 100 ml. The *E. coli* criterion is based on a geometric mean of at least five samples collected during the recreational season (April 1 – October 31).

Designated recreational uses for Deer Creek WBID 4077 and WBID 3826 are listed as Whole Body Contact – Class A (**WBC-A**) and SCR. The Missouri WQS *E. coli* criterion for WBC-A is 126 MPN per 100 ml. The WQS for SCR is 1134 MPN per 100 ml. The *E. coli* criterion is based on a geometric mean of at least five samples collected during the recreational season (April 1 – October 31).

The *E. coli* criteria listed in the previous two paragraphs refers to gaining stream segments. Losing stream segments have a unique *E. coli* criterion of 126 MPN at any time of the year. Deer Creek has two losing segments. The segment of WBID 4078 downstream of I-64 is designated as losing as well as the entire segment of WBID 4077.

Deer Creek WBID 4077 and Two-mile Creek WBID 4079 were placed on the USEPA approved 303(d) list of impaired waters for impairment by *E. coli* in 2022 and 2016

respectively. The source of *E. coli* is listed as Urban Runoff/Storm Sewers or Source Unknown.

Total Maximum Daily Loads (**TMDL**) for *E. coli* pollution of Deer Creek WBID 3826 and Black Creek WBID 3825 were approved in 2019. *E. coli* TMDLs for Two-mile Creek WBID 4079 and Deer Creek 4077 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 levels of nutrients and *E. coli* concentrations in the Deer Creek 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]

Over the past decade the Missouri Botanical Garden and the Deer Creek Watershed Alliance have developed a program in the Deer Creek watershed to emphasize voluntary, plant-based solutions to reduce nonpoint source pollutants in stormwater runoff. These best management practices are believed to be an effective way to address nonpoint source nutrients and *E. coli* in the watershed and may be key to reducing loading of these pollutants.

2.0 Project Objectives

This study will focus on the collection of water quality data from the Deer Creek watershed in St. Louis County, Missouri. Of specific interest are sampling sites without current data. This project's data will help the department understand the source of nutrients, total suspended solids, and *E. coli.* Understanding the source of pollutants is key to tracking and updating best management water quality targets for the ongoing Deer Creek watershed 319 project managed by the Missouri Botanical Gardens and the Deer Creek Watershed Alliance.

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

1. Collect monthly samples for total phosphorus (**TP**), total nitrogen (**TN**), and total suspended solids (**TSS**) from April 2025 through October 2025.
2. Collect monthly *E. coli* samples during the recreational season (April 1, 2025 – October 31, 2025).
3. Measure stream discharge, temperature, and dissolved oxygen as field parameters in association with each sampling event using USEPA approved/accepted standard methods.
4. Send TN, TP, and TSS samples to the Department's ESP for analysis using USEPA approved/accepted standard methods (hereafter referred to as **standard methods**).
5. Send *E. coli* samples to the Department's St. Louis Regional Office for analysis using USEPA approved/accepted standard methods.
6. Analyze 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, TSS, dissolved oxygen, and *E. coli* bacteria data to establish concentrations and loading prior to implementation of BMPs.
8. Use temperature, conductivity, and transparency as supplementary data in evaluating BMPs.

3.0 Project Planning

Beginning in August 2024, Mr. Randy Sarver, VWQM Coordinator with the Department, and Ms. Stacy Arnold began discussions to investigate the possibility of a CSI Project on the main stem of Deer Creek and major Deer Creek tributaries. Ms. Arnold is a Stream Team, Level 3, VWQM volunteer; a member of Stream Teams 2926 and 4149; a Stream Teams United volunteer and former Board Member; and a VWQM cooperator in four previous CSI Projects in the Deer Creek watershed (the 2021-2022 Deer Creek CSI Project, the 2022-2023 Windrush Creek CSI Project, the 2023-2024 Two-mile Creek CSI Project, and the 2024-2025 Shady Grove Creek CSI Project). Mr. Steven McCarthy, a Stream Team Level 3 VWQM volunteer and member of Stream Team 5099, has also agreed to participate in the Deer Creek watershed monitoring project. Mr. McCarthy is a Stream Team, Level 3, VWQM member; and was a VWQM cooperator in the same four CSI Projects as Ms. Arnold.

On July 31, 2024, Mr. Sarver recruited Ms. Katie Franke, a Stream Team, Level 2 VWQM Program member and member of Stream Team 6186. The addition of Ms. Franke will allow the creation of a second sampling team which will result in a timelier collection of samples and stream discharge.

On August 26, 2024, Mr. Sarver also recruited two more VWQM Program members as part of a second sampling team for the project. Mr. Adam Rembert, a Stream Team, Level 2 VWQM Program member and Mr. Bob Virag, a Stream Team, Level 3 VWQM Program member will allow additional manpower for timely collection of samples and stream discharge. Mr. Rembert and Mr. Virag are members of Stream Team 2760.

On September 10, 2024, Mr. Sarver and Mr. Rembert performed field reconnaissance of lower Deer Creek watershed locations to look for access to water quality monitoring sites.

On October 29, 2024, Mr. Sarver, Mr. Rembert, and Ms. Arnold performed field reconnaissance of upper Deer Creek watershed locations to look for access to water quality monitoring sites.

4.0 Sampling Location

Sampling for this project will be focused at ten locations in the Deer Creek watershed. Two sampling locations will be located on the Deer Creek mainstem, and eight sampling locations will be located on major tributaries to Deer Creek. See Figure 1 for a general map of the sampling locations.

Site 3973/0.25 (Hampton Branch – WBID 3973) is located in Kellogg Park at 2531 Circle Drive. GPS derived Universal Transverse Mercator (UTM) coordinates are: 732332 Easting and 4277477 Northing in Zone 15. The accuracy is ±6.0 meters. UTM coordinates were converted to decimal degrees of 38.615400 latitude and -90.331529 longitude. See Figure 2 for a more detailed map of the sampling location.

Site 4077/0.87 (Deer Creek – WBID 4077) is located Approximately 500 meters downstream from the Brentwood Blvd. Bridge. GPS derived Universal Transverse Mercator (UTM) coordinates are: 731039 Easting and 4276476 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees, of 38.606730 latitude and -90.346697 longitude. See Figure 3 for a more detailed map of the sampling location.

Site 4077/1.6/0.32 (Rock Hill Creek – WBID 5026) is located immediately upstream from Des Peres Avenue Bridge. GPS derived UTM coordinates are: 729794 Easting and 4276417 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.606520 latitude and -90.361000 longitude. See Figure 4 for a more detailed map of the sampling location.

Site 4078/1.1/0.2 (Unnamed Tributary to Deer Creek – WBID 5026) is located immediately downstream from the driveway bridge to 19 Overbrook Drive. GPS derived UTM coordinates are: 728750 Easting and 4277543 Northing in Zone 15. The accuracy is ±6.0 meters. UTM coordinates were converted to decimal degrees of 38.616930 latitude and -90.372608 longitude. See Figure 5 for a more detailed map of the sampling location.

Site 4079/0.20 (Two-mile Creek – WBID 4079) is located immediately upstream from the Overbrook Drive Bridge at 25 Overbrook Drive. GPS derived UTM coordinates are: 728390 Easting and 4277844 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.619730 latitude and -90.376640 longitude. See Figure 6 for a more detailed map of the sampling location.

Site 4078/2.15/0.02 (Unnamed Tributary to Deer Creek – WBID 5026) is located approximately 0.5 miles upstream from the Litzinger Road Bridge. GPS derived UTM coordinates are: 727933 Easting and 4278877 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.629150 latitude and -90.381546 longitude. See Figure 7 for a more detailed map of the sampling location.

Site 4078/2.62/0.03 (Unnamed Tributary to Deer Creek – WBID 5026) is located immediately downstream from South 40 Drive @ greenway trail bridge. GPS derived UTM coordinates are: 727315 Easting and 4279272 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.632860 latitude and -90.388510 longitude. See Figure 8 for a more detailed map of the sampling location.

Site 4078/3.99/0.07 (Denny Creek -WBID 5026) is located immediately upstream from Conway Road. GPS derived UTM coordinates are: 726188 Easting and 4280354 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.642890 latitude and -90.401093 longitude. See Figure 9 for a more detailed map of the sampling location.

Site 4078/4.71/0.09 (Monsanto-Sunswept Creek – WBID 5026) is located immediately upstream from Glen Abbey Drive. GPS derived UTM coordinates are: 725196 Easting and 4280664 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.645940 latitude and -90.412376 longitude. See Figure 10 for a more detailed map of the sampling location.

Site 4078/6.0 (Deer Creek - WBID 4078) is located approximately 150 meters SW from the end of Mosley Road. GPS derived UTM coordinates are: 723624 Easting and 4280896 Northing in Zone 15. The accuracy is ±5.0 meters. UTM coordinates were converted to decimal degrees of 38.648420 latitude and -90.430351 longitude. See Figure 11 for a more detailed map of the sampling location.

Figure 1
Map of the Deer Creek Watershed Sampling Locations

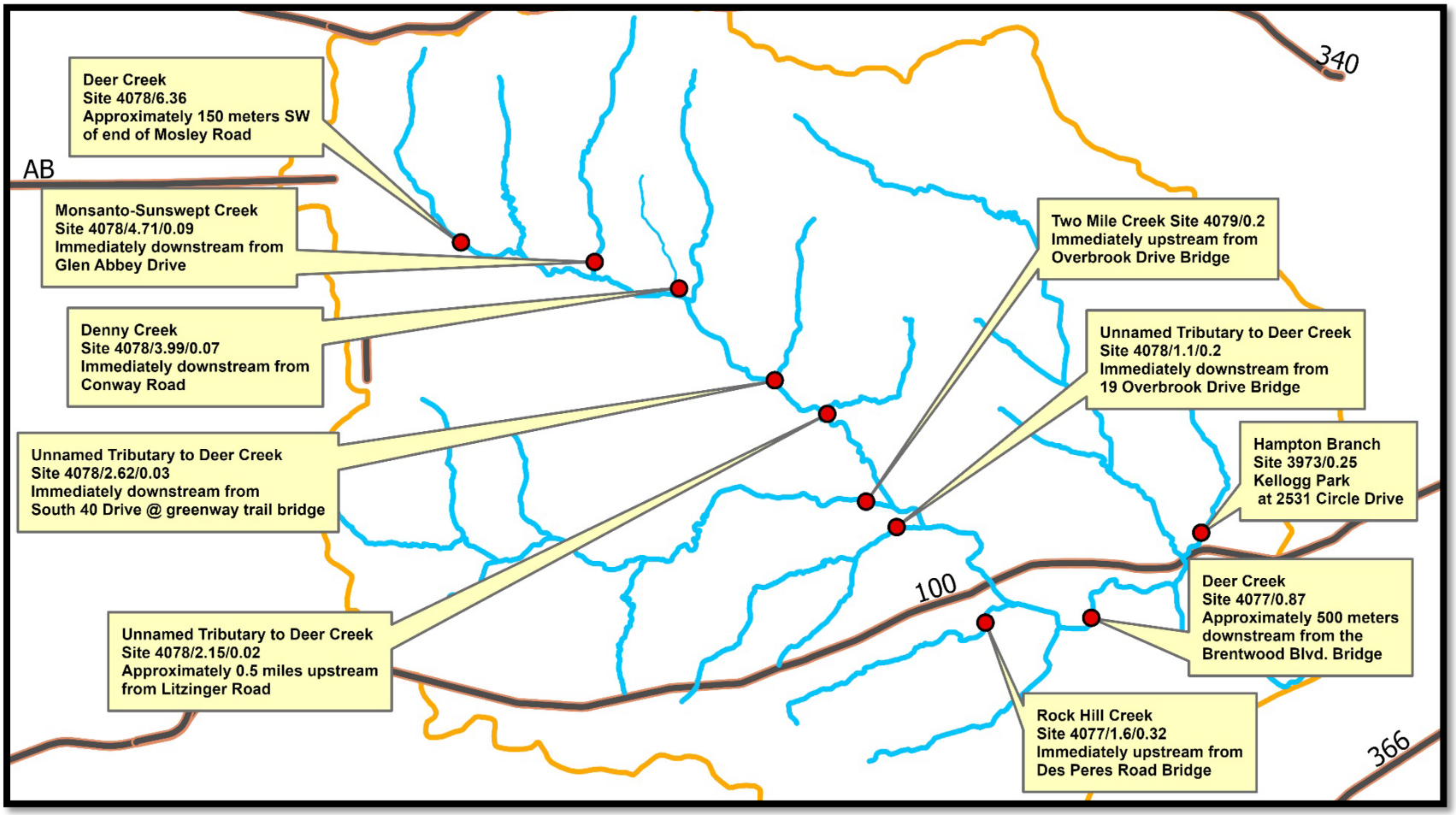

Figure 2
Map of Hampton Branch: Site 3973/0.25

Figure 3
Map of Deer Creek: Site 4077/0.87

Figure 4
Map of Rock Hill Creek: Site 4077/1.6/0.32

Figure 5
Map of Unnamed Tributary to Deer Creek: Site 4078/1.1/0.2

Figure 6
Map of Two-mile Creek: Site 4079/0.20

Figure 7
Map of Unnamed Tributary to Deer Creek: Site 4078/2.15/0.02

Figure 8
Map of Unnamed Tributary to Deer Creek: Site 4078/2.62/0.03

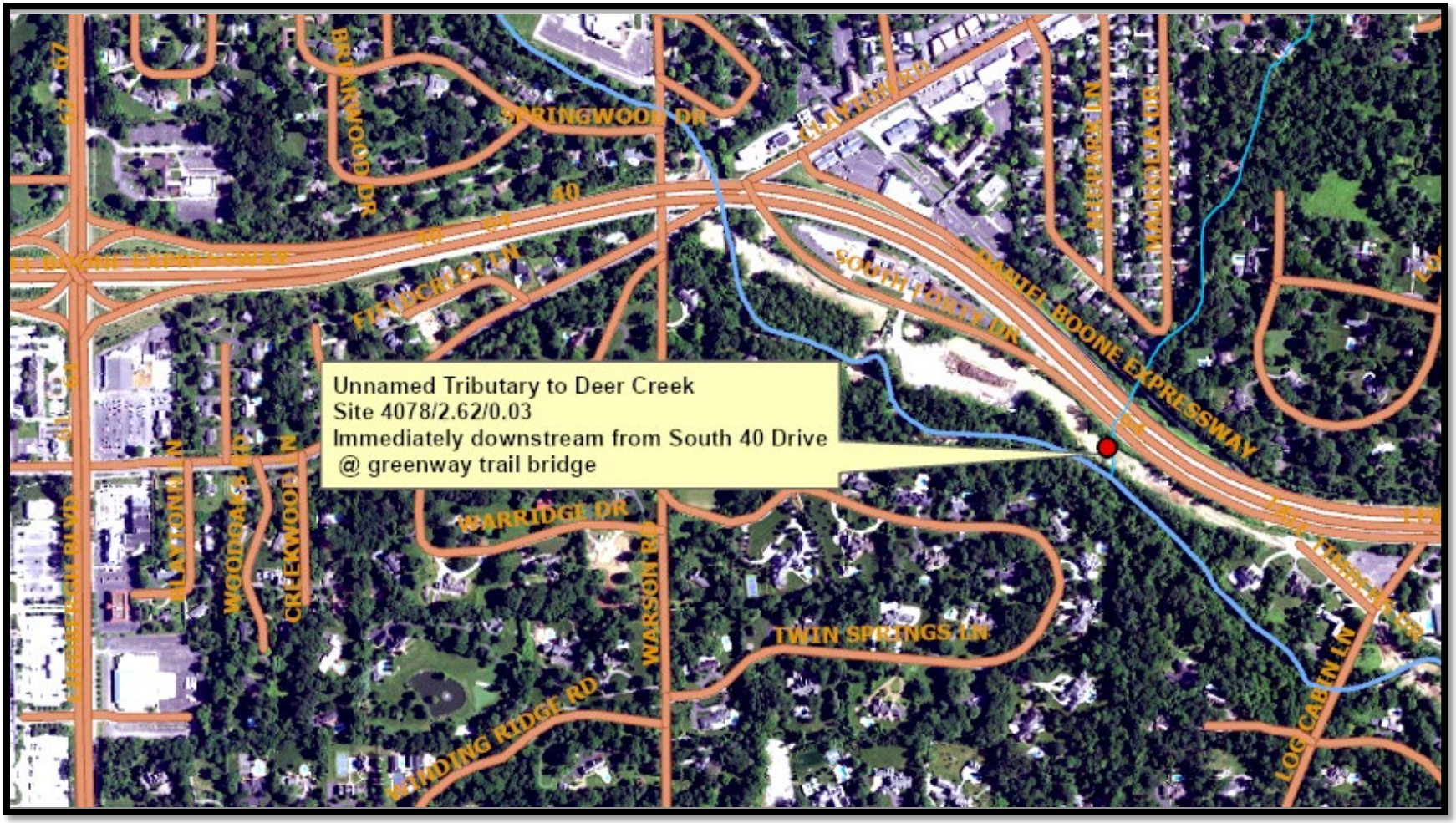

Figure 9
Map of Denny Creek: Site 4078/3.99/0.07

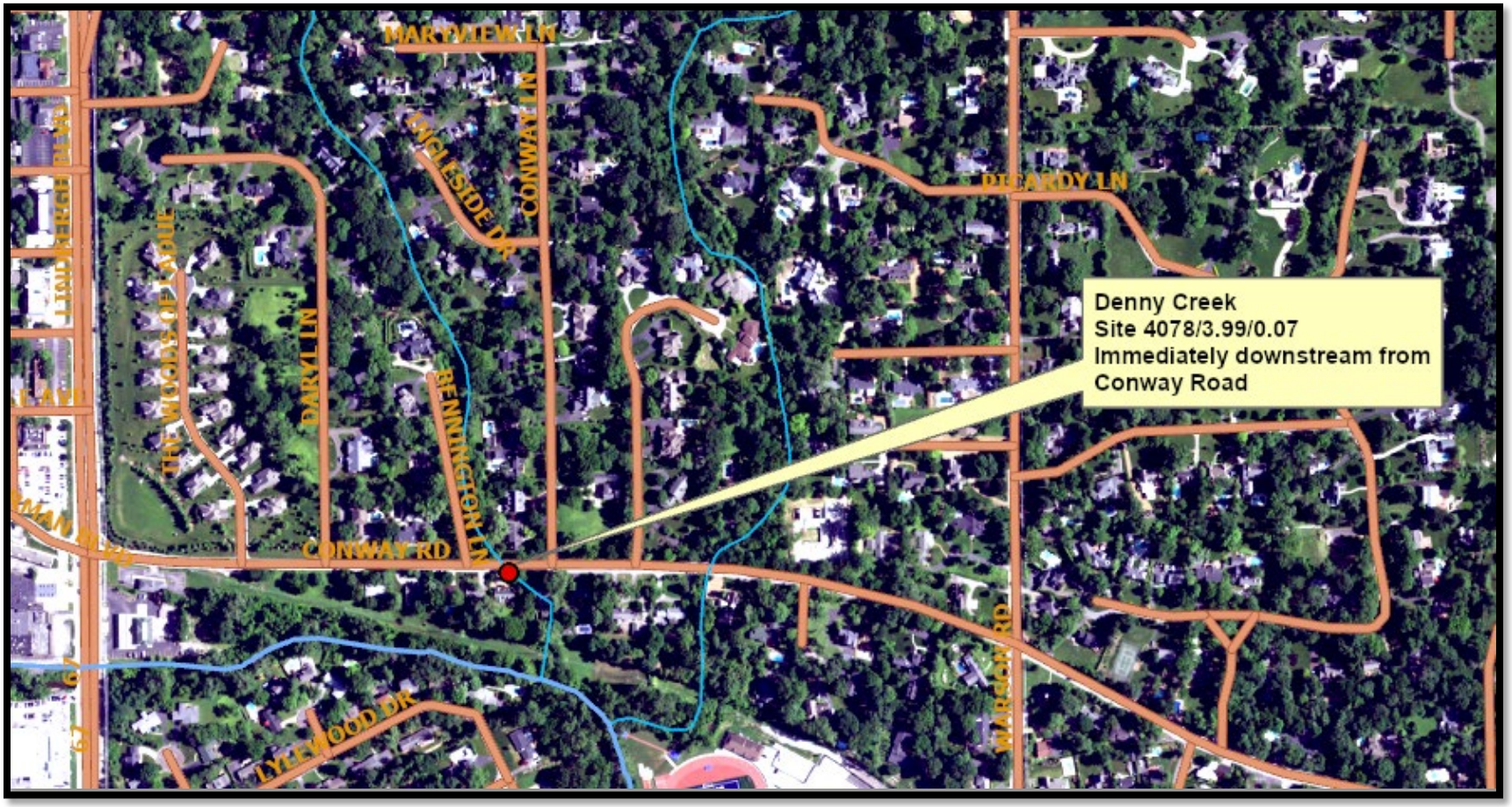

Figure 10
Map of Monsanto-Sunswept Creek: Site 4078/4.71/0.09

Figure 11
Map of Deer Creek: Site 4078/6.36

5.0 Sampling Method

Standard method samples for TP, TN, and TSS 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.

Dissolved oxygen will be measured following SOP *MDNR-ESP-103 Field Analysis of Dissolved Oxygen using Meters* and will be reported on the Chain-of-Custody. Training will be provided to the volunteers by the ESP VWQM Coordinator. Water temperature will be measured following *SOP MDNR-ESP-101 Field Measurement of Water Temperature* and will be reported on the 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 TSS 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 Senior Services (**MDHSS**) 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 the Department's St. Louis Regional Office (**SLRO**). The SLRO 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, TSS, and *E. coli* samples will be collected monthly from April 2025 – October 2025. Standard method water temperature and dissolved oxygen measurements will occur in conjunction with each standard method sample collection. Discharge measurements and

VWQM field analyses will also occur in conjunction with each standard method sample collection. A set of duplicate samples will be randomly collected from one sampling station during each sampling event (see Table 1 –Sample Collection Schedule).

Table 1
Sample Collection Schedule (2025)

	April	May	June	July	Aug.	Sept.	Oct.
Standard Method Nutrient Samples							
Standard Method *E. coli*							
Standard Method TSS							
Standard Method Dissolved Oxygen and Water Temperature Measurements							
Discharge Measurements							
VWQM Field Analyses							
Duplicate Standard Method Samples							

5.2 Stream Team Sampling Responsibilities

- Use appropriate methods to collect and preserve monthly TP, TN, TSS, and E. coli water samples for standard method analyses.
- Use appropriate method to measure water temperature and dissolved oxygen.
- Prepare equipment and perform field analyses of conductivity and water transparency using VWQM methods. Record the data in a field notebook.
- 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, deliver the nutrient and TSS samples at one of the courier locations for shipment to the Department's ESP.
- On the same day of collection, deliver the *E. coli* samples to the SLRO within 6 hours of collection.

5.3 Department Sampling Responsibilities

- Provide sample containers.
- Provide chains-of-custody for samples.
- Provide training for TP, TN, and TSS sample collection and preservation.
- Provide H_2SO_4 preservative for TP and TN sample preservation.
- Provide training for the proper measurement of dissolved oxygen and water temperature.
- Provide two loaner dissolved oxygen meters.
- 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, stream flow measurements will be made 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 it is located 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 rates of nutrients, TSS and *E. coli*. Flow measurement training will be provided to all project participants following the *SOP MDNR-ESP-113 Flow Measurements in Open Channels.*

6.1 Stream Team Flow Measurement Responsibilities

- Provide one 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 one loaner flow measurement meter and associated equipment.
- 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 volunteer methods.

7.1 Standard Method Nutrient Analyses

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

Total Phosphorus: USEPA Method 365.1
Total Nitrogen: USGS Method I-4650-03

7.2 Standard Method TSS Analyses

The standard analytical methods used by ESP for TSS analysis is:

Method #2540, part D; Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017

7.3 Standard Method *E. coli* Analyses

The standard analytical 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 approved USEPA methods.

7.4 Standard Method Dissolved Oxygen

The standard analytical method used by ESP for dissolved oxygen is:

The Department's Standard Operating Procedure *MDNR-ESP-103, Field Analysis of Dissolved Oxygen using Meters*, based on USEPA approved methods.

7.5 Standard Method Water Temperature Measurement

The standard analytical method used by ESP for water temperature is:

The Department's Standard Operating Procedure *MDNR-ESP-101, Field Measurement of Water Temperature*, based on USEPA approved methods.

7.6 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 a Hach Pocket Pro model meter and water transparency will be analyzed using a VWQM water transparency tube. Applicable VWQM Program SOPs can be found at 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 dissolved oxygen, water temperature, and discharge measurements will be reported as field parameters on the appropriate Department Chain-of-Custody.
- Since analyses for conductivity and water transparency will utilize VWQM Program procedures, the results will be entered into field notes.

8.2 Department Data Reporting Responsibilities

- Analytical results for TP, TN, TSS, dissolved oxygen, temperature, and *E. coli* will be reported via the ESP LIMS.
- Results for conductivity and water transparency will not be reported via the ESP LIMS; however, the results will be available in field notes and a final spreadsheet.
- Analysis will be charged to Labor Distribution Profile (**LDPR**) code, Volunteer Monitoring (**FEVLM**) and will automatically be provided to the WPP Project Manager. 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 each sampling date (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, TSS 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.
- Review training with volunteers if necessary.
- Make one yearly field audit during the life of the project.
- Update the project plan as necessary.

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