



Devil's Icebox Spring Branch CSI Project Report

**Devil's Icebox Spring Branch
Boone County, Missouri**

November 2017 – October 2018

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**), Randy Sarver of the Department, Environmental Services Program (**ESP**) planned and coordinated a Cooperative Stream Investigation (**CSI**) Project with Ms. Lynne Hooper (Stream Team 4794; Volunteer Water Quality Monitoring (**VWQM**) Program), and the Boone County Regional Sewer District. The Devil's Icebox Spring Branch CSI project was planned as a one year *E. coli* monitoring project with sampling to occur from November 2017 through October 2018. Because of job duty changes that affected oversight of CSI projects, the Devil's Icebox Spring Branch project could not be completed as planned. However, a smaller set of samples were collected; including five samples from the winter season in 2017, and another 5 samples from the recreational season in 2018. The objective of the project was to provide data in support of waterbody assessment and *E. coli* source tracking information for Gans Creek. A project plan was finalized on December 14, 2017.

2.0 Project Background

The Devil's Icebox Spring Branch is located within Rock Bridge Memorial State Park in Boone County, Missouri and is an unclassified tributary to Gans Creek. This spring branch is also known as Connor's Cave Creek. Gans Creek is assigned Waterbody Identification Number (WBID) 1004, with a Class C designation. The recreational designated uses for Gans Creek are Whole Body Contact – Class A (WBC-A) and Secondary Contact Recreation (SCR). The Devil's Icebox Spring Branch flows approximately 0.4 miles through Rockbridge State Park before joining Gans Creek approximately 0.12 miles downstream from Highway 163. Devils Icebox Spring Branch maintains permanent flow during most years.

WBC-A recreational use has a water quality criterion for *E. coli* of 126 colonies/100 mL. This criterion is interpreted as the geometric mean of at least five samples taken during the recreational season (April 1 to October 31) of any given year. SCR recreational use has a water quality criterion for *E. coli* of 1134 colonies/100 mL. This criterion is also interpreted as the geometric mean of at least five samples taken during the recreational season of any given year. A water body is judged to be impaired if the water quality criteria are exceeded in any of the last three years for which there is adequate data. In the 2018 303(d) listing worksheets for Gans Creek, the WBC-A criterion was exceeded at least once in the last three years of available data and is judged as impaired for bacteria.

As part of a Bonne Femme Watershed Project, preliminary *E. coli* data has been collected since the 4th quarter of 2016 from Devil's Icebox Spring Branch by the laboratory of Bob Lerch of the United States Department of Agriculture, Agriculture Research Service. This preliminary data suggests that Devil's Icebox Spring Branch may be an additional source of *E. coli* to Gans Creek and ultimately, Little Bonne Femme Creek. Gans Creek ends and Little Bonne Femme Creek begins at the mouth of an unnamed tributary just 0.1 miles downstream from the mouth of the spring branch. In addition to potential contributions of *E. coli* to Gans Creek, the spring branch is within a popular area of Rock Bridge Memorial State Park and is very likely used for SCR.

3.0 Study Area

The monitoring site for this project was selected during a September 5, 2017 reconnaissance trip to Devil's Icebox Spring Branch. The site, which is near the mouth of Devil's Icebox Cave, can be reached by following the park trail system from the public parking lot off Highway 163. A map of the sampling location and surrounding watershed are shown in Figure 1.

3.1 Site Description

Figure 1 displays the Devil's Icebox Spring Branch monitoring site, as well as the general study area. The monitoring site was selected to be consistent with historic data. The coordinates listed for the sampling sites were GPS derived and are included in the following site description, as well as being included on the chain-of-custody.

Site 1004/0.1/0.4: Devil's Icebox Spring Branch in Rock Bridge Memorial State Park; downstream from the Devil's Icebox cave mouth. GPS derived Universal Transverse Mercator (UTM) coordinates are: 558420 Easting and 4302673 Northing in Zone 15.

4.0 Methods

4.1 Samples Collection

Surface water grab samples were collected in accordance with the Department's Standard Operating Procedures (SOP) MDNR-ESP-001 (Required/Recommended Containers, Volume, Preservatives, Holding Times, and Special Sampling Considerations) and MDNR-ESP-005, (General Sampling Considerations Including the Collection of Grab, Composite, and Modified Composite Samples from Stream and Wastewater Flows).

4.2 Chain-of-Custody

In accordance with the Department's SOP MDNR-ESP-002 (Field Sheet and Chain-of-Custody Record) each sample received a numbered label before being placed on ice in a cooler. The corresponding label number was entered onto a Department chain-of-custody form indicating the date, time and location of collection, and parameter to be analyzed. The CSI Project volunteer maintained custody of the sample until analyses were completed at the Boone County Regional Sewer District Laboratory.

4.3 Discharge Measurements

Stream discharge was not measured during this project. The nearest United States Geological Survey (USGS) stream gauging station is number 06910230 at Hinkson Creek in Columbia, MO. Data from the USGS web site <https://waterdata.usgs.gov/mo/nwis/rt> was used to graph discharge from gauge 06910230 for a period of record from two days before the winter and recreational season *E. coli* data collected at Devils' Icebox Spring Branch. Figure 2 is a graph of the 2017 winter season discharge at gauge 06910230; and Figure 3 is a graph of 2018 recreational season discharge at gauge 06910230. Patterns of discharge in Devils' Icebox Spring Branch may be similar to the Hinkson Creek gauging station, however there is most likely a time delay for surface runoff to enter the Devil's Icebox Cave system through the local karst geology.

Figure 1 - Devil's Icebox Spring Branch Map

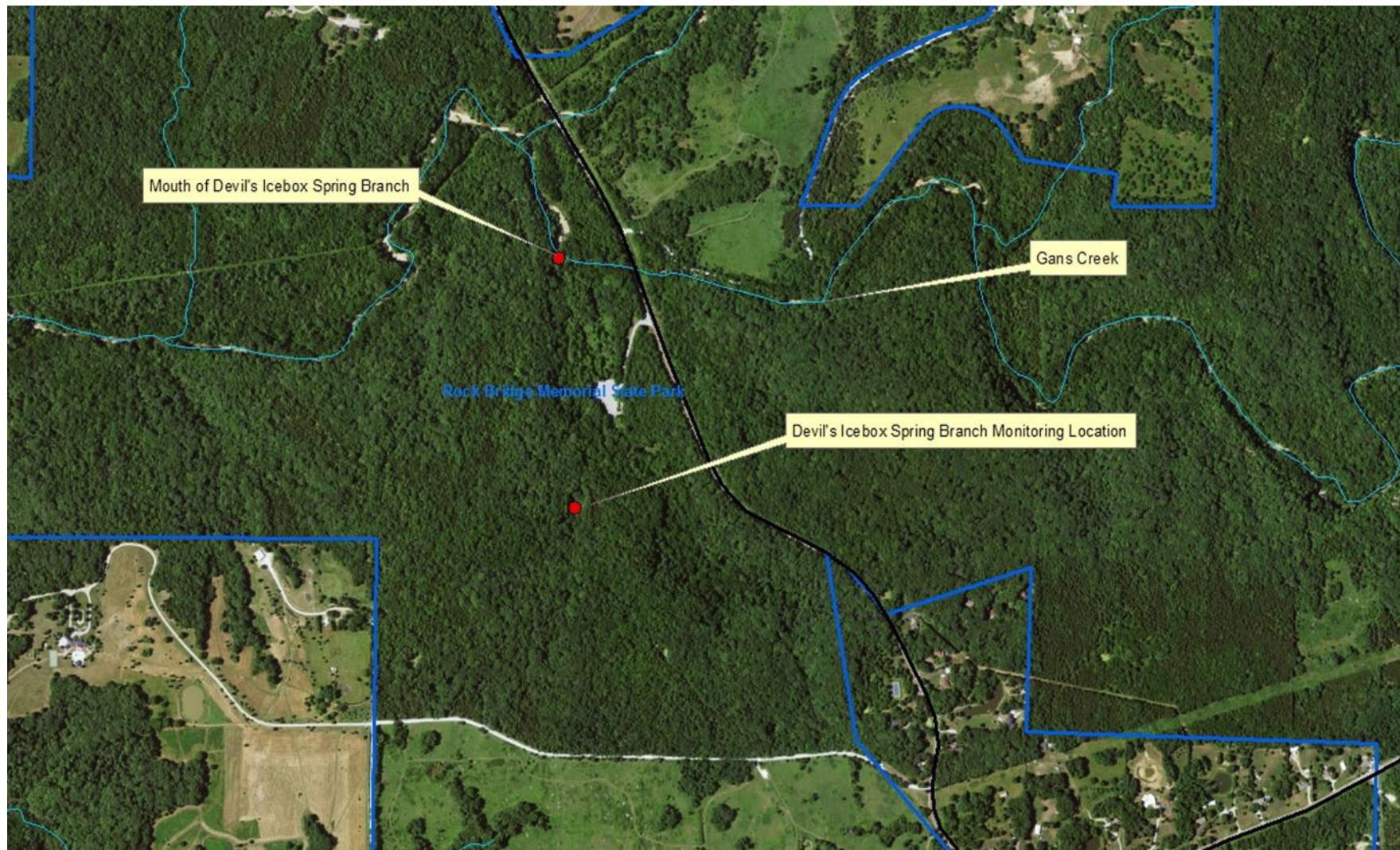


Figure 2 - 2017 Winter season discharge at gauge 06910230

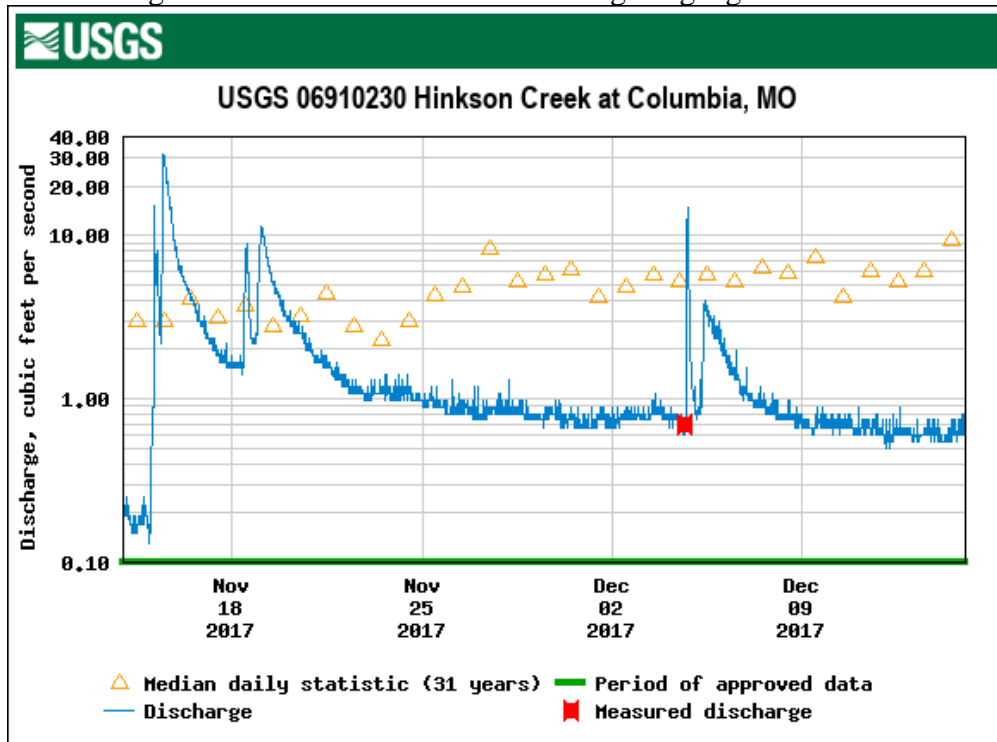
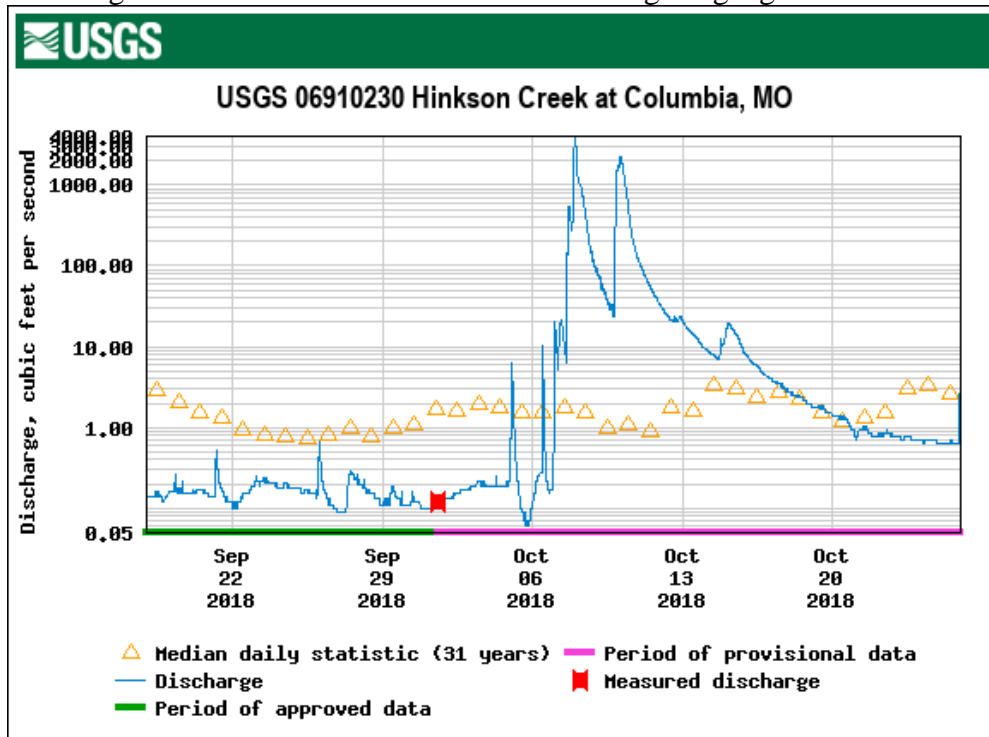


Figure 3 - 2018 Recreational season discharge at gauge 06910230



4.4 Sample Analyses

Water samples were analyzed by Ms. Hooper at the Boone County Regional Sewer District Laboratory for Most Probable Number (MPN) per 100 milliliter *E. coli* bacteria counts using IDEXX Colilert equipment and supplies. In addition to being a VWQM member, Ms. Hooper is also the Urban Hydrologist for Boone County. She received training by the Boone County Regional Sewer District Laboratory in IDEXX *E. coli* analysis; and was supervised during analyses by Mr. Virgil Farnen, supervisor of the Boone County Regional Sewer District Laboratory. Bacterial sample analysis was consistent with the Department's SOP MDNR-ESP-109 (Analysis of *E. coli* and Total Coliforms Using IDEXX Colilert and Quanti-Tray Test Method, based on United States Environmental Protection Agency [USEPA] methods).

4.5 Quality Assurance/Quality Control (QA/QC)

4.5.1 QA/QC Methods

Sample collections and analyses were conducted in accordance with the applicable SOPs and Fiscal Year 2018 Quality Assurance Project Plan for CSI Projects. One field and laboratory audit of Ms. Hooper (VWQM Volunteer) was performed on September 20, 2018.

4.5.2 QA/QC Samples

Negative controls were analyzed with each set of *E. coli* samples (see Appendices A & B). All negative controls were reported as <1.0/100 ml MPN. During the September 20, 2018 audit, an IDEXX *E. coli* positive control was provided for analysis. The IDEXX Lot# was 060418; with an expected result range of 8-260/100 ml MPN. The actual result of 41.0/100 ml MPN was within the expected range.

One field duplicate sample was collected during the project (see Appendix B). A precision criterion for duplicates was calculated based on the formula in Standard Method for Examination of Water and Wasterwater (22nd Edition); Microbial Examination; QA/QC; Section 9.0 (e). After each set of samples was analyzed, a |R| value was calculated for the duplicate sample results; followed by a comparison to the criterion. The value |R| is an absolute value calculated by subtracting the *log* of a duplicate sample from the *log* of the original sample. The duplicate sample |R| value listed in Appendix B was below the criterion [0.37].

5.0 Data Results

Please refer to Appendix A and Appendix B for *E. coli* results. Appendix A contains results from the 2017 winter season and Appendix B contains the results from the 2018 recreational season.

6.0 Data Analysis

The major objectives of the Devil's Icebox Spring Branch CSI Project were to provide data in support of waterbody assessment and to provide *E. coli* source tracking information for Gans Creek. Standard analysis for *E. coli* data is the calculation of a geometric mean (**geomean**) of the samples taken from a waterbody in the recreational season (see below and Appendices A & B). For comparison between seasons, data was also analyzed for the 2017 winter season. Additional graphic data analysis of maximum, minimum, and geomean *E. coli* values help to visually represent variability of *E. coli* loading to a stream (see Appendix C).

The *E. coli* geomean of seasonal samples collected during this project were as follows:

- 2017 Winter Season = 4.0/100 ml MPN
- 2018 Recreational Season = 321.0/100 ml MPN

7.0 Discussion

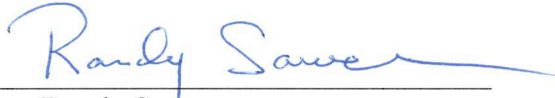
There are no designated uses for Devil's Icebox Spring Branch. Therefore water quality protection is provided by narrative general criteria. The general criterion most applicable to recreational use states that "there shall be no significant human health hazard from incidental contact with the water". The recreational season geomean from 2018 would exceed whole body contact Class A or Class B criteria, however it would not exceed the SCR criteria of 1134 colonies/100 mL. Because the Devil's Icebox Spring Branch contains water a majority of the time, and because it is used for SCR by visitors to Rock Bridge State Park, it should be considered for inclusion as a classified stream under the Missouri Use Designation Dataset (MUDD) Version 1.0.

E. coli data from Devil's Icebox Spring Branch demonstrated a distinct difference between the winter season and recreational season; with the recreational geomean significantly higher than the winter geomean. Water temperature most likely influenced the survival of *E. coli* bacteria in the winter season, although discharge could also be a contributing factor to the difference in *E. coli* concentrations.

Although the *E. coli* data from this project demonstrates that the Devil's Icebox Spring Branch contributes to the loading of Gans Creek, lack of discharge data and concurrent *E. coli* data from Gans Creek prevents an estimate of the load allocation. Although loading cannot be calculated, higher discharge data from Hinkson Creek does correspond to the higher recreational season *E. coli* data from Devil's Icebox Spring Branch. These higher *E. coli* concentrations most likely indicate that surface runoff coming through the Devil's Icebox Cave system is related to *E. coli* concentrations.

To help identify sources of *E. coli* from surface runoff, a bacterial source tracking project is currently underway in the Bonne Femme Creek watershed. Bacterial source tracking data from Devil's Icebox Spring Branch, and other locations in the Bonne Femme Creek watershed will be reported by Ms. Hooper in a separate future report.

Submitted by:

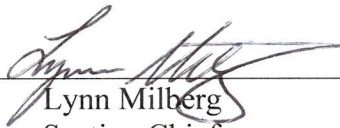


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Appendix A

Devil's Ice Box Spring Branch *E. coli* data winter results

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Appendix A – Devil's Icebox Spring Branch *E. coli* Data Winter Season Results

Sampling Date	Site 1004/0.1/0.4 <i>E. coli</i> Results (MPN/100 ml)	Negative Control Results
11/16/2017	8.6	<1.0
11/21/2017	6.3	<1.0
11/30/2017	6.3	<1.0
12/6/2017	1.0	<1.0
12/14/2017	3.1	<1.0
Maximum	8.6	
Minimum	1.0	
Geomean	4.0	
n	5	

Appendix B

Devil's Icebox Spring Branch *E. coli* data recreational Season results

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Appendix B – Devil's Icebox Spring Branch *E. coli* Data Recreational Season Results

Sampling Date	Site 1004/0.1/0.4 <i>E. coli</i> Results (MPN/100 ml)	Duplicate Sample Result	Average of Duplicates	Negative Control Results	R for Duplicate Samples
9/20/2018	870.4	1158.8	1014.6	<1.0	0.12
10/4/2018	651.0			<1.0	
10/11/2018	3265.6			<1.0	
10/18/2018	59.0			<1.0	
10/25/2018	26.8			<1.0	
Maximum	3265.6				
Minimum	26.8				
Geomean	321.0				
n	5				

Bold = duplicate sample values

*Duplicate average used to calculate geomean

Appendix C

**Devil's Icebox Spring Branch Maximum, Minimum, and Geomean graph of
E. coli data**

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Appendix C – Devil's Icebox Spring Branch Maximum, Minimum, and Geomean Graph of *E. coli* Data

Devil's Icebox Spring Branch CSI Project *E. coli* Data
Winter Season 11/16/2017 - 12/14/2017
Recreational Season 9/20/2018 - 10/25/2018
(log Base 10 scale)



	Winter Season (n=5)	Recreational Season (n=5)
Maximum	8.6	3265.6
Minimum	1	26.8
Geomean	4.0	321.0