

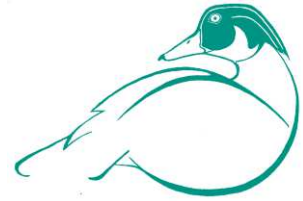
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Final Report
Fecal Coliform Bacteria Monitoring for the
Sleepy Creek Watershed
319 Project Water 2017-2019 Monitoring
15 Months at 6 sites

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Participating Agencies and Organizations

West Virginia Conservation Agency

WV DEP

Sleepy Creek Watershed Association



*Sleepy Creek
Watershed Association*

Project Summary

Cacapon Institute (CI) under contract with the WV Conservation Agency and subject to review by the 319 project team, monitored Sleepy Creek and certain tributaries for fecal coliform bacteria as outlined below.

Background

The Sleepy Creek (WVP-9, TMDL SWS 9001 – 9063) watershed is located in Morgan County, West Virginia (87%) and Fredrick County, Virginia (13%). Sleepy Creek flows 42 miles north into the Potomac River. Within the watershed two streams had a TMDL (Total Maximum Daily Load), Sleepy Creek (main stem) and Indian Run tributary (WVP-9-G). Both Sleepy Creek and Indian Run were listed as impaired “relative to numeric water quality criteria for fecal coliform bacteria” in the 2007 TMDL. Indian Run was officially delisted as of 2012 (See: [“Planting Trees and Upgrading Septic Systems Decreases Bacteria in Run”](#)). Sleepy Creek remains on the impaired list.

West Virginia Department of Environmental Protection has a holistic approach to TMDL development where they set pre-TMDL sample sites in areas where previous sampling efforts (targeted sampling based on their 5-year rotating plan) show even a single 'hit' for fecal. In Sleepy Creek's case, a single sample (out of 11 pre-TMDL samples) had a result of 560 cfu/100ml. The pre-TMDL data was deemed sufficient to list the stream for the first time on the 2006 303(d) list. Data collected for the purpose of supporting TMDL development was put into the WVDEP 'decision database' that is used to track assessment decisions. This decision database produced the following description: *List for fecal from mouth to RM 18.0 and again from RM 26.7 to headwaters 2003/2004 TMDL data had 1/11 violations near mouth, 2/11 at RM 8.0, 0/12 at RM 18, 1/12 at RM 26.7, and 2/11 at RM 36.8.* (John Wirts, WVDEP, personal communication).

The following monitoring actions and sampling results occurred as components of the 2008 Watershed Based Plan, as conducted by Cacapon Institute. A QAPP for all water quality monitoring was prepared.

Fecal coliform bacteria levels were monitored at nine sites monthly between March 2010 and September 2011 to gather additional data necessary to identify “hot spots” and possible sources of fecal pollution entering the main stem of Sleepy Creek. During 2010/2011 implementation plan monitoring, four sites had more than one 400 cfu/100ml exceedence: Sleepy Creek (SC) at Shades Road, SC at Middle Fork, SC at Ruffed Grouse Road, and SC at Morgan Road. These sites were selected by the Sleepy Creek 319 Team for additional monitoring in 2014 and 2015, with additional sites added with the goal of identifying tributaries that contribute to the fecal coliform problem in the Sleepy Creek mainstem (Middle Fork and South Forks,). During the fifteen month study period, only the Yellow Springs and Sleepy Creek at Shades Rd. sites never exceeded the 400 cfu/100ml standard, Yellow Springs never exceeded 200 cfu/100ml. All of the other five sites had at least one exceedence of 400 cfu/100 ml. The Sleepy Creek at Ruffed Grouse Rd (road renamed to Bridgecreek Lane) had five bacteria counts greater than 400 cfu/100 ml, Sleepy Creek at Morgan Road had two, and Sleepy Creek below Middle Fork, Middle Fork, and South Fork each had one.

The Sleepy Creek Monitoring Project Team decided that future monitoring should focus on the Bridgecreek Lane (formerly Ruffed Grouse Road) area that had the most frequent exceedences in past monitoring in order to further localize the bacterial source(s) in this area. Additionally, the group decided to add a site on previously unmonitored Meadow Branch Run (which enters Sleepy Creek shortly before it empties into Sleepy Creek Watershed 2017-2019 Fecal Coliform Bacteria Monitoring

the Potomac River) due to the Spruce Pines Hollow subdivision, built with no requirement for "cabins" to have septic systems.

Monitoring Plan

Beginning in October 2017, CI conducted 15 months of monthly sampling, plus two "weather event" sampling runs, with one site on Meadow Branch and five mainstem and small tributary sites at and upstream of the Bridgecreek Lane (formerly Ruffed Grouse Road) site. Starting at the uppermost site, sampling sites were the original Sleepy Creek at Morgan Road site, Sleepy Creek at Fish Hatchery Road, Sleepy Creek above confluence with unnamed tributary at Bridgecreek Lane, tributary at Bridgecreek Lane, and Sleepy Creek below the tributary confluence mixing zone. One additional duplicate sample was collected during each sampling trip. Final sites were selected by the Sleepy Creek Monitoring Project Team. Samples were collected only at sites with public access and/or landowner permission. Samples were also periodically collected well downstream of the focus area in Sleepy Creek at Eckard Lane, near Route 9.

The original intent was for monthly sampling at these sites for 15 months; however, field conditions (extreme cold and frozen streams in winter 2017-2018) resulted in a decision by the project team to take a sampling hiatus from January until April 2018. In addition, the project team met on October 23, 2018 to discuss a revised sampling schedule and make changes in sample sites based on results to date. The project team decided to stop sampling the following three sites: Meadow Branch, Sleepy Creek at Fish Hatchery Road, Sleepy Creek above confluence with unnamed tributary at Bridgecreek Lane. Three new sites were added: Sleepy Creek mainstem sites at Johnsons Mill and Crone Lane and a tributary in the lower reaches of Sleepy Creek, Swim Run. The team also decided to continue with the winter sampling hiatus from December through March.

Additional samples collected by CI simultaneously with bacterial analysis samples were prepared and stored according to USGS protocols for molecular source tracking analyses; with the addition of an additive, samples can be frozen until the fecal indicator results are available or until convenient for shipment/analysis. It was originally planned that only those samples significantly positive by culture ($>200\text{cfu}/100\text{ ml}$) would be considered for further molecular tests. However, as counts were generally low the project team decided part way through the project period to drop the minimum count to $100\text{cfu}/100\text{ ml}$ for USGS source analysis.

Field and Laboratory Methods

Cacapon Institute is a West Virginia Certified Laboratory (Certificate Number 228), and performed field collections and laboratory analyses as laid out in the organization's approved SOPs.

Water samples were collected midstream 10-15 cm below the surface. When water levels precluded wading into the river, samples were collected from shore or bridges using an extension sampler. Sampling containers, storage conditions and holding times followed APHA (APHA, 1992). One daily duplicate sample was collected.

Fecal Coliform Bacteria were determined using the Membrane Filtration Method by filtering three known volumes of sample (3 ml, 10 ml, 30 ml) through three separate 0.45 micrometer filters, transferring the filters to petri dishes containing a selective growth medium (PourRite m-FC/Rosalic Acid Broth Ampules -Hach Cat# 24285-20), incubating the petri dish at a selective temperature of $44.5\text{ }^{\circ}\text{C} + 0.2\text{ }^{\circ}\text{C}$ in a Millepore Dual Chamber

Incubator (Cat# XX63 LK1 15), and counting the number of resulting colonies at 24 hours (\pm 2 hours). Results were expressed as number of colony forming units per 100 ml.

Results

The West Virginia standard for fecal coliform bacteria specifies that the maximum allowable level of fecal coliform for primary contact recreation shall not exceed 200 cfu/100 mL as a monthly geometric mean (based on not less than 5 samples per month). The fecal coliform count also shall not exceed 400 cfu/100 mL in more than 10 percent of all samples taken during any one month. The data collected during this study does not allow a direct comparison to the state standard of 200 cfu/100 mL as a monthly geometric mean because samples were only collected at each site at most two times per month. When fewer than five samples are collected per month, the applicable standard becomes 400 cfu/100 mL. For that reason, the results of this study will be discussed in the context of the 400 cfu/100ml part of the fecal coliform bacteria standard. 200 cfu/100 ml is discussed as a “warning” level.

Further, since the suite of sampling sites changed in October 2018, results below are broken down for the periods October 2017 through September 2018, October 2018 through December 2019, and a final tabulation for only sites that were sampled throughout the project period.

The tables below provide descriptive statistics for each sampling period, either by site or by date. The last two columns provide the total number of samples that exceeded 400 and 200 cfu/100 ml, respectively. Mean values varied much more widely than median values and tended to be higher, sometimes much higher. This is characteristic of non-point source data that is skewed by a few high values recorded during precipitation events. The median is the preferred "measure of central tendency" for non point data, while the mean and maximum values are more reflective of the tendency of each site towards high concentrations during runoff events.

Results for period from October 2017 through September 2018

Sampling Site	Number of Samples	Minimum	25th Quartile	Median	Mean	75th Quartile	Maximum	No. \geq 400	No. \geq 200
SC at Morgan Road	10	1	33	78	187	129	1250	1	1
SC at Fish Hatchery Road	9	3	48	73	91	150	183	0	0
SC above Bridgecreek Lane	9	3	29	77	94	164	213	0	1
Unnamed Tributary at Bridgecreek Lane	8	1	5.5	82	585	1100	2367	3	3
SC below Bridgecreek Lane	10	1	34.8	97	266	138	1950	1	1
Meadow Branch	10	1	6	15	76	42	600	1	1
SC at Eckard Lane	6	3	28.5	77	422	640	2000	1	1

Two sites (Table 1) never exceeded 400 cfu/100 ml: Sleepy Creek mainstem sites at Fish Hatchery Road and above Bridgecreek Lane. The Unnamed Tributary at Bridgecreek Lane exceeded 400 cfu/100 ml three times, while the remaining sites had a single exceedance.

Table 2: Fecal coliform bacteria for all sites on each of the sampling dates during the October 2017 through September 2018 period. Results reported in colony forming units per 100 ml.

Table 2. Sampling Date	Number of Samples	Minimum	25th Quartile	Median	Mean	75th Quartile	Maximum	No. >= 400	No. >= 200
10/6/2017	8	3	8.5	43	38	64	73	0	0
10/30/2017	5	600	800	1250	1360	1975	2000	5	5
11/15/2017	6	3	6	10	12	16	33	0	0
12/27/2017	6	1	1	1	2	3	3	0	0
4/17/2018	6	13	13	57	56	85	120	0	0
5/23/2018	7	7	40	77	217	107	1133	1	1
6/25/2018	6	23	53	88	456	672	2367	1	1
7/27/2018	7	40	87	163	146	187	213	0	1
8/20/2018	6	47	67	112	116	173	183	0	0
9/27/2018	7	17	77	100	105	157	173	0	0

Three dates had bacteria counts exceeding the 400 cfu/100 ml standard in at least one sampling site:

- All of the samples collected on October 30, 2017 exceeded 400 cfu/100 ml; these samples were collected following heavy rain over 24 hour period that ended during the night. This storm sampling event didn't capture the most active surface runoff period. The project team agreed to a revised sampling site list to collect "cumulative" data for the watershed.
- Samples collected on 5/23/2018 and 6/25/2018 in the Unnamed Tributary that flows into Sleepy Creek at Bridgecreek Lane yielded bacteria counts of 1133 and 2367 cfu/100 ml, respectively. No other sites on those two days yielded high or even borderline fecal coliform bacteria counts. Neither of these sampling dates were associated with precipitation in the previous 24 hours, but both occurred in the context of periods of frequent rain, on the falling limb of high water events, and ground that was either saturated (5/23/2018) and fairly wet (6/25/2018).
- Results supported the decision to sample the Unnamed Tributary at BridgeCreek Lane, as it was the only site to have more than a single 400 cfu/100ml bacteria count exceedance. However, those high counts did not seem to deliver high bacteria counts to Sleepy Creek below the confluence of the two streams, indicating that the high counts in the tributary were quickly diluted in the much higher stream flows in Sleepy Creek.
- One site (Sleepy Creek above Bridgecreek Lane) had a fecal coliform bacteria count (213 cfu/100 ml)

that exceeded the cautionary limit of 200 cfu/100 ml on 7/27/2018. This date also had a relatively high median bacteria count of 146 cfu/100 ml. As with the dates that exceeded the legal standard, precipitation appears to have been associated with these elevated counts. Heavy rains over three days ended two days prior to sampling and streams were still showing the effects, as indicated by somewhat elevated turbidities. Ground was still wet, but didn't seem to be saturated.

Results for period from October 2018 through December 2019

Table 3. Fecal coliform bacteria at seven sampling sites in the Sleepy Creek watershed from the October 2018 through December 2019 study period. Results reported in colony forming units per 100 ml.

Table 3. Sampling Site	Number of Samples	Minimum	25th Quartile	Median	Mean	75th Quartile	Maximum	No. >= 400	No. >= 200
Mainstem at Eckerd Lane	11	10	47	67	266	133	2100	1	2
Mainstem at Johnsons Mill	11	33	40	80	146	250	480	2	3
Mainstem at Morgan Rd - VA Line	11	7	20	83	246	170	1900	1	2
Mainstem below Bridge Creek Lane	11	10	30	126	202	290	867	1	3
SC Mainstem at Crone Lane	9	7	23	53	297	235	2000	1	2
SC Trib at Swim Run	10	3	22	39	66	104	220	0	1
Trib at Bridge Creek Lane	6	17	19	27	52	105	127	0	0

Two sites (Table 3) never exceeded 400 cfu/100 ml: Unnamed Tributary at Bridgecreek Lane and Swim Run. The Sleepy Creek mainstem at Johns Mill exceeded 400 cfu/100 ml twice, while the remaining sites had a single exceedance.

Table 4: Fecal coliform bacteria for all sites on each of the sampling dates during the October 2017 through September 2018 period. Results reported in colony forming units per 100 ml.

Table 4. Sampling Date	Number of Samples	Minimum	25th Quartile	Median	Mean	75th Quartile	Maximum	No. >= 400	No. >= 200
10/30/2018	6	17	17	27	36	57.5	80	0	0
11/26/2018	6	17	34	64	60	84	97	0	0
4/11/2019	7	7	10	20	30	40	97	0	0
5/24/2019	7	20	43	60	79	117	150	0	0
6/18/2019	7	77	127	200	185	250	290	0	4
7/29/2019	6	27	47	102	191	405	480	1	2
8/29/2019	6	33	44	75	76	100	140	0	0
9/30/2019	5	33	450	1900	1380	2050	2100	4	4
10/22/2019	6	30	35	47	69	94	196	0	0
11/21/2019	6	3	6	14	17	27	47	0	0
12/18/2019	7	30	100	170	207	340	390	0	3

- Four of the samples collected on September 30, 2019 exceeded 400 cfu/100 ml; moderate rain occurred before the sampling period, but generally the region was in severe drought and the streams were very low. Tributary at Bridge Creek and Swim Run were dry.
- The 400 cfu/100 ml exceedence on July 29, 2019 occurred during extremely dry weather when river flow was very low.
- The four 200 cfu/100 ml exceedences on June 18, 2019 occurred following moderate rainfall, the ground was damp.
- The three 200 cfu/100 ml exceedences on December 18, 2019 occurred following substantial rainfall and Sleepy Creek was turbid and flowing strongly.

Discussion and Conclusions

The primary result was that, as with previous monitoring efforts in the Sleepy Creek watershed, fecal coliform bacteria 400 and 200 cfu/100 ml concentration exceedences occurred infrequently both temporally and spatially. The initial focus on the Bridgecreek Lane area that had the most frequent exceedences in past monitoring did yield the useful result that, during the sampling period ending in September 2018, a tiny unnamed tributary that flowed into Sleepy Creek at Bridgecreek Lane was most likely to have high bacterial counts, twice very high. However, the flow in this tributary was very low compared to the flow in the Sleepy Creek mainstem and it did not deliver high counts at the site that in previous monitoring efforts was most likely to be to have high bacterial counts. Also, no high counts were recovered from this tributary after June 2018.

The Meadow Branch Run site that was added due to concerns over a subdivision with no septic systems was dropped in October 2018 after sampling found no sign of fecal bacterial contamination. The Swim Run tributary site that was added in the second half of this project demonstrated little evidence of bacterial contamination.

As with previous monitoring efforts, high bacteria counts were often associated with periods of significant precipitation. However, unlike previous monitoring, episodic high counts also happened during low flow, dry conditions. While we do not yet have the formal results from the USGS source tracking, it seems that no useful sourcing information was gained from this effort (William Schahill, USGS, personal communication).

We learned from landowners that septage has been and is currently field applied on fields upstream of Bridgecreek Lane in both West Virginia and over the line in Virginia. While this practice certainly could be an important source of fecal contamination in Sleepy Creek we have no direct evidence that this is the case.

In conclusion, to repeat the topline result from this monitoring program, as with previous monitoring efforts in the Sleepy Creek watershed, fecal coliform bacteria 400 and 200 cfu/100 ml concentration exceedences occurred infrequently both temporally and spatially. No specific information has been gained that would focus best management practice implementation to address this highly episodic problem.

The data collected for this study is appended to this report. Field and laboratory data sheets are available for review at Cacapon Institute's laboratory; these sheets provide specific information regarding dates, times, and staff involved in collecting and processing samples.

Acknowledgments

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Citations

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Reference

Sleepy Creek Watershed Association. www.sleepycreekwatershed.org

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