

# **Fecal Coliform Bacteria Monitoring for the Warm Springs Watershed Association Final Report**

Prepared for: Warm Springs Watershed Association

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## **Participating Agencies and Organizations**

Warm Springs Watershed Association  
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## **Introduction and Background**

Warm Springs Run (WSR) is located in Morgan County, West Virginia. It flows 10.3 miles north into the Potomac River. Warm Spring Run was listed by WVDEP on the 2012 303(d) list as impaired for fecal coliform bacteria, based on data collected by WVDEP in 2007 and 2009.

The Comprehensive Watershed Based Management Plan for Warm Springs Run was prepared by GeoConcepts Engineering Inc for WSWA in 2012: The report noted: "As can be seen from the data shown on Table 4, wide variation in values for fecal coliform colonies was observed throughout the sampling period. The data for August 16, 2007 showed a consistent high spike in the coliform data, starting well upstream at Mile Point 8.2, and extending along the entire length of the run. Historical meteorological data records show there was approximately 0.5 inches of rain the day the June 21, 2012 samples were collected; however, it is unknown whether this may have affected the reported fecal coliform test result." (Denton Jr, 2012)

The WSWA asked Cacapon Institute (CI) to conduct 'pre-TMDL monitoring' for fecal coliform bacteria and to help the organization prepare and successfully submit a QAPP for this fecal coliform monitoring project.

## **Sampling Design**

The purpose of this study is to augment the 2007/2009 WVDEP data that led to WSR being identified as impaired on the 2012 303(d) list for fecal coliform bacteria' leading to a better understanding of the problem and also to inform the pending TMDL source tracking study.

Exceedences of the fecal coliform standard -- (400 cfu/100ml), and the caution level of 200 cfu/100ml -- during the pre-303(d) monitoring period at five sites in WSR were frequent. CI sampled eight (8) locations, in WSR and one tributary (Yellow Spring Run), the five original sites plus four additional, in an effort to locate regions with consistent fecal coliform contamination.

Sampling locations were based on results of previous sampling and local knowledge of conditions on the ground. Sampling was done at these sites quarterly for one year, plus two episodically conducted storm event sampling trips. Sampling helped determine if fecal coliform contamination remains an issue in WSR. One duplicate sample was collected on each sampling trip. The working group may decide to add sites for source tracking and have less storm sampling.

Samples were collected only at sites with public access and/or landowner permission.

## Field and Laboratory Methods

Cacapon Institute is a West Virginia Certified Laboratory, 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 (typically 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  $44.5^{\circ}\text{C} + 0.2^{\circ}\text{C}$  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.

## Statistical methods

Data distributions are displayed below in tables of summary statistics.

## 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 once 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.

Table 1 provides basic descriptive statistics for each of the sampling sites; 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 this parameter, while the mean and maximum values are more reflective of the tendency of each site towards high concentrations during runoff events. All sites had widely variable bacterial counts over

the sampling period. All sites that were regularly sampled had at least one exceedence of the 400 cfu/100 mL standard, three sites had 2 or more 400 counts (Yellow Run, and Warm Springs Run at Fairview Drive and Country Inn). All but one regularly sampled site had two or more exceedences of the 200 cfu/100 mL warning level; Fairview Drive and Country Inn sites were notable for the frequency of results greater than 200 cfu/100 ml (5 and 4, respectively).

Table 1. Summary results. Fecal Coliform Bacteria by sampling site reported as colony forming units per 100 milliliters.							
Sample Site	Mean	Median	Min	Max	N	>= 400	>=200
LaFarge Driveway/Apple Valley Waste	337	35	1	1500	5	1	1
WSR Eddies Tires/Floyds Cows	168	64	3	460	6	1	2
WSR Wydmeyer ~ Rm 8.6	129	69	7	400	6	1	2
Yellow Run at Sheetz	352	119	1	967	6	2	2
WSR above Country Inn	764	624	13	1800	6	3	4
WSR Jimstown Rd Rm 5.8	197	140	16	500	6	1	2
WSR Sandmine Rd.	173	121	10	440	4	1	2
WSR Fairview Dr	386	330	127	880	6	1	5
WSR ~rm 0.7 Airport Road	222	162	33	480	6	2	2
WSR ~rm 0.2	390	390	390	390	1		1

Table 2 indicates the mean and media values generally varied much more narrowly on each sampling date than in Table 1, which provided statistics by site. This would imply that bacteria levels at all or most sites were responding to similar “drivers” on any given day. Median fecal coliform bacteria levels on 6/20/2014 were higher than any other date, and all sites either exceeded 200 or 400 cfu/100 ml on that date. The weather on that date was hot, humid, and a significant rain (~0.3 inches) had fallen the previous day. A second sampling run was performed three days after the notable 6/20/2014 event, and on that date six out of nine sites exceeded the 200 cfu/100 ml warning level but only two exceeded 400 cfu/100 ml. The complete raw data table in Appendix 1 includes field notes and USGS stream flow data from the flow station on Warm Springs Run at Jimstown Road.

March 2014 samples were collected during a period of snow melt, with active surface runoff over frozen ground occurring. Surface runoff during this period did not result in elevated bacterial counts throughout the watershed, with only one site exceeding 200 cfu/100 ml.

May 2014 samples were collected about 48 hours after a major rainfall event. The intent was to capture unfrozen ground, but saturated conditions to try to separate a “failed septic” signature from the elevated fecal bacteria counts generally associated with surface runoff. There was no surface runoff observed, ground was wet/damp but drying and streams recently at bankfull were receding. The two most downstream sites had bacterial counts in excess of 400 cfu/100 ml, the rest were well below 200.

Table 2. Summary results. Fecal Coliform Bacteria by sampling date reported as colony forming units per 100 milliliters.							
	Mean	Median	Min	Max	N	>= 400	>=200
7/22/2013	432	201	93	1800	8	2	4
10/30/2013	113	57	1	360	8	0	2
3/10/2014	53	27	1	310	9	0	1
5/2/2014	181	50	25	880	9	2	2
6/20/2014	655	480	350	1500	9	7	9
6/23/2014	413	217	10	1467	9	2	6

## Discussion and Conclusions

As noted in the introduction, the Comprehensive Watershed Based Management Plan for Warm Springs Run was prepared by GeoConcepts Engineering Inc for WSWA in 2012: The report noted: “As can be seen from the data shown on Table 4, wide variation in values for fecal coliform colonies was observed throughout the sampling period.” The results of the current study are consistent with that previous result. The dates on which numerous elevated counts were observed (7/22/2013 and 6/20/2014) did not have similar antecedent precipitation conditions, with 7/22/2013 having virtually no precipitation for the preceding week, while 6/20/2014 followed a significant precipitation event the previous day. Both of these days were, however, quite warm, with temperatures exceeding 85 degrees Fahrenheit. The sampling on 6/23/2014 that was done as a follow-up to the 6/20 result also occurred following a week where more than 0.60 inch of rain fell.

The results of this study support the listing of this stream as impaired for fecal coliform bacteria. The drivers for elevated fecal coliform bacteria counts at the sampled sites remain unclear.

## Acknowledgments

This report was prepared by Neil Gillies, Cacapon Institute. Field and laboratory work was conducted by Frank Rodgers and Neil Gillies, Cacapon Institute. This project was supported by funding from the West Virginia Stream Partners Program and by the Warm Springs Watershed Association leadership and members.

## Citations

APHA, 1992. Standard Methods for the Examination of Water and Wastewater, 18th

edition. American Public Health Association, Washington, DC Various pagination.

Denton Jr., Robert K. 2012. Comprehensive Watershed Based Management Plan for Warm Springs Run. A Potomac Direct Drains Watershed. Morgan County, WV. Prepared by GeoConcepts Engineering Inc. for Warm Springs Watershed Association on June 21, 2012.

TMDL, 2007. Total Maximum Daily Loads for Selected Streams in the Potomac Direct Drains Watershed, West Virginia. TETRA Tech, for WVDEP. February 2007, Draft Report.

Station	Date	Time	Sampler	Precip last 24 hrs	USGS Flow (cfs)	pH	Temp	Conductivity	Fecal Coliform (cfu/100ml)	Code	Comments
WSR Eddies Tires/Floyds Cows	7/22/2013	855	Gillies	trace		6.59	19.5		460		
WSR Wydmeyer ~ Rm 8.6	7/22/2013	910	Gillies	trace		7.3	21.1		93		
Yellow Run at Sheetz	7/22/2013	925	Gillies	trace		7.43	20.6		192	E	
WSR above Country Inn =~Rm 8.2????	7/22/2013	931	Gillies	trace		7.57	21.4		1800		
WSR Jimstown Rd Rm 5.8	7/22/2013	945	Gillies	trace	2.3	7.68	21.4		210		
WSR Fairview Dr	7/22/2013	954	Gillies	trace		7.58	21.4		127		
WSR Fairview Dr duplicate fecal	7/22/2013	954	Gillies	trace					110	Dup	
WSR ~rm 0.7	7/22/2013	1014	Gillies	trace		7.97	22.3		183		River cloudy-milky/gray, appears to be industrial waste
WSR ~rm 0.2	7/22/2013	1037	Gillies	trace		8.03	22.3		390		River cloudy-milky/gray, appears to be industrial waste
LaFarge Driveway/Apple Valley Waste	10/30/2013	1030	Rodgers	none		6.81	9.4	618	140	e	Barely running
WSR Eddies Tires/Floyds Cows	10/30/2013	1050	Rodgers	none		7.35	12.3	599	3	e	
WSR Wydmeyer ~ Rm 8.6	10/30/2013	1058	Rodgers	none		8.07	10.2	454	7	e	
Yellow Run at Sheetz	10/30/2013	1105	Rodgers	none		7.97	10.9	439	1	LT-e	
WSR above Country Inn =~Rm 8.2????	10/30/2013	1112	Rodgers	none		8.25	10.0	454	280		General Note: Run too low to dip bags; most samples taken at surface
WSR Jimstown Rd Rm 5.8	10/30/2013	1125	Rodgers	none	4.8	8.17	14.7	324	37	e	
WSR Fairview Dr	10/30/2013	1141	Rodgers	none		8.54	8.4	369	360		
WSR Fairview Dr duplicate fecal	10/30/2013	1141	Rodgers	none		8.54	8.4	370	490		
WSR ~rm 0.7 Airport Road	10/30/2013	1148	Rodgers	none		8.44	8.4	345	77		
LaFarge Driveway/Apple Valley Waste	3/10/2014	1130	Rodgers	none		7.58	3.6		1	LT-e	
WSR Eddies Tires/Floyds Cows	3/10/2014	1120	Rodgers	none		7.9	4.5		27	e	General Notes: These March samples were collected during a period of snow melt. There was active surface runoff occurring. The stream(s) was generally clear, except at the two lower sites. At Fairview Drive the water was light brown with a rusty smell, and at Airport Road it was less brown with no odor.
WSR Wydmeyer ~ Rm 8.6	3/10/2014	1114	Rodgers	none		7.83	3.9		30	e	
Yellow Run at Sheetz	3/10/2014	946	Rodgers	none		7.77	3.2		40	e	
WSR above Country Inn =~Rm 8.2????	3/10/2014	1105	Rodgers	none		8.27	4.0		13	e	
WSR Jimstown Rd Rm 5.8	3/10/2014	958	Rodgers	none	9.6	7.69	7.2		16	e	
WSR Sandmine Rd.	3/10/2014	1008	Rodgers	none		7.92	5.9		10	e	
WSR Fairview Dr	3/10/2014	1028	Rodgers	none		8.26	4.8		310		
WSR ~rm 0.7 Airport Road	3/10/2014	1046	Rodgers	none		8.19	4.4		33	e	
WSR ~rm 0.7 Airport Road duplicate	3/10/2014	1046	Rodgers	none					23	e Duplicate	
LaFarge Driveway/Apple Valley Waste	5/2/2014		Rodgers	none		6.2	13.9		35	e	General Notes: These May samples were collected about 48 hours after a major rainfall event. The intent was to capture unfrozen ground saturated conditions. There was no surface runoff observed, ground was wet/damp but drying. Streams were recently at bankful now receding. Faint odor of sewage at Jimstown and Sandmine.
WSR Eddies Tires/Floyds Cows	5/2/2014		Rodgers	none		6.46	12.8		50	e	
WSR Wydmeyer ~ Rm 8.6	5/2/2014		Rodgers	none		6.32	11.8		45	e	
Yellow Run at Sheetz - SPLIT	5/2/2014		Rodgers	none		7.74	10.8		45	e	
Yellow Run at Sheetz - SPLIT	5/2/2014		Rodgers	none					35	e split	
WSR above Country Inn =~Rm 8.2????	5/2/2014		Rodgers	none		6.66	11.8		55	e	
WSR Jimstown Rd Rm 5.8	5/2/2014		Rodgers	none	16	6.6	12		70	e	
WSR Sandmine Rd.	5/2/2014		Rodgers	none		6.49	11.8		25	e	
WSR Fairview Dr	5/2/2014		Rodgers	none		6.97	11.3		880		
WSR ~rm 0.7 Airport Road	5/2/2014		Rodgers	none		6.76	11		420		
LaFarge Driveway/Apple Valley Waste	6/20/2014		Gillies	Moderate		7.3	20		1500		These samples were collected during a period of regular rainfall events over the preceding days and overnight before this sampling. A WeatherUnderground station for Berkeley Springs notes 0.31" of precip the previous day. The flow through the culvert at the uppermost site (Apple Valley Waste) was modest but present. Stream water at Fairview and Airport was somewhat turbid, milky color (12.0 and 11.0 NTU, respectively).
WSR Eddies Tires/Floyds Cows	6/20/2014		Gillies	Moderate		7.4	19		390		
WSR Wydmeyer ~ Rm 8.6	6/20/2014		Gillies	Moderate		7.7	19		400		
Yellow Run at Sheetz	6/20/2014		Gillies	Moderate		7.9	19		867		
WSR above Country Inn =~Rm 8.2????	6/20/2014		Gillies	Moderate		8.1	20		967		
WSR Jimstown Rd Rm 5.8	6/20/2014		Gillies	Moderate	5	8	21		500		
WSR Sandmine Rd.	6/20/2014		Gillies	Moderate		8.1	20		440		
WSR Fairview Dr	6/20/2014		Gillies	Moderate		8.4	20.5		350		
WSR Fairview Dr duplicate fecal	6/20/2014		Gillies	Moderate					350		
WSR ~rm 0.7 Airport Road	6/20/2014		Gillies	Moderate		8.3	20.5		480		
LaFarge Driveway/Apple Valley Waste	6/23/2014		Gillies	None		7.2	19		10	e	Samples collected as a followup to the high concentration samples from 6/20. No precipitation in previous 2 days.
WSR Eddies Tires/Floyds Cows	6/23/2014		Gillies	None		7.5	20		77		
WSR Eddies Tires/Floyds Cows DUPLICATE	6/23/2014		Gillies	None					57	e	
WSR Wydmeyer ~ Rm 8.6	6/23/2014		Gillies	None		7.9	19		201		
Yellow Run at Sheetz	6/23/2014		Gillies	None		8	19.5		967		
WSR above Country Inn =~Rm 8.2????	6/23/2014		Gillies	None		8.2	20		1467		

WSR Jimstown Rd Rm 5.8	6/23/2014		Gillies	None	5.2	8.1	20.5		350	
WSR Sandmine Rd.	6/23/2014		Gillies	None		8.2	20		217	K
WSR Fairview Dr	6/23/2014		Gillies	None		8.6	20		290	
WSR ~rm 0.7 Airport Road	6/23/2014		Gillies	None		8.5	20		140	