FECAL COLIFORM T.M.D.L. IMPLEMENTATION - A CASE STUDY MCINTOSH TRAIL REGIONAL DEVELOPMENT CENTER, GRIFFIN, GA

Charles D. Absher

AUTHOR: Senior Engineer. Integrated Science & Engineering. 275 South Lee Street, Fayetteville, GA 30214.
REFERENCE: Proceedings of the 2003 Georgia Water Resources Conference, held April 23-24, 2003, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. Fecal coliform is the most frequently listed stream impairment on the Georgia 303(d) list, the listing of streams and associated water quality impairments required under the US Clean Water Act. In many instances, the stream is categorized as impaired based on a minimal water quality data set. Under these circumstances it is difficult to implement a TMDL that will serve to improve the water quality. There is a need for additional water quality data along with watershed studies to focus on the specific pollution sources. This is the only way to have a meaningful impact on water quality through cost-effective application of limited financial resources.

BACKGROUND

There are over 22,000 stream miles in the State of Georgia. Over 13,000 miles of stream or 1,523 stream segments are found on the 305b list, the Clean Water Act requirement summarizing the water quality evaluations for the State's water bodies. On the State's 2002 listing, 47% of the evaluated streams segments are categorized as "supporting" their designated uses. This 47% is found to have no water quality impairments. Of the remainder, 29% are categorized as "partially supporting" their designated uses (an intermediate level of water quality impairment), while 24% are categorized as "non-supporting" (critically impaired).

Of the segments categorized as either "partially supporting" or "non-supporting", 62% show the listing impairment to be either fecal coliform alone, or fecal coliform in conjunction with another pollutant. In 44% of the impaired stream segments, fecal coliform is the only impairment cause. Clearly, fecal coliform is the major water quality impairment as determined by the State of Georgia. Adequately addressing this water quality issue can produce a major improvement in the State's streams.

Why are we concerned over excessive levels of fecal coliform? An article from the 9/5/02 online edition of the Dublin Courier Herald describes the death of an 11-year old boy from a rare parasitic infection, a parasite that thrives on and is found with fecal coliform. The boy was swimming in the Oconee River and it is believed he accidentally inhaled river water. The infection can only enter the body through inhalation and it is almost always fatal. Monitoring and controlling bacterial levels is not only a water quality issue, but a human health issue as well.

CURRENT WATER QUALITY STANDARDS

The State has currently under review a revision of the bacterial standard, primarily to shift from fecal coliform to Escherichia coli (E. coli) as the indicator bacteria. The E. coli bacterium is more indicative of a potential human pollution source than fecal coliform. However, current TMDLs are written based on fecal coliform, and the current State standards are still in force as of March 2002.

The State standard for most designated stream uses is a geometric mean of 200 CFU (colony forming units or sometimes MPN, most probable number) per 100 ml. This standard is applicable from May through October. The geometric mean must be calculated from at least four samples taken within a 30-day period, with at least 24-hours between samples. For the months of November through April, the geometric mean is increased to 1,000 per 100 ml, with a maximum single sample value of 4,000 per 100 ml. No particular environmental characteristic says wintertime bacterial levels are less critical than summer time levels, except that human contact with polluted water is more likely to occur during the summer months, thus the lower summer maximum. In practical terms of addressing a bacterial impairment, levels below the summer standard ensure that the standard is met throughout the year. Furthermore, if violations are from non-human sources, the summer maximum is increased to 500 per 100 ml geometric mean for free flowing freshwater streams. A shift to an E. coli standard would more clearly

4/14/95	170
5/16/95	110
6/27/95	80
7/18/95	20
8/15/95	110
9/24/95	24000
10/24/95	430
11/21/95	80

$$GM_{\bar{y}} = \sqrt[n]{y_1 y_2 y_3 \cdots y_n}$$

GM = 201 per 100 ml
Avg. = 3,125 per 100 ml

Figure 1. Comparison of geometric mean vs. standard average.

differentiate between human or non-human bacterial pollution sources.

The geometric mean is an averaging technique that essentially lessens the weight of outlier sample results, or results that don't fall within a reasonable range of magnitude within the overall sample database. Mathematically, the geometric mean is the nth root of the product of n values. Comparing a standard average to a geometric mean, the mean reflects the more typical values of a data set by reducing the impact of the outlier values.

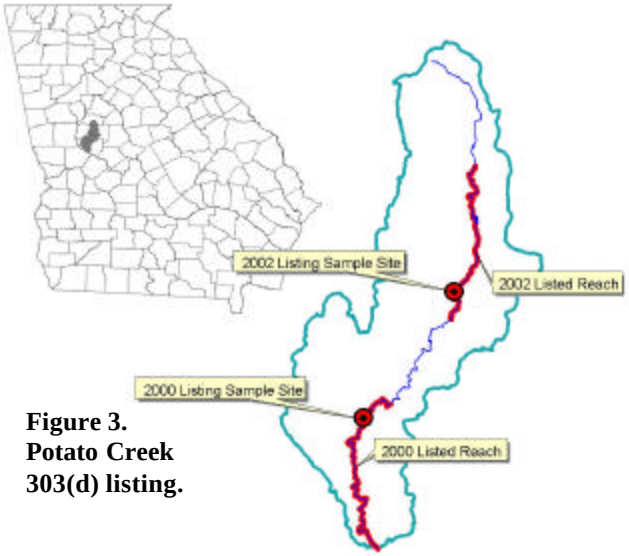

Figure 3. Potato Creek 303(d) listing.

THE POTATO CREEK IMPAIRMENT LISTING

The Potato Creek Watershed covers approximately 237 square miles within the Upper Flint Watershed and is tributary to the Upper Flint River. The lower portion of Potato Creek was placed on the "partially supporting" 2000 list, based on the data shown previously in the

Figure 2. 2002 listing data.

Lower Potato Creek

Upson	Discharge	Fecal	GeoMean
1/25/00 11:10	515	3500	
2/22/00 10:25	96	20	85
2/29/00 10:45	106	50	
3/6/00 10:40	112	230	
3/15/00 12:05	145	230	
4/17/00 10:40	89		
5/15/00 8:55	16	170	74
5/23/00 8:40	20	20	
6/1/00 9:25	14	80	
6/12/00 8:45	8.1	110	
7/25/00 9:35	3.7	20	127
8/1/00 8:45	0.87	230	
8/8/00 8:30	16	170	
8/15/00 9:50	2.4	330	
9/5/00 11:05	47		
10/10/00 8:35			
11/6/00 9:15		220	158
11/13/00 9:00		130	
11/27/00 9:40		1100	
12/5/00 9:45		20	

Middle Potato Creek

Lamar	Discharge	Fecal	GeoMean
1/25/00 9:45	294	1100	
2/22/00 9:00	47	140	146
2/29/00 8:50	54	110	
3/6/00 9:20	51	130	
3/15/00 13:05	62	230	
4/17/00 9:30	136		
5/15/00 7:45	16	940	316
5/23/00 7:45	14	220	
5/31/00 9:50	12	230	
6/12/00 7:40	7.5	210	
7/25/00 8:10	6.2	790	719
8/1/00 7:30	5.3	330	
8/8/00 7:40	10	790	
8/15/00 7:45	4.7	1300	
9/5/00 9:40	32		
10/10/00 8:35			
11/6/00 9:15		140	220
11/13/00 9:00		330	
11/27/00 9:40		230	
12/5/00 9:45		220	

geometric mean / standard average comparison. Subsequently for the 2002 list, additional monitoring caused the lower portion to be categorized as "supporting", while the middle section was given a "non-supporting" classification. The data for the 2000 listing did not follow the State criteria for calculating a geometric mean, while the data for the 2002 listing did.

Aerial photography and field survey of the areas around the sample sites show a dairy farm upstream of the middle sample location. Is this the source of bacteria? High fecal levels only tell us there is a problem, it doesn't tell us where that problem originates, or what might be the source. Fecal coliforms are generated from a variety of animal as well as human sources, and in some cases can occur naturally in soil and water. A technique for identifying the source of bacterial pollution is necessary.

POTATO CREEK T.M.D.L.

EPA Region 4 issued the Potato Creek TMDL in February 1998. It was calculated using the EPA BASINS software system, specifically with the Nonpoint Source Model (NPSM). A summer 30-day geometric mean of 293 CFU per 100 ml was modeled and a TMDL target level of 175 CFU per 100 ml was specified. There was also a recommendation in the TMDL document for further study within the Watershed.

A TMDL Implementation Plan was developed by the McIntosh Trail Regional Development Center and submitted to the Georgia Environmental Protection Division (EPD) of the Department of Natural Resources in early 2002. This was part of the effort by Regional Development Centers across the State to assist EPD with TMDL implementation plans. It was clear during development of the Implementation Plan that additional data and study was necessary to focus Best Management Practices (BMPs) on areas and sources of bacterial pollution. Without this focus, there would not be an efficient application of limited financial resources to adequately address compliance with the TMDL.

As a result, the McIntosh RDC sponsored an EPA 319 Grant Application to help fund a revision of the Implementation Plan based on the results of Bacterial Source Tracking (BST) to identify sources of fecal coliform. A partnership was formulated with the University of Georgia, a leader in BST technology, and six communities with jurisdictions in the Potato Creek Watershed. These communities committed matching funding to the effort. EPA has approved the Grant and work will begin in early 2003.

PREVIOUS STUDIES

There have been additional efforts in the Potato Creek Watershed to identify specific areas with excessive levels of fecal coliform. These additional efforts have been sponsored by the City of Griffin in their role as a leader in understanding and addressing water quality issues within a small municipal jurisdiction, and application of the knowledge gained on a State Wide basis. Three specific study efforts have been completed in an attempt to determine the scope and source of bacterial pollution.

The first of these was a Watershed Assessment conducted in the Potato Creek headwaters primarily within the City of Griffin with some additional study in Spalding County. In summary, the study indicated that some areas within the City did have excessive fecal levels, while these excessive levels did not extend beyond the County boundary. However, lab analysis of the water quality samples only indicated the relative nature of the problem, not the type of fecal bacterium or its source.

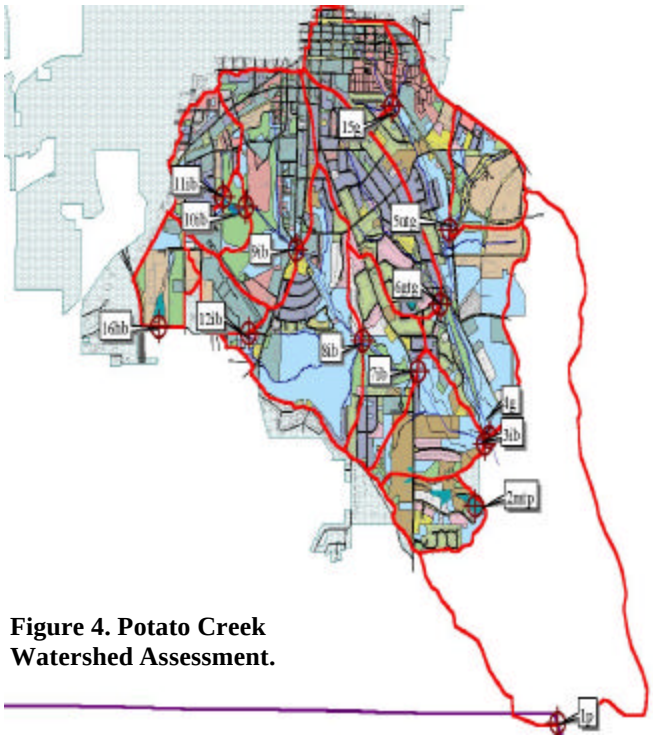

Figure 4. Potato Creek Watershed Assessment.

The second study was a Bacterial Identification project within and upstream of the middle stream segment. The sample sites were the same locations used by EPD to include the upper portion of Potato Creek on the 303(d) list as impaired due to biota impacts. Although the study did show the predominant bacterium in the water samples, it did not indicate with any certainty the absence or presence of fecal bacteria. In retrospect, a concurrent lab analysis specifically for fecal coliform should have been conducted to determine the correlation between fecal and the dominant bacterium. However, this still would not have identified a specific bacterial source.

The third study has been conducted preliminary to awardance of the 319 Grant. It consisted of one day of sampling for E. coli at 34 sample sites along the main reach of Potato Creek. The focus of the 319 Project will be to obtain a clear differentiation of wet weather and dry weather sample results. The theory is that dry weather results will be more indicative of a persistent bacterial source, such as a leaking sewer or septic system, or possibly a wet weather stream traversing an animal husbandry operation. Wet weather results will be indicative of transient sources, occurring when stormwater produces substantial run-off from areas not contributing to a dry weather stream flow. The initial sampling effort has rendered information, not only on bacterial levels, but also on expected sampling logistics and access.

TARGETED SAMPLING

Additional samples will be obtained at these 34 sites in order to develop a targeted plan for additional sampling of the watershed. The main stream results will allow for elimination of some areas from further sampling, while other areas will be "targeted" with additional sample sites to produce further isolation of bacterial source areas. As the source areas become clearly isolated, a DNA typing method will be used to identify the specific source of the bacterial pollution. In addition, the initial regional type samplings will include analysis for fecal coliform to develop correlations between fecal coliform and *E. coli.*

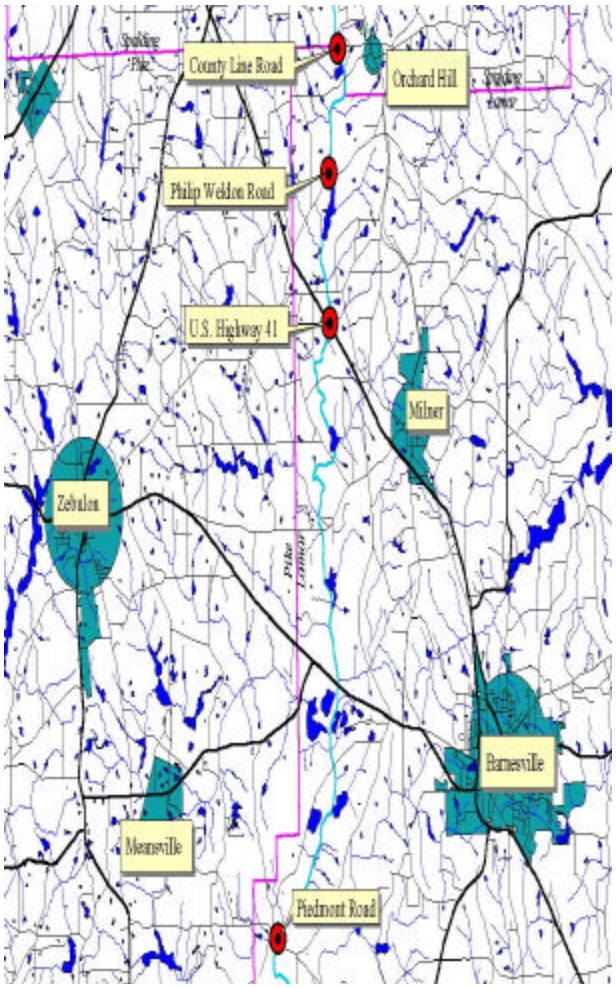

Figure. 5. Potato Creek bacterial identification.

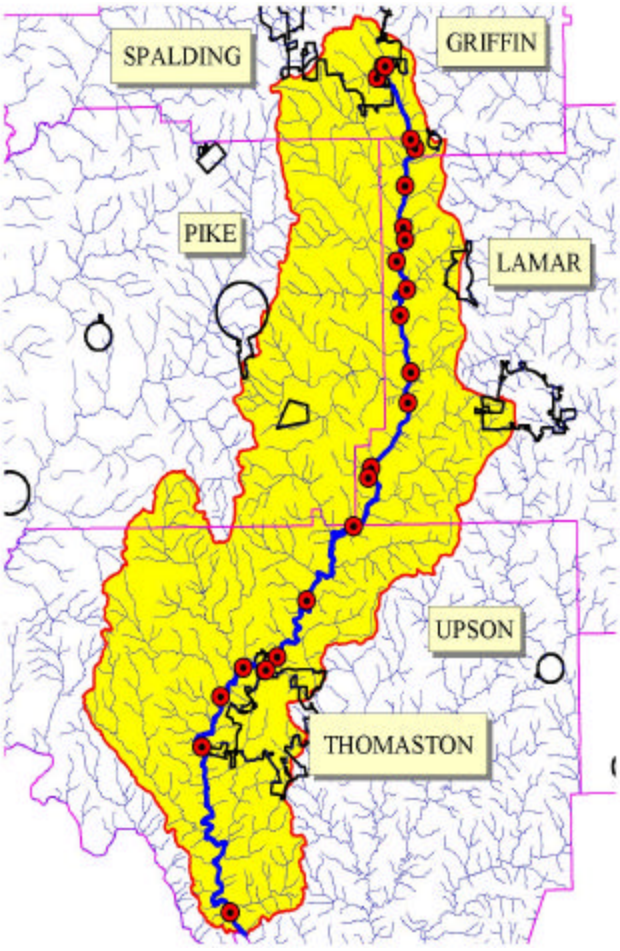

Figure 6. Potato Creek preliminary 319 grant sampling.

TMDL IMPLEMENTATION PLAN REVISION

The 319 Grant Project will be focused on developing a cost-effective and targeting implementation that will apply resources to specific areas of bacterial remediation. Specific objectives will be:

- Establishing a targeted BST program in the Watershed
- Isolating pollution source sub-watersheds to establish BMP implementation areas
- Clearly identifying sources of bacterial pollution
- Identifying BMPs for implementation that will effectively and in a cost-effective manner, reduce bacterial pollution sources inputs to Potato Creek.

COMMUNITY INVOLVEMENT

The success of any TMDL implementation depends upon the coordination between jurisdictions over which the Watershed extends. This Project will be facilitated through a Regional Environmental Advisory Committee already established by the McIntosh Trail RDC and composed of representatives from the six affected municipal jurisdictions and other interested parties within the Watershed. This Committee has already been functioning beginning with the initial TMDL Implementation Plan formulation and has continued through the Grant Application process. The Committee framework will provide a mechanism for ensuring that recommended BMPs have the greatest probability of successful implementation.

CONCLUSION

The 319 Grant will facilitate funding of a project to revise a TMDL Implementation Plan so that it focuses remedial efforts where they will provide the most impact to water quality improvement. A sound and comprehensive Plan will leverage the limited financial resources available for addressing water quality issues within the Watershed. The Project will also help to identify issues related to a practical application of BST technology. This technology is the necessary mechanism to identify specific sources of bacterial pollution, and thus establishing remedial focus where the limited financial resources can be applied most effectively.