North Carolina Addendum to the Low pH TMDL for the Great Smoky Mountains National Park, TN

August, 2012

Waterbody IDs:
2-79-(24)ut4
7-10

Submitted by:
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Introduction

The Tennessee Department of Environment and Conservation developed a Total Daily Maximum Load (TMDL) for the Great Smoky Mountains National Park in 2010 to address low pH impairments. The TMDL was approved by EPA Region 4 on September 7, 2010.

This addendum to the Great Smoky Mountains TMDL is to address additional assessment units on the 303(d) list for low pH impairments in the mountains of North Carolina. These assessment units drain forested areas at high elevations in western North Carolina and were first included on the 303(d) list in 2010. The impaired waters and associated assessment units (AUs) are shown below:

Waterbody Name [Assessment Unit]	Description	Water Quality Classification	Miles
Unnamed tributary to Tuckasegee River [2-79-(24)ut4]	Source to Tuckasegee River	C	1.3
Hollow Poplar Creek [7-10]	From source to Nolichucky River	C; Tr	5.6

Area Description

Both waterbodies are located in the Blue Ridge Mountains of western North Carolina and drain high altitude ridges in predominantly forested watersheds. The tributary to the Tukasegee River is located in Jackson County and drains the northern slope of Cullowhee Mountain from an elevation of approximately 4,000 feet (Figure 1).

Poplar Hollow Branch is located in Mitchell County and drains the southern slope of Unaka Mountain from an elevation of approximately 5,000 feet (Figure 2).

There are no NPDES wastewater or stormwater permits in these watersheds.

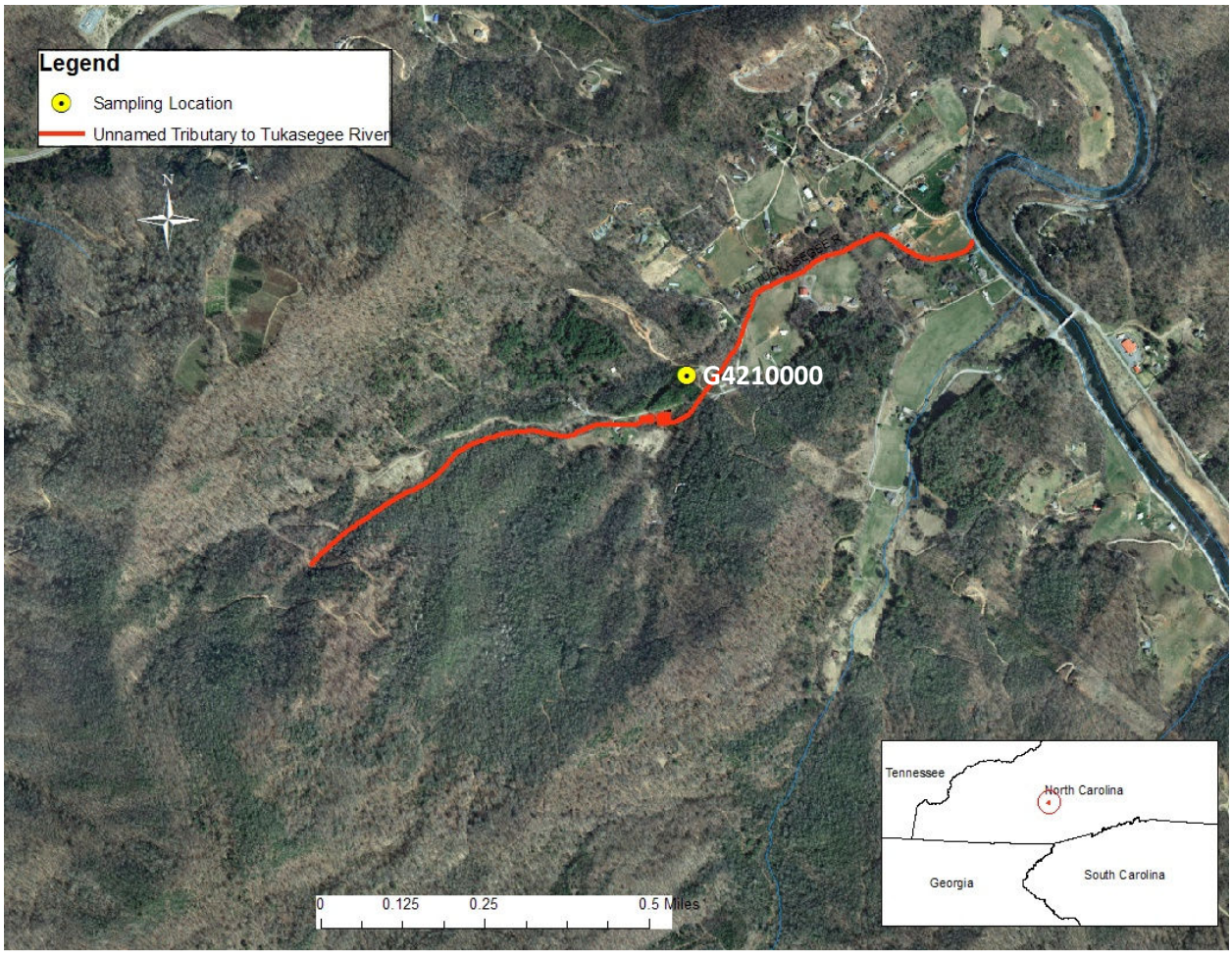


Figure 1 - Unnamed Tributary to the Tuckasegee River

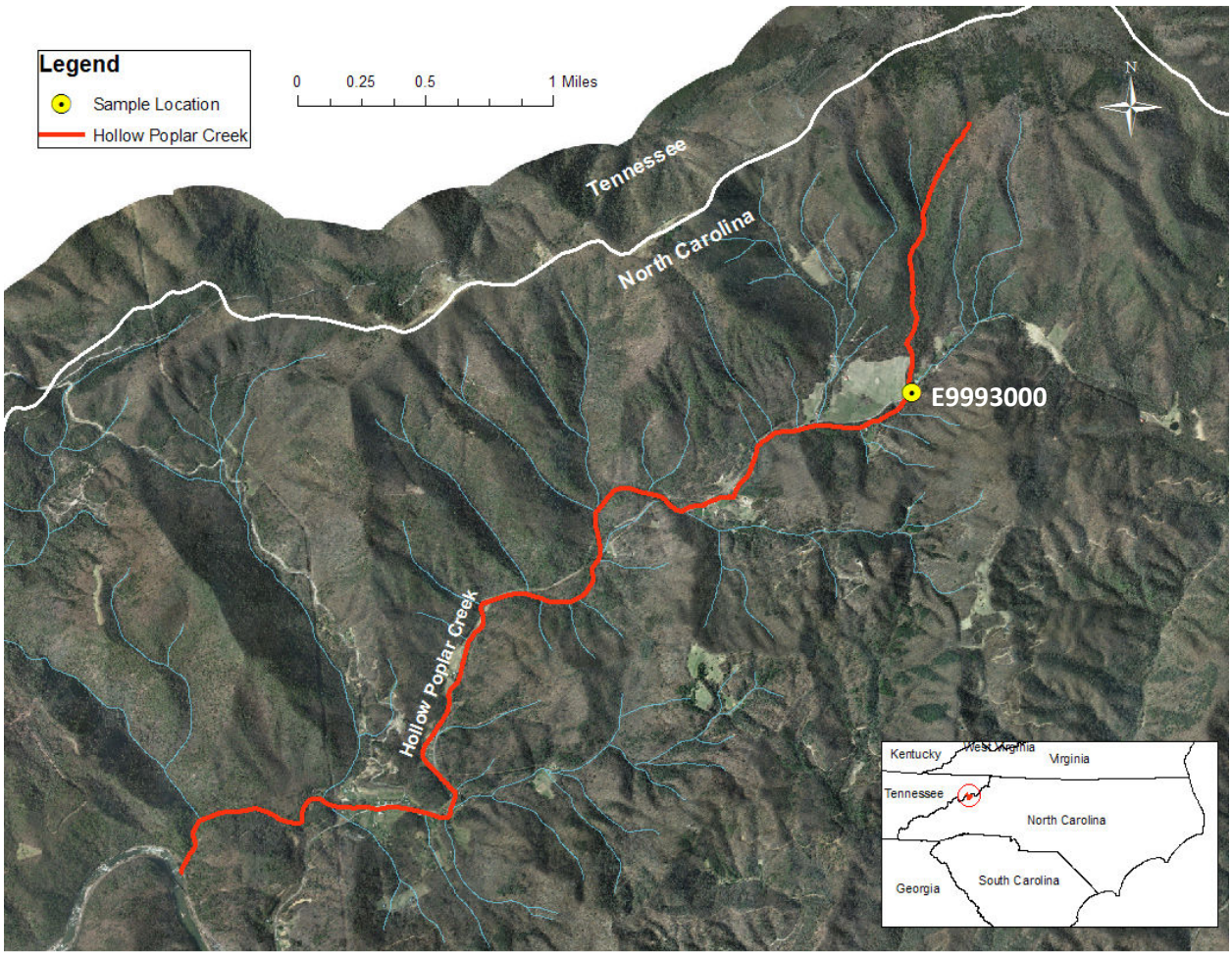


Figure 2 - Hollow Poplar Creek

Documentation of Impairment

The two addendum assessment units in the North Carolina mountains were listed in Category 5 of the 2010 North Carolina Integrated Report for low pH. These streams do not meet their designated uses. Waters within this classification, according to 15A NCAC 02B.0221 (Fresh Surface Water Quality Standards for Class C Waters), must meet the following water quality criteria for pH in order to meet their designated use: "pH shall be normal for the waters in the area, which generally shall range between 6.0 and 9.0 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions." Data collected on these streams through the NC Random Ambient Monitoring System is shown in Appendix A.

Low pH in western North Carolina streams has been documented by others as well. Recent USDA Forest Service surveys have shown widespread occurrence of streams having low acid neutralizing capacity (ANC) and pH in the mountains of western North Carolina, attributable to deposition of sulfur and nitrogen compounds from the atmosphere. Modeling has been performed to estimate the sensitivity of watersheds in the Southern Blue Ridge province to

changes in atmospheric sulfur deposition (Sullivan *et al.* 2007). US National Park Service is funding a similar project, *Application of a Dynamic Watershed Biogeochemical Model (PnET-BGC) to Evaluate the Recovery of Sensitive Aquatic Resources at Great Smoky Mountains National Park From the Effects of Acidic Deposition*. Data collected by the US National Park Service in the Great Smoky Mountains National Park is shown in Appendix B. A partnership among state and Federal agencies and universities continues toward TMDL implementation, with efforts underway to quantify sources and emissions reductions needed to increase stream ANC in these higher elevations in Tennessee and North Carolina. Scenarios of pollution, climate trends, and resulting stream pH will be modeled. Results will let the Park, and state and federal regulators know what reductions in sulfate and nitrate emissions are needed.

TMDL Reductions

The 2010 Great Smoky Mountains TMDL (http://tn.gov/environment/wpc/tmdl/approvedtmdl/gsm_ph.pdf) requires instream ANC of 6-50 µeq/L. These targets are also appropriate for the addendum assessment units and other forested high elevation streams in western North Carolina, in order for the streams to achieve and maintain the pH standard.

Full implementation of the 2010 Great Smoky Mountains TMDL and achievement of the ANC targets of 6-50 µeq/L is expected to achieve water quality standards in the addendum waters. DWQ may reevaluate the need for individual TMDLs for the addendum waters if the required targets are determined to be insufficient.

Public Participation

The 2010 Great Smoky Mountains TMDL was placed on Public Notice for a 60-day period. Notice was given via the following: Tennessee Department of Environment and Conservation website, TN NPDES permit Public Notice mailing, and letter sent to water quality partners.

A draft of this addendum to the Great Smoky Mountains TMDL was publicly noticed through electronic notification of the draft addendum to known interested parties. The addendum was available on the DWQ's website at http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls during the comment period, August 2-21, 2012.

Literature Cited

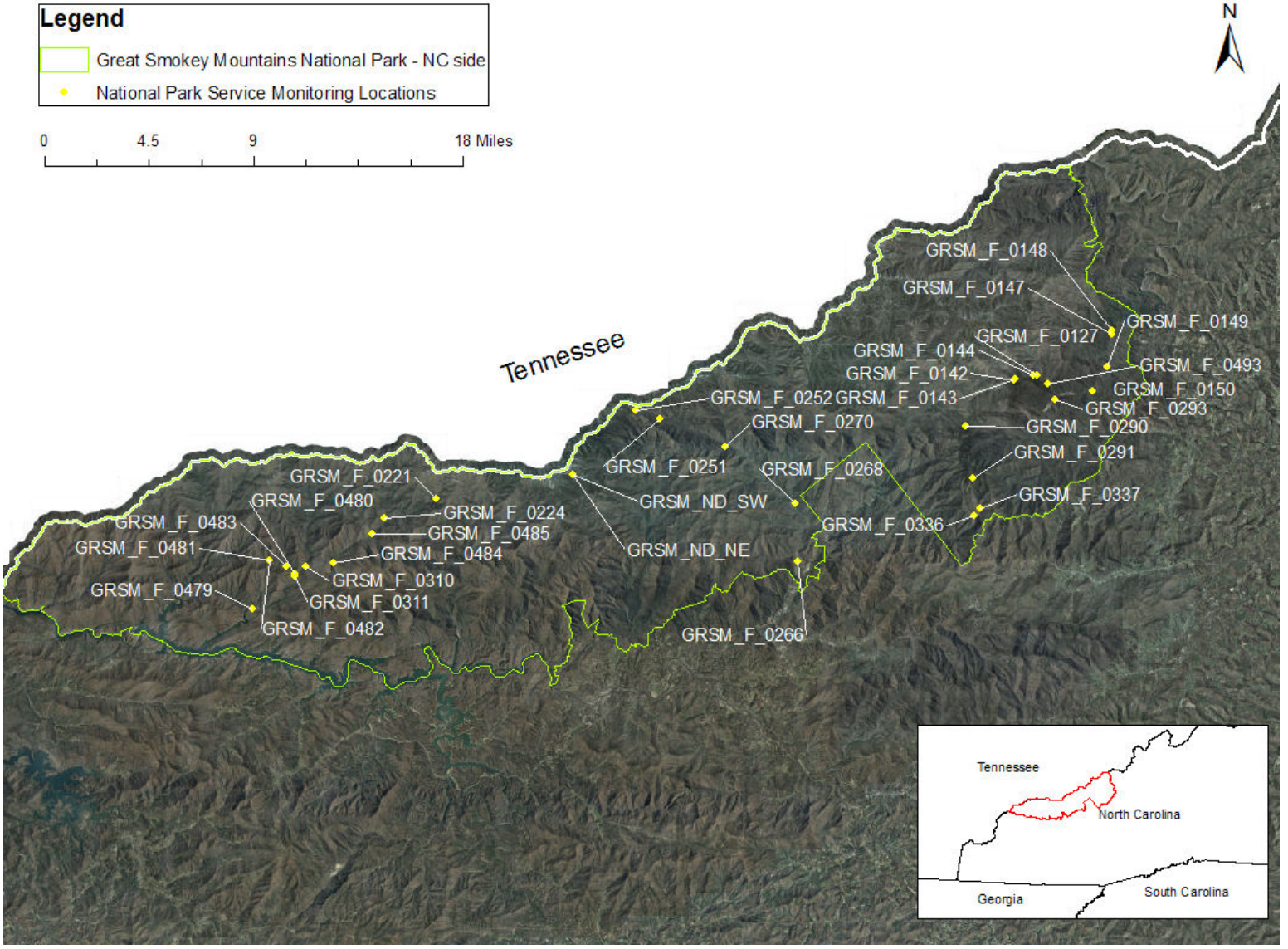
Sullivan, T.J., Cosby, B.J., Snyder, K.U., Herlihy, A.T., Jackson, B., 2007. Model-based Assessment of the Effects of Acidic Deposition on Sensitive Watershed Resources in the National Forests of North Carolina, Tennessee, and South Carolina. Final report prepared for USDA Forest Service, Asheville. NC. E&S Environmental Chemistry, Inc., Corvallis, OR.

Appendix A: NC Random Ambient Monitoring System (RAMS) Data

NC RAMS Data			
G4210000 - UT to Tuckasegee River		**E9993000 - Hollow Poplar Creek**	
Date	**pH measured**	**Date**	**pH Measured**
3/21/2007	6.8	3/28/2007	6.3
4/23/2007	6.7	5/9/2007	6.2
5/29/2007	6.5	6/12/2007	6.6
6/25/2007	6.4	7/10/2007	6.4
7/24/2007	6.5	8/21/2007	6.7
8/29/2007	6.7	9/26/2007	6.3
9/12/2007	6.4	10/17/2007	5.8
11/12/2007	6.4	11/13/2007	6.2
12/11/2007	6.6	12/14/2007	6.0
1/21/2008	5.6	1/7/2008	6.3
1/29/2008	5.9	2/25/2008	6.4
2/11/2008	5.7	3/6/2008	5.9
3/24/2008	6.7	4/11/2008	6.6
4/30/2008	6.5	5/13/2008	7.1
5/30/2008	6.3	6/18/2008	6.9
6/16/2008	7.4	8/26/2008	5.8
7/29/2008	6.4	9/11/2008	6.0
8/20/2008	5.8	10/8/2008	6.7
9/24/2008	6.6	11/3/2008	6.4
10/15/2008	6.6	12/3/2008	5.3
11/5/2008	6.2		
12/16/2008	6.0		
Average*	**6.2**		**6.1**
Minimum	**5.6**		**5.3**
Maximum	**7.4**		**7.1**

* Average pH values were calculated by taking the mean of the hydrogen ion concentration for the dataset, then converting the value back to pH

Appendix B: US National Park Service Sampling Locations and Data



pH					
Station/Parameter	**Data Period**	**Data Points**	**Average**	**Min**	**Max**
GRSM_F_0127	1993-2003	42	6.4	6.0	6.8
GRSM_F_0142	1994-2008	69	6.5	5.9	6.9
GRSM_F_0143	1994-2008	71	6.4	5.6	7.0
GRSM_F_0144	1993-2008	70	6.5	5.5	6.9
GRSM_F_0147	1993-2008	87	6.6	6.1	7.1
GRSM_F_0148	1993-2008	64	6.7	6.3	7.2
GRSM_F_0149	1993-2008	63	6.6	6.2	7.1
GRSM_F_0150	1993-2003	35	6.6	6.3	7.1
GRSM_F_0221	1993-2008	37	6.2	5.6	6.6
GRSM_F_0224	2004-2008	8	6.3	5.9	6.8
GRSM_F_0251	1993-2008	87	6.1	5.6	6.6
GRSM_F_0252	1993-2008	73	5.4	4.6	7.0
GRSM_F_0266	1993-2003	35	6.5	6.1	7.0
GRSM_F_0268	1994-2008	73	6.5	6.0	7.0
GRSM_F_0270	2004-2008	28	6.4	5.9	6.8
GRSM_F_0290	1994-2003	24	5.1	4.4	6.2
GRSM_F_0291	1994-2003	42	6.1	5.6	6.7
GRSM_F_0293	1993-2008	91	6.6	6.2	7.1
GRSM_F_0310	1993-2008	49	6.5	6.0	7.1
GRSM_F_0311	1993-2008	42	6.5	6.1	6.9
GRSM_F_0336	1995-2003	41	6.4	6.1	6.8
GRSM_F_0337	1995-2003	45	6.3	5.9	6.7
GRSM_F_0479	1996-2008	38	6.5	6.0	7.0
GRSM_F_0480	1996-2008	37	6.5	6.1	7.1
GRSM_F_0481	1996-2008	36	6.5	6.1	7.0
GRSM_F_0482	1996-2008	35	6.5	6.1	7.1
GRSM_F_0483	1996-2008	37	6.6	6.1	7.1
GRSM_F_0484	1996-2008	36	6.4	6.0	6.9
GRSM_F_0485	1996-2008	36	6.5	6.1	7.0
GRSM_F_0493	1996-2008	55	6.5	6.1	7.0
GRSM_ND_NE	1991-2008	656	5.6	3.5	8.4
GRSM_ND_SW	1991-2008	657	5.8	3.3	8.0
Totals		**2805**	**6.1**	**3.3**	**8.4**

Acid Neutralizing Capacity (ueq/L)					
Station	**Data Period**	**Data Points**	**Average**	**Min**	**Max**
GRSM_F_0127	1993-2003	42	47.03	19.47	86.67
GRSM_F_0142	1994-2008	69	58.80	31.22	147.40
GRSM_F_0143	1994-2008	71	50.34	15.53	105.74
GRSM_F_0144	1993-2008	69	54.12	26.26	95.13
GRSM_F_0147	1993-2008	87	85.02	39.62	126.60
GRSM_F_0148	1993-2008	64	123.56	66.84	216.29
GRSM_F_0149	1993-2008	63	82.39	41.76	124.05
GRSM_F_0150	1993-2003	35	79.35	39.09	113.10
GRSM_F_0221	1993-2008	37	29.18	2.12	66.22
GRSM_F_0224	2004-2008	8	45.40	28.98	67.83
GRSM_F_0251	1993-2008	87	22.43	-3.27	63.85
GRSM_F_0252	1993-2008	73	21.58	-21.22	746.60
GRSM_F_0266	1993-2003	35	74.23	40.27	159.74
GRSM_F_0268	1994-2008	73	62.54	23.36	178.00
GRSM_F_0270	2004-2008	28	47.44	25.51	73.43
GRSM_F_0290	1994-2003	24	-4.04	-40.51	32.51
GRSM_F_0291	1994-2003	42	25.61	3.75	61.94
GRSM_F_0293	1993-2008	90	86.20	45.70	133.20
GRSM_F_0310	1993-2008	49	77.64	44.05	173.80
GRSM_F_0311	1993-2008	42	67.18	36.37	162.76
GRSM_F_0336	1995-2003	41	49.71	32.15	118.02
GRSM_F_0337	1995-2003	46	41.60	20.89	67.99
GRSM_F_0479	1996-2008	38	69.11	41.34	106.43
GRSM_F_0480	1996-2008	37	86.16	64.65	137.80
GRSM_F_0481	1996-2008	36	87.46	55.43	153.91
GRSM_F_0482	1996-2008	35	90.32	64.18	156.26
GRSM_F_0483	1996-2008	37	87.39	45.23	165.02
GRSM_F_0484	1996-2008	36	56.23	32.65	138.33
GRSM_F_0485	1996-2008	36	72.60	40.26	139.69
GRSM_F_0493	1996-2008	55	70.84	30.55	143.50
GRSM_ND_NE	1991-2008	649	4.06	-21.57	35.82
GRSM_ND_SW	1991-2008	651	11.60	-13.79	51.85
Totals		**2791**	**37.12**	**-40.51**	**746.60**

Appendix C: Public Comments and Responses

Addendum to the Low pH TMDL for the Great Smoky Mountains National Park, TN
Public Comment Responsiveness Summary

August 2012

The public comment period extended from August 2, 2012 through August 21, 2012. Comments were received from the North Carolina Department of Transportation. These comments with the NC Division of Water Quality responses are provided in the Responsiveness Summary presented below.

1. Neither the draft Addendum, nor the Tennessee TMDL report from which the draft Addendum was based, identifies a specific pollutant of concern. Instead, both documents refer to an instream numeric target for "acidic neutralizing capacity" (ANC) which is a measure of a system's ability to neutralize acid and not a pollutant of concern. Please identify a pollutant of concern in the draft Addendum.

Response: The impairment is low pH, which although not a pollutant, is associated with state-adopted, EPA-approved instream numeric criteria. ANC is a common surrogate for pH in TMDLs. The low pH is attributable to sulfur dioxide and nitrogen oxide emissions from sources outside the TMDL area. The text has been revised for clarification.

2. Please describe the scientific cause and effect relationship between the pollutant of concern and the pH water quality standard.

Response: The relationship between ANC and pH is controlled by well-defined aquatic equilibrium chemistry. ANC is an indicator related to both pH and NOx/SOx deposition. Sulfate and nitrate's acidifying effects contribute to degradation of water quality by lowering the acid neutralizing capacity (ANC). As the ANC decreases, streams can acidify to the point where they are no longer capable of supporting aquatic life.

3. The draft Addendum does not identify any point and/or non-point sources of the pollutant of concern and notes that both waterbodies in question drain predominantly forested watersheds. Please clarify whether or not DWQ believes the impairment is caused by natural background conditions and whether or not the range of pHs observed for the two waterbodies are normal for the waters in the area. If sources other than natural background conditions are contributing pollutant loading, then please identify any point and non-point sources.

Response: The low pH is attributable to sulfur dioxide and nitrogen oxide emissions from (nonpoint) sources outside the TMDL area. The text has been revised for clarification.

4. Please calculate the pollutant loading from any point and non-point sources.

Response: The original TMDL included loads. Because this is an addendum to that TMDL, it is not necessary to include additional load calculations here. The primary purpose of the addendum is to acknowledge that full implementation of the TMDL is expected to achieve the water quality standard in the addendum streams.

5. Please calculate the loading capacity of both waterbodies addressed by the draft Addendum for the pollutant of concern. Please note that the TMDLs presented in Table 5 of the Tennessee TMDL report appear to be in error as they reflect *minimum* loading capacities rather than a *maximum* allowable pollutant load as defined in 40 CFR 130.2.

Response: See response to 4. above. A footnote for Table 5 in the Tennessee TMDL states: "The TMDL is also expressed in terms of minimum allowable water column concentration because TDEC recognizes that these values provide information that potentially will be more useful regarding TMDL implementation efforts than the values that are expressed in terms of an allowable load." Further, the goal of the TMDL is a higher ANC than observed, and a higher pH than observed, so it would not be appropriate to express the goals as maxima.

6. On p. 5 of the draft nAddendum DWQ indicates that instream acid neutralizing capacity concentrations of 6-50 µeq/L are appropriate targets for the addendum assessment units and other forested high elevation streams in western North Carolina. This stated ANC target range implies that DWQ is establishing a "surrogate" water quality standard for selected streams in western NC without going through a rule making process. Please note that surrogate water quality standards are not recognized in the 15A NCAC 2B .0100 and .0200 rules and thus should not be the basis for loading capacity calculations.

Response: The text has been revised for clarification. The targets are appropriate for meeting the pH water quality standard in 15A NCAC 2B .0200.

7. Appendix A of the draft Addendum includes tables which report maximum, minimum, and average pH values for various periods of time. For the NC ambient monitoring data NCDOT recommends reporting average pH based on first calculating a mean hydrogen ion concentration for the dataset then converting this value into pH. Because pH is a logarithmic scale it is often not appropriate to directly average individual pH values. For the table in Appendix A which reports ANC for a number of National Park Service stations, please report units.

Response: Revisions have been made as suggested.

8. The draft Addendum was made available for public comment from August 2-21, 2012. It is unclear why DWQ has limited the comment period to 19 days when NCDWQ's website[1] states: "*All TMDLs developed for the Division of Water Quality are available for comment for a period of 30 to 45 days*." We respectfully request that future public draft TMDLs be available for a minimum of 30 days to allow for adequate review and response.

Response: The original TMDL was made available for public comment for 60 days. We believed that a shorter review period would be adequate for this 10-page (including Appendices) Addendum. We will continue to make TMDLs available for comment for at least 30 days.