5-alt REPORT FOR GAP CREEK
IN THE WATAUGA RIVER WATERSHED (06010103)

AN ALTERNATIVE RESTORATION APPROACH UNDER THE LONG-TERM VISION FOR TMDLs

Tennessee Department of Environment and Conservation
Division of Water Resources

September 16, 2019

Background.

EPA's current Vision for the Clean Water Act (CWA) 303(d) program provides a more updated and collaborative framework for more efficient implementation of the program through the states. In particular, it encourages focusing attention on priority waters and acknowledges states have flexibility in using available tools beyond Total Maximum Daily Loads (TMDLs) to attain water quality restoration and protection. In the Integrated Reporting Guidance issued in 2016, EPA acknowledged the most effective method for achieving water quality standards for some water quality impaired segments may be through controls developed and implemented in advance of a TMDL. Alternative approaches designated in the Integrated Report as sub-category 5-alt—in advance of a TMDL—recognize that an alternative restoration approach may be more effective than TMDL reports in reaching the goal of re-attaining support status for impaired waters. If an alternative restoration approach does not show progress in attaining water quality standards, the impaired segment will be reprioritized for TMDL development.

In 2015, Tennessee developed a priority framework document outlining plans to implement prioritization of alternative restoration projects. In it, Tennessee has identified HUC-12s with both nutrient-impaired streams and source water protection areas. In keeping with Tennessee's watershed approach and corresponding schedule, Tennessee considered Group 1 and Group 2 watersheds for alternative plans in FY-2019. This report addresses Gap Creek in Subwatershed 060101030505 in the Watauga River Watershed (06010103).

HUC 10	HUC 12	IMPAIRED STREAM	STREAM ID
0601010305 Boone Lake	060101030505 Gap Creek	Gap Creek	TN06010103008_0800

Table 1. Numbers and Names of HUCs and Nutrient-Impaired Streams in the Report. *HUC, Hydrologic Unit Code.*

I. Nutrient-Impaired Waterbodies to be Addressed.

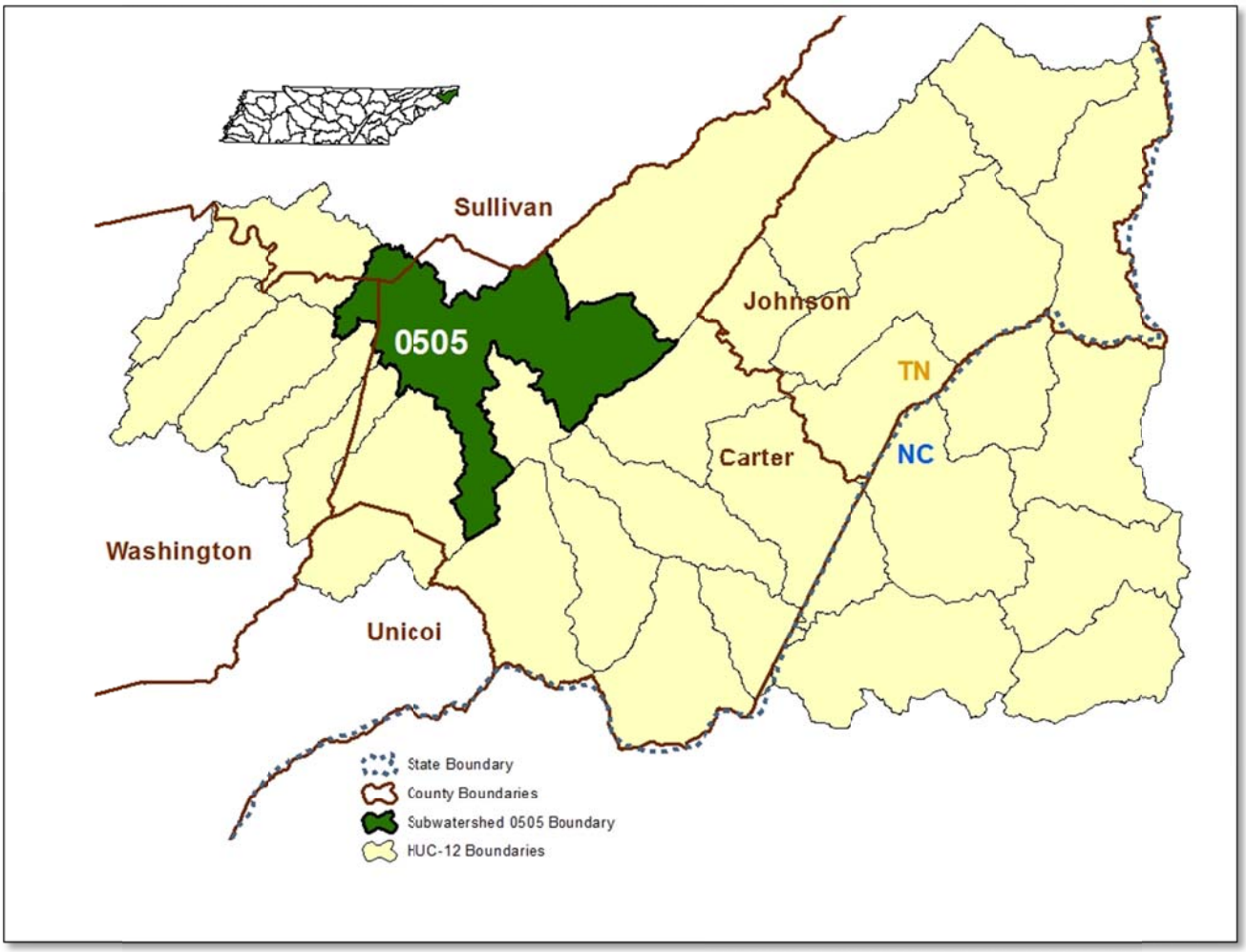


Figure 1. Location of HUC-12 Subwatershed 060101030505 in the Watauga River Watershed. *Subwatershed 060101030505 is Gap Creek Subwatershed. Gap Creek is within the Subwatershed 060101030505 boundary.*

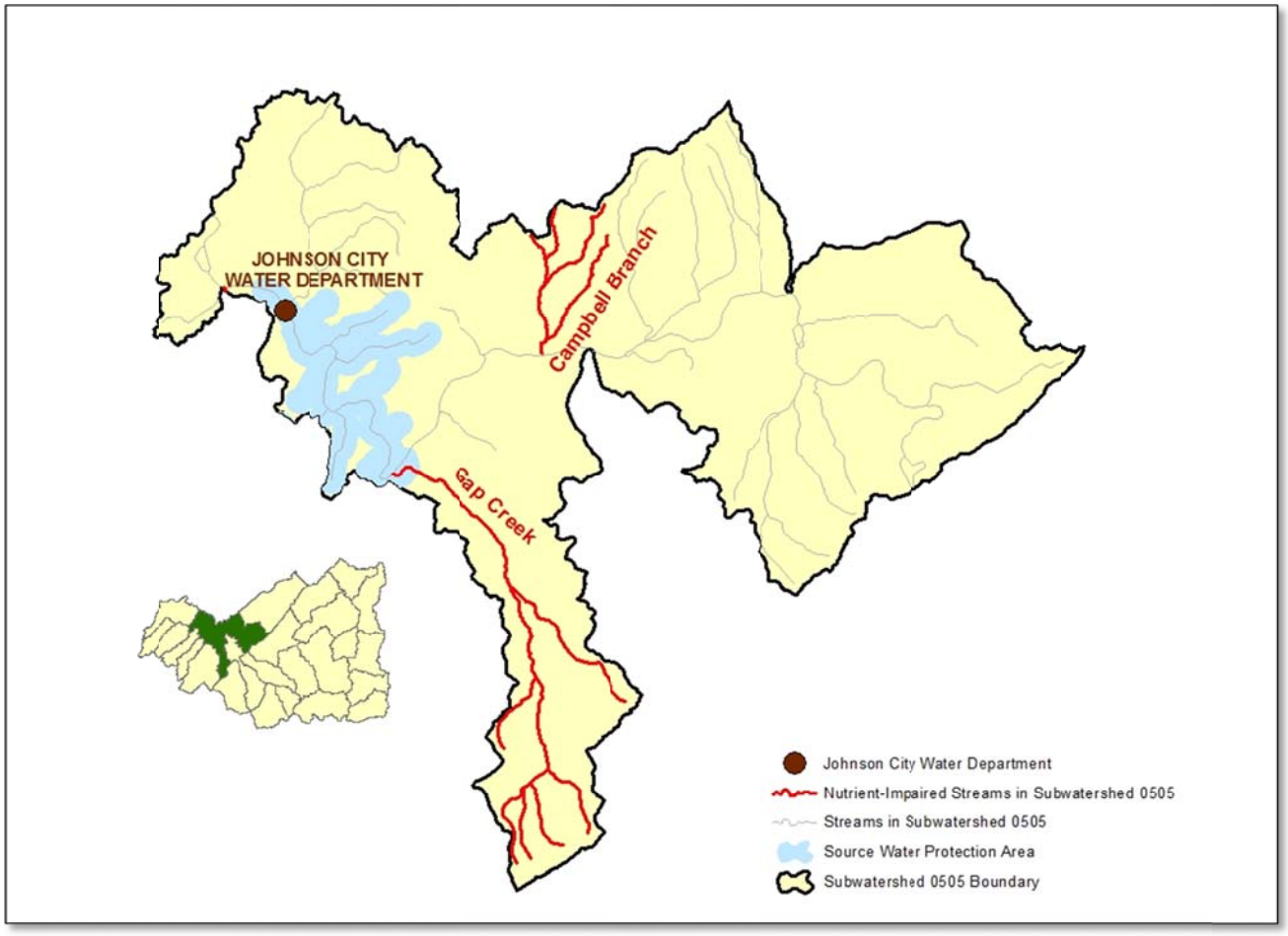


Figure 2. Illustration of Nutrient-Impaired Streams and Source Water Protection Area in HUC-12 Subwatershed 060101030505. *Only activities in Gap Creek will be addressed in this report.*

SEGMENT NUMBER	NAME	COUNTY	MILES	CAUSES/TMDL PRIORITY)	SOURCES
TN06010103008_0800	Gap Creek	Carter	15.93	Nitrates/Nitrite (Nitrate + Nitrite as N) TMDL Priority: Low	Municipal (Urbanized High Density Area)

Table 2. Water Quality Description of Gap Creek in Subwatershed 060101030505 from Tennessee's List of Impaired Streams (04/01/2018). *Table 2 is the complete listing of causes of impairment for Gap Creek.*

II. Action Plan that Addresses Point and Nonpoint Sources.

Tennessee is using both a point source and nonpoint source (NPS) approach for addressing nutrients in the Gap Creek subwatershed. Tennessee will use the process described in the Tennessee Nutrient Reduction Framework (the Framework) to address these sources.

Point Sources. Under the Framework, planning is HUC-10-based and uses SPARROW-derived (**Spa**tially **R**eferenced **R**egressions **o**n **W**atershed attributes) nutrient loads to describe a process to calculate an enrichment factor (total load divided by background load) and the percent contribution by point sources. National Pollutant Discharge Elimination System (NPDES) permit writers consider this information when setting permit limits for nutrients.

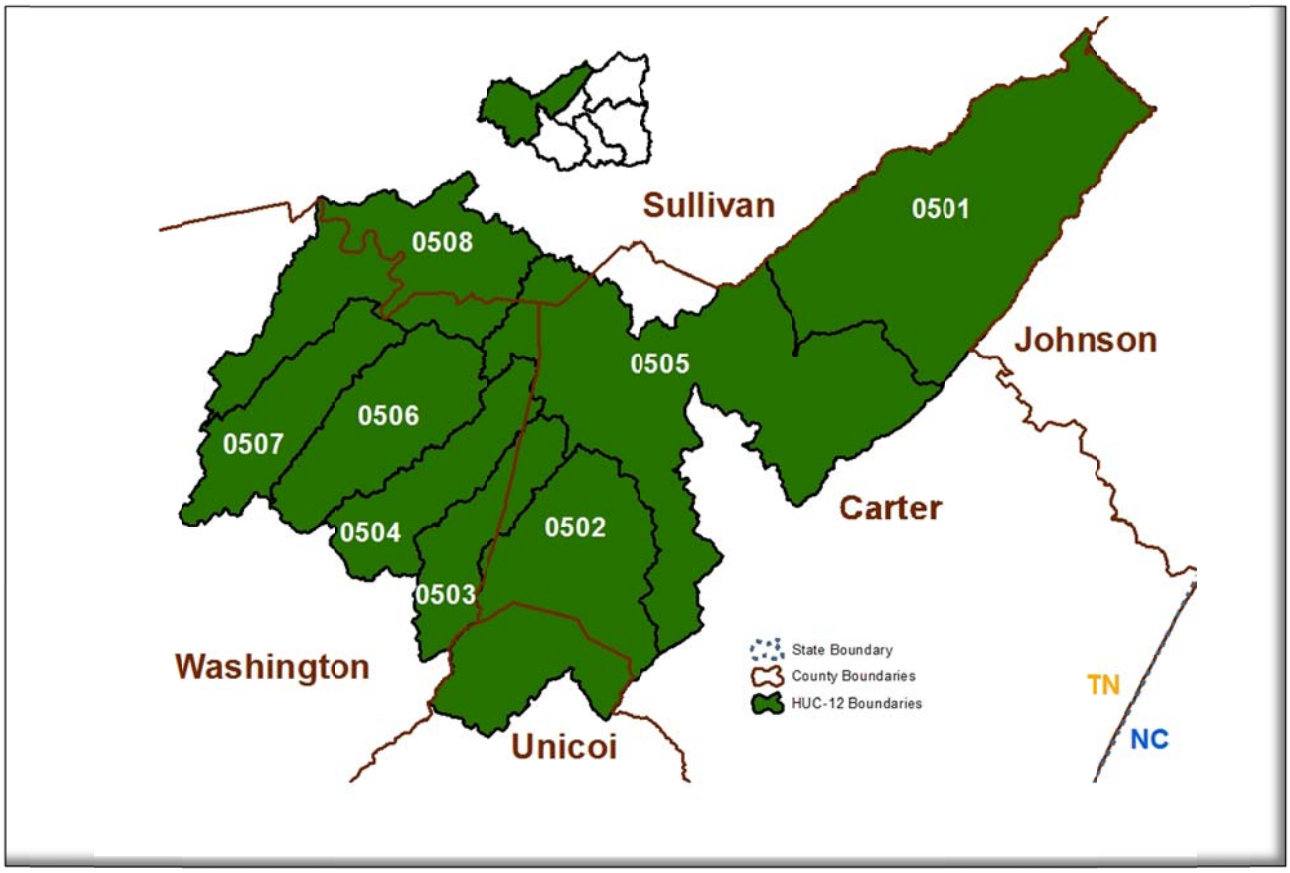


Figure 3. Location of HUC-10 Subwatershed 0601010305. *Subwatershed 0601010305 is composed of eight HUC-12s.*

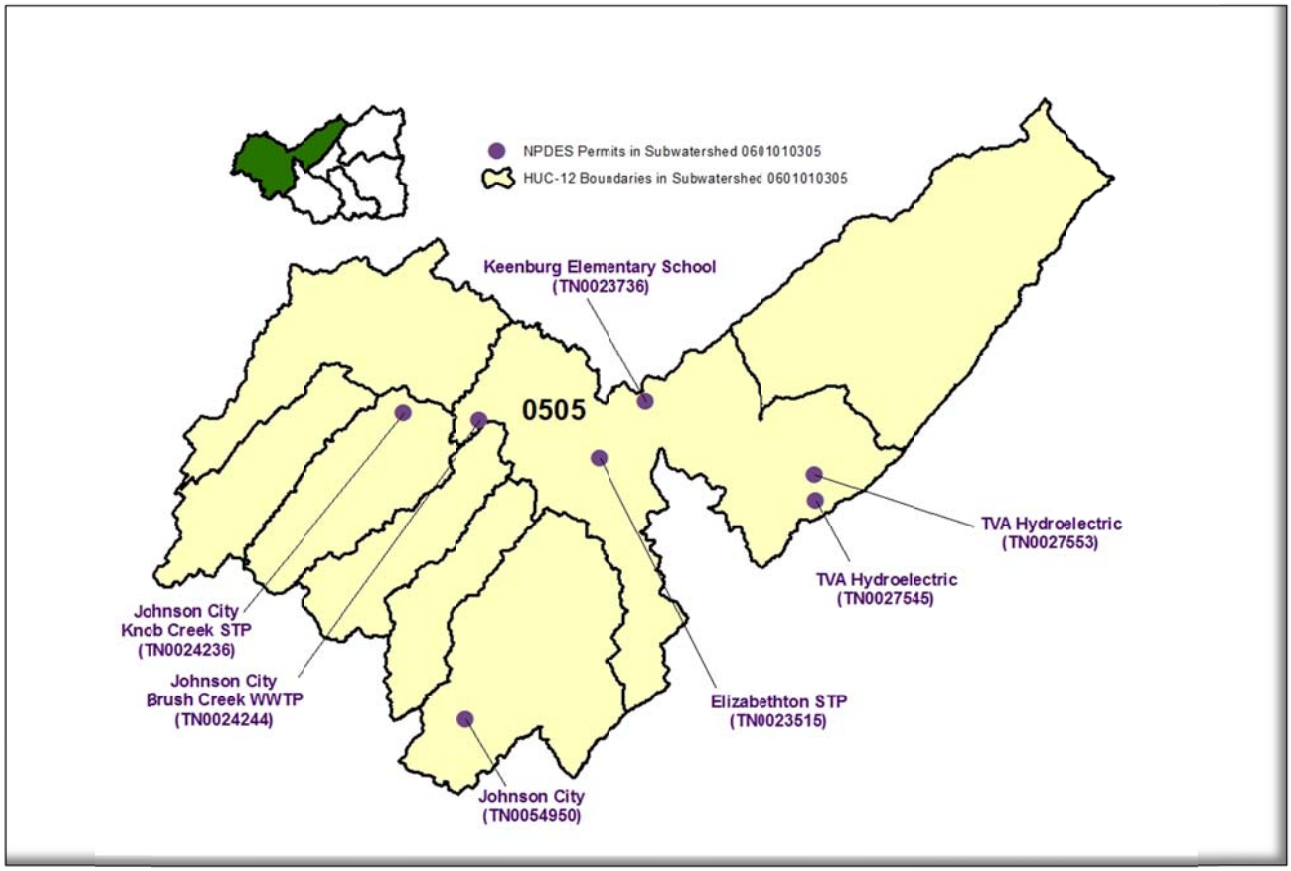
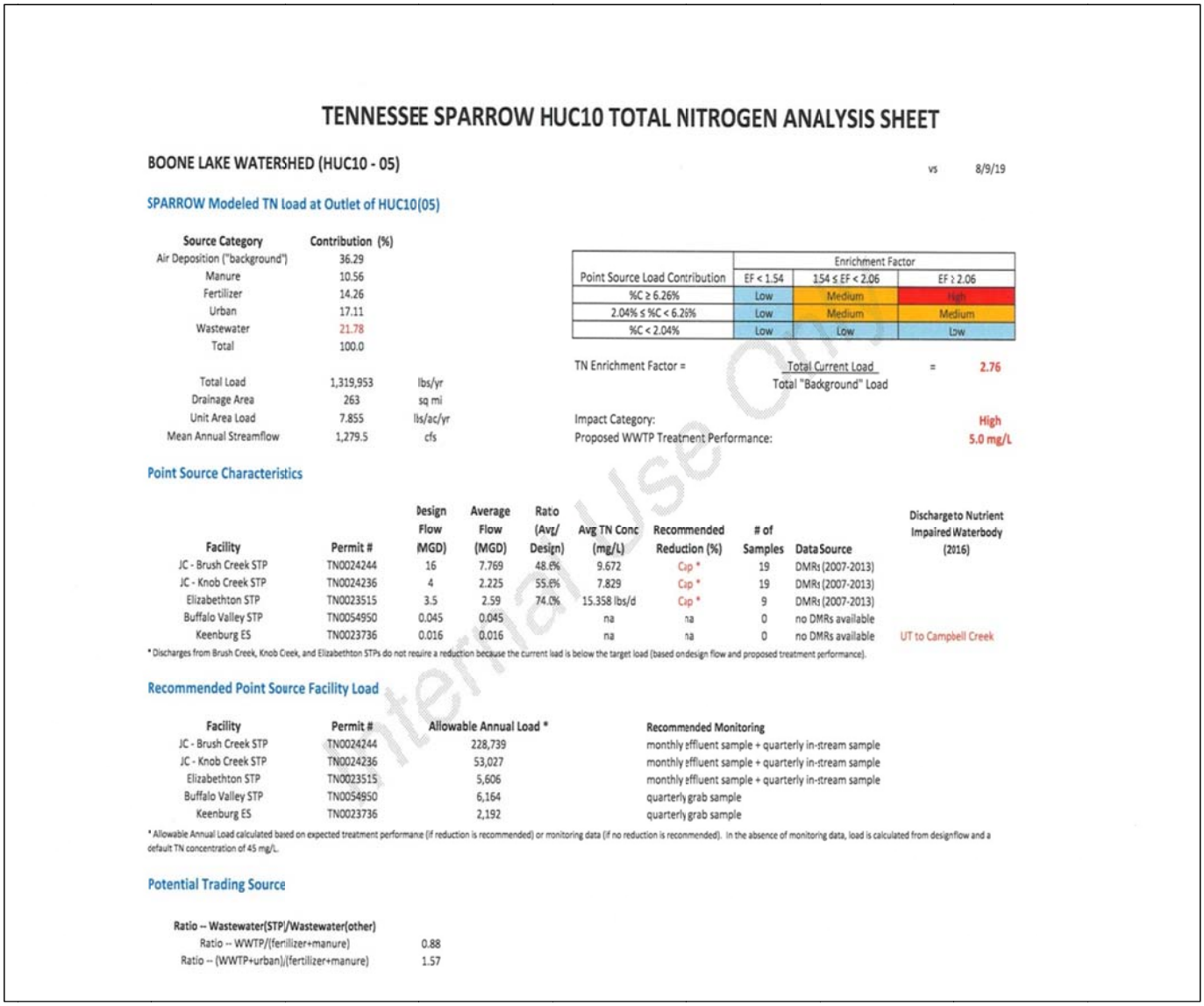


Figure 4. Illustration of NPDES Permit Locations in HUC-10 Subwatershed 0601010305. *Three NPDES permittees discharge to Subwatershed 060101030505 (TN0024244, TN0023515, TN0023736). TVA permitted facilities are hydroelectric and their discharges are river water (TN0027545 and TN0027553) so will not be considered further.*

Using data from the USGS SPARROW model, analysis sheets have been created for the point sources in subwatershed 0601010305 (Figures 5 and 6), none of which discharge to Gap Creek directly.



TENNESSEE SPARROW HUC10 TOTAL NITROGEN ANALYSIS SHEET

BOONE LAKE WATERSHED (HUC10 - 05) vs 8/9/19

SPARROW Modeled TN load at Outlet of HUC10(05)

Source Category	Contribution (%)
Air Deposition ("background")	36.29
Manure	10.56
Fertilizer	14.26
Urban	17.11
Wastewater	21.78
Total	100.0

Total Load	1,319,953	lbs/yr
Drainage Area	263	sq mi
Unit Area Load	7.855	lls/ac/yr
Mean Annual Streamflow	1,279.5	cfs

Point Source Load Contribution	Enrichment Factor EF < 1.54	1.54 ≤ EF < 2.06	EF ≥ 2.06
%C ≥ 6.26%	Low	Medium	High
2.04% ≤ %C < 6.26%	Low	Medium	Medium
%C < 2.04%	Low	Low	Low

TN Enrichment Factor = Total Current Load / Total "Background" Load = 2.76

Impact Category: High

Proposed WWTP Treatment Performance: 5.0 mg/L

Point Source Characteristics

Facility	Permit #	Design Flow MGD)	Average Flow (MGD)	Ratio (Avg/ Design)	Avg TN Conc (mg/L)	Recommended Reduction (%)	# of Samples	Data Source	Discharge to Nutrient Impaired Waterbody (2016)
JC - Brush Creek STP	TN0024244	16	7.769	48.6%	9.672	Cap *	19	DMRs (2007-2013)	
JC - Knob Creek STP	TN0024236	4	2.225	55.6%	7.829	Cap *	19	DMRs (2007-2013)	
Elizabethton STP	TN0023515	3.5	2.59	74.0%	15.358 lbs/d	Cap *	9	DMRs (2007-2013)	
Buffalo Valley STP	TN0054950	0.045	0.045		na	na	0	no DMRs available	
Keenburg ES	TN0023736	0.016	0.016		na	na	0	no DMRs available	UT to Campbell Creek

* Discharges from Brush Creek, Knob Creek, and Elizabethton STPs do not require a reduction because the current load is below the target load (based on design flow and proposed treatment performance).

Recommended Point Source Facility Load

Facility	Permit #	Allowable Annual Load *	Recommended Monitoring
JC - Brush Creek STP	TN0024244	228,739	monthly effluent sample + quarterly in-stream sample
JC - Knob Creek STP	TN0024236	53,027	monthly effluent sample + quarterly in-stream sample
Elizabethton STP	TN0023515	5,606	monthly effluent sample + quarterly in-stream sample
Buffalo Valley STP	TN0054950	6,164	quarterly grab sample
Keenburg ES	TN0023736	2,192	quarterly grab sample

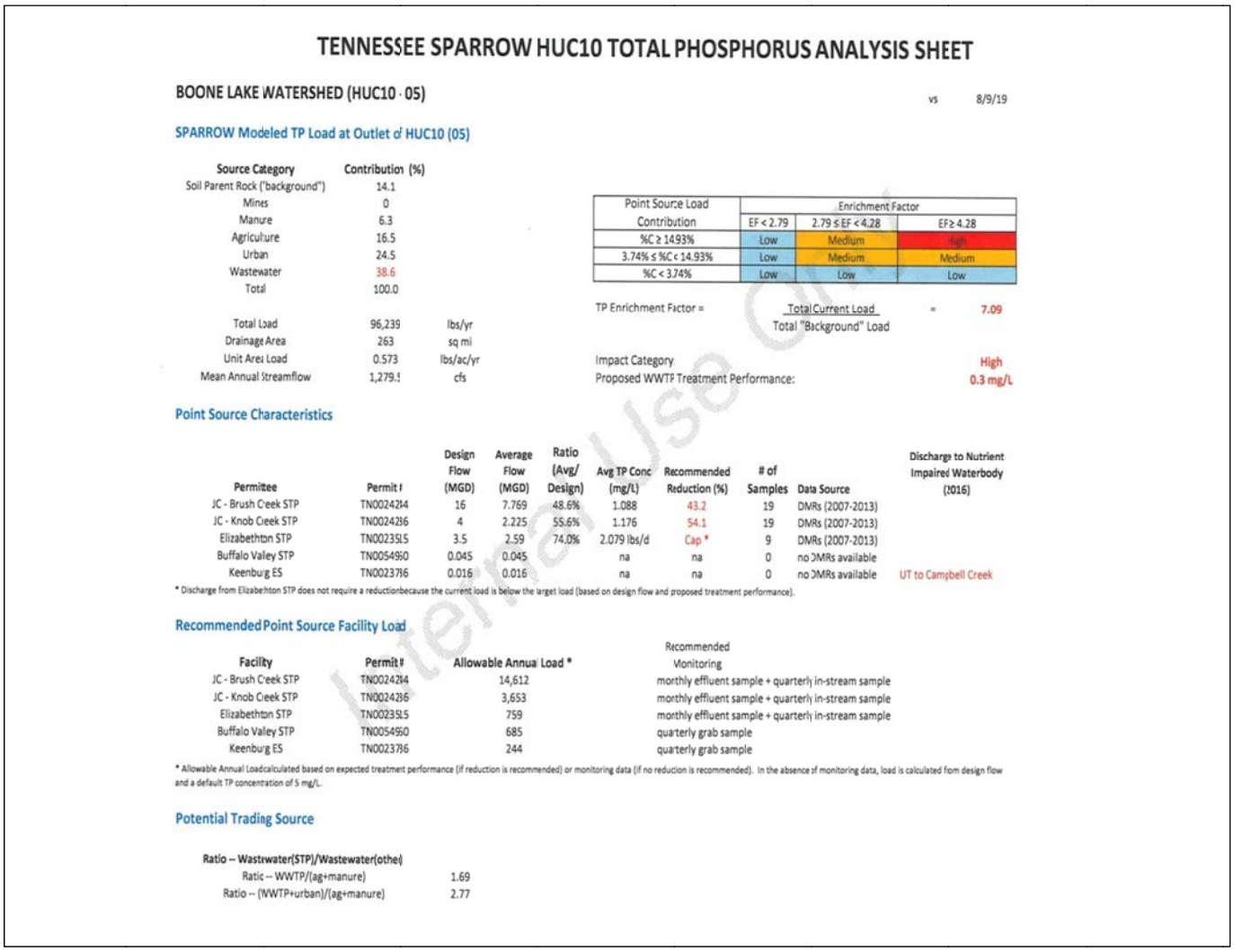
* Allowable Annual Load calculated based on expected treatment performance (if reduction is recommended) or monitoring data (if no reduction is recommended). In the absence of monitoring data, load is calculated from design flow and a default TN concentration of 45 mg/L.

Potential Trading Source

Ratio -- Wastewater(STP)/Wastewater(other)	
Ratio -- WWTP/(fertilizer+manure)	0.88
Ratio -- (WWTP+urban)/(fertilizer+manure)	1.57

Figure 5. Analysis Sheet for Total Nitrogen for NPDES Facilities in HUC-10 Subwatershed 0601010305. *CFS, Cubic Feet per Second; DMR, Discharge Monitoring Report; EF, Enrichment Factor; ES, Elementary School; MGD, Million Gallons per Day; NA, Not Applicable; STP, Sewage Treatment Plant; UT, Unnamed Tributary. Calculated loads are based on measured flow, not design flows. This data is presented for informational purposes only.*

Based on the wastewater contribution (21.78%) and the enrichment factor (2.76), the process described in the Framework categorizes facilities in this HUC-10 as "High" for nitrogen, indicating reductions may be necessary.



TENNESSEE SPARROW HUC10 TOTAL PHOSPHORUS ANALYSIS SHEET

BOONE LAKE WATERSHED (HUC10 · 05) vs 8/9/19

SPARROW Modeled TP Load at Outlet of HUC10 (05)

Source Category	Contribution (%)
Soil Parent Rock ("background")	14.1
Mines	0
Manure	6.3
Agriculture	16.5
Urban	24.5
Wastewater	38.6
Total	100.0

Total Load	96,239	lbs/yr
Drainage Area	263	sq mi
Unit Area Load	0.573	lbs/ac/yr
Mean Annual Streamflow	1,279.5	cfs

Point Source Load Contribution	Enrichment Factor		
	EF < 2.79	2.79 ≤ EF < 4.28	EF≥ 4.28
%C ≥ 14.93%	Low	Medium	High
3.74% ≤ %C < 14.93%	Low	Medium	Medium
%C < 3.74%	Low	Low	Low

TP Enrichment Factor = Total Current Load / Total "Background" Load = 7.09

Impact Category: High

Proposed WWTP Treatment Performance: 0.3 mg/L

Point Source Characteristics

Permittee	Permit #	Design Flow (MGD)	Average Flow (MGD)	Ratio (Avg/ Design)	Avg TP Conc (mg/L)	Recommended Reduction (%)	# of Samples	Data Source	Discharge to Nutrient Impaired Waterbody (2016)
JC - Brush Creek STP	TN0024244	16	7.769	48.6%	1.088	43.2	19	DMRs (2007-2013)	
JC - Knob Creek STP	TN0024236	4	2.225	55.6%	1.176	54.1	19	DMRs (2007-2013)	
Elizabethton STP	TN0023515	3.5	2.59	74.0%	2.079 lbs/d	Cap *	9	DMRs (2007-2013)	
Buffalo Valley STP	TN0054950	0.045	0.045		na	na	0	no DMRs available	
Keenburg ES	TN0023736	0.016	0.016		na	na	0	no DMRs available	UT to Campbell Creek

* Discharge from Elizabethton STP does not require a reductionbecause the current load is below the target load (based on design flow and proposed treatment performance).

Recommended Point Source Facility Load

Facilty	Permit #	Allowable Annual Load *	Recommended Monitoring
JC - Brush Creek STP	TN0024244	14,612	monthly effluent sample + quarterly in-stream sample
JC - Knob Creek STP	TN0024236	3,653	monthly effluent sample + quarterly in-stream sample
Elizabethton STP	TN0023515	759	monthly effluent sample + quarterly in-stream sample
Buffalo Valley STP	TN0054950	685	quarterly grab sample
Keenburg ES	TN0023736	244	quarterly grab sample

* Allowable Annual Loadcalculated based on expected treatment performance (if reduction is recommended) or monitoring data (if no reduction is recommended). In the absence of monitoring data, load is calculated fom design flow and a default TP concentration of 5 mg/L.

Potential Trading Source

Ratio -- Wastewater(STP)/Wastewater(other)	
Ratio -- WWTP/(ag+manure)	1.69
Ratio -- (WWTP+urban)/(ag+manure)	2.77

Figure 6. Analysis Sheet for Total Phosphorus for NPDES Facilities in HUC-10 Subwatershed 0601010305. *CFS, Cubic Feet per Second; DMR, Discharge Monitoring Report; EF, Enrichment Factor; ES, Elementary School; MGD, Million Gallons per Day; NA, Not Applicable; STP, Sewage Treatment Plant; UT, Unnamed Tributary. Calculated loads are based on measured flow, not design flows. This data is presented for informational purposes only. Gap Creek is not impaired for phosphorus at this time.*

Based on the wastewater contribution (38.6%) and the enrichment factor (7.09), the process described in the Framework categorizes facilities in this HUC-10 as "High" for phosphorus, indicating reductions may be necessary.

These analysis sheets act as a decision matrix and help permit writers establish nutrient limits based on 1) enrichment factors and 2) percent contribution in the watershed using the process described in the Framework. The analysis sheets indicate the trading potential between point and nonpoint sources, which TDEC is in the early stages of exploring. In support of that, TDEC secured a grant from the Tennessee Valley Authority (TVA) to explore the feasibility of nutrient trading in the Tennessee Valley.

There are three NPDES facilities that discharge within the 0505 HUC-12 Subwatershed; none of them discharge to Gap Creek.

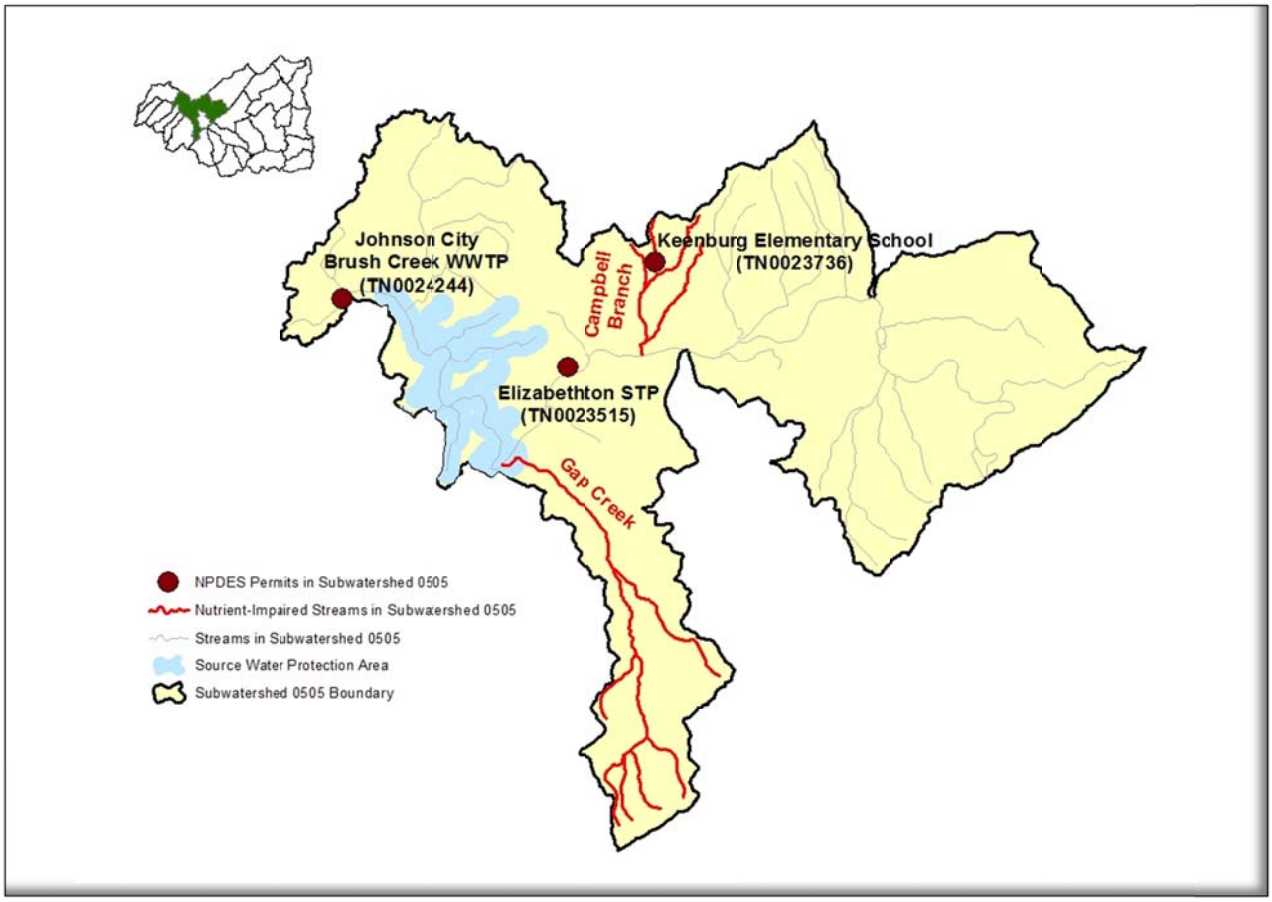


Figure 7. Illustration of Nutrient-Impaired Streams, Source Water Protection Area, and NPDES Facilities in HUC-12 Subwatershed 060101030505. *TN0024244 (Johnson City-Brush Creek WWTP) discharges to Watauga River at RM 16.4. TN0023736 (Keenburg Elementary School STP) discharges to Unnamed Tributary at mile 0.2 to Campbell Creek at mile 1.7. TN0023515 (Elizabethton STP) discharges to Watauga River at RM 24.3. NPDES, National Pollutant Discharge Elimination System; STP, Sewage Treatment Plant; WWTP, Waste Water Treatment Plant. Campbell Creek is shown to illustrate all nutrient-impaired streams in Subwatershed 06010103005. Implementation plans are not covered in this report.*

Keenburg Elementary School is a minor discharger, so under Tennessee's Framework is not being considered for revised permit limits. The remaining two permits will expire in 2021 and the SPARROW Analysis sheets will be considered when establishing nitrogen and phosphorus limits. Currently, nitrogen and phosphorus NPDES permit requirements are:

PERMIT NUMBER	PERMITTEE	NITROGEN	PHOSPHORUS
TN0024244	Johnson City-Brush Creek WWTP*	Report Only	Report Only
TN0023515	Elizabethton STP*	Report Only	Report Only

Table 3. Summary of Nitrogen and Phosphorus Requirements for Select NPDES Facilities in HUC 12-Subwatershed 060101030505. **Sample Type: Composite; Frequency: Quarterly; Statistical Base: Daily Maximum. STP, Sewage Treatment Plant; WWTP, Waste Water Treatment Plant.*

In addition, Tennessee is always evaluating if a facility would be a good candidate for plant optimization, the process by which waste water treatment plants develop standard operating procedures for optimizing nitrogen removal, phosphorus removal, and energy consumption. Tennessee has completed two rounds of plant optimization and plans to continue encouraging WWTPs to use this nutrient reduction approach. Both the Elizabethton STP and the Johnson City Brush Creek STP will evaluate the opportunities of biological nutrient removal in the next permit cycle.

Nonpoint Sources. In rural areas of Tennessee, excess nutrients in streams are frequently due to several agricultural practices (mostly poor pasture management and livestock access to the stream) and failing septic systems. Proper pasture management has been known to improve water quality for some time. In the USDA publication "Nutrient Management in Pastures and Haylands," authors Wood, *et al*. argue for the judicious use of nutrients in managing the nation's pastures and haylands.

The Land and Water Stewardship Section (LWSS) within the Tennessee Department of Agriculture (TDA), administers the Section 319 Nonpoint Source Program and the state-funded Agricultural Resources Conservation Fund Program to assist landowners who wish to install Best Management Practices (BMPs). In the Watauga River's Gap Creek Subwatershed 060101030505, practices installed by stakeholders were all United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS)-approved practices designed to reduce sediment and nutrients.

Two grants totaling over $85,000 have been awarded to stakeholders in this watershed. The initial 319-funded Gap Creek Restoration project was led by the Boone Lake Partnership, Inc. (Boone Partnership), whose members are stakeholders from municipalities, businesses, watershed groups, state and federal agencies, universities, local educators, conservation groups, and unaffiliated citizens. The Boone Partnership built the initial project on the EPA guidance manual for illicit stormwater detection and elimination. Stakeholders used the Stream Corridor Assessment Survey (the survey) as a tool to identify restoration opportunities. The survey was also used to collect information on the general condition of both in-stream and riparian corridor habitats, as well as healthy stream sections that may be in need of environmental protection.

Project #1. Proposed Activities.

Boone partnership and stakeholders evaluated the nine steps in a nonpoint watershed plan to form their watershed restoration plan:

1. Identification of causes and sources of impairment. Stakeholders started with the list of impaired streams and fine-tuned it by the use of stormwater outfall mapping.
2. Estimate of the load reductions expected for management measures employed. This estimate was based on the sediment TMDL approved by EPA (March, 2006) for Watauga River Watershed. The TMDL calculated the sediment load reduction to be 79.2% in order to re-attain water quality standards (overland transport of nutrients is greatly reduced when overland transport of sediment is reduced).
3. Description of nonpoint source management measures that need to be implemented to achieve load reductions described in the sediment TMDL and identification of critical areas in which those measures will need to be implemented.
4. Analysis of the amount of technical assistance needed to implement BMPs, associated costs, and partners.
5. Information and education component that will be used to enhance public understanding of the project and encourage their participation in selecting, designing, and implementing nonpoint source management measures that will be implemented. This will be accomplished by using public meetings, posting signs, and touring the project site. The Boone Partnership will work with the City of Elizabethton to finalize a guidance brochure for developers.
6. Schedule for implementing nonpoint source management measures identified in the plan that are practicable.
7. Description of interim, measurable milestones for determining whether nonpoint source management measures or other control measures are being implemented.
8. A set of criteria that can be used to determine whether load reductions are being achieved, and criteria for determining progress toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of implementation efforts that includes TDEC and the City of Elizabethton as partners.

In the proposal, the Boone Partnership identified BMPs needed to restore Gap Creek:

DESCRIPTION OF BMP	UNITS	AMOUNT (FEET)	ESTIMATED COST ($)
Riparian Buffer Creation	4	380	380
Riparan Buffer/Streambank Stabilization	1	30	1,500
Streambank Stabilization	3	250	12,500
Riparian Buffer/Livestock Exclusion	2	500	1,000
Watering Facility	1		2,500

Table 4. BMPs Identified by Stakeholders as Necessary to Restore Gap Creek in Project #1.

One of the first actions planned was to contact all landowners adjacent to Gap Creek in order to plan and install the needed BMPs and to provide information and assistance that will be available through the project. The Boone Partnership proposed to discuss the project at public meetings including Boone Partnership and other community meetings. Other proposed activities to involve and inform the public are news articles and the placement of signs at BMP sites to explain the project.

The Boone Lake Partnership planned several educational opportunities for stakeholders:

EDUCATIONAL EVENT	QUANTITY	BUDGET ESTIMATE ($)
Public Outreach	1	550
Media Materials (Brochures, flyers, publications)	1	500
Signage for BMP sites	2	1,000
BMP Tour	1	800
Technical and Administrative Assistance		4,000

Table 5. Educational Events Conducted by Stakeholders in Project #1.

Project #1. Accomplishments (11/01/2009-10/03/2013).

The primary focus of on-the-ground activities was for portions of HUC-12 Subwatershed 060101030505 with agricultural, residential, and industrial land uses. In the first year, a team composed of the Boone Partnership, City of Elizabethton stormwater department, NRCS, TDEC, TVA, and land owners conducted field trips to identify potential projects. The team then approached land owners with riparian projects (stream bank stabilization or restoration) that had an added benefit of protecting septic tank field lines in a nearby trailer park from eroding stream banks. The fact that the restoration team was a mix of agency and stakeholders helped with obtaining contracts with landowners.

Stream bank work using NRCS-approved methods was conducted at eleven sites where landowners, Boone Partnership, and volunteers identified need. Activities included:

- Restoring riparian zones with native plants
- Sloping and terracing eroded stream banks
- Stabilizing stream banks with rocks and root wads (successful in protecting septic field lines)

MILESTONE	COMPLETED
Secure Technical Assistance	√
Initiate/Coordinate Monitoring (with TDEC)	√
Complete Initial Public Outreach	√
Develop/Distribute Educational Materials	√
Complete Planning and Engineering Designs	√
Install BMPs	√
Install Signs at BMP Sites	√
Guidance brochure for developers	√
Conduct Final Public meeting and Tour of BMPs	√

Table 6. Tasks and Status of Boone Lake Partnership-Led Project #1.

PARTNER	ACTIVITY	CONTRIBUTION
Boone Partnership	Project management	In-Kind
Boone Partnership	Permit fees	Cash
TVA	Technical assistance	In-Kind
TDEC	Water quality monitoring	In-Kind
TDA	BMP technical assistance	In-Kind
Land Owners	Cost share	Cash
Land Owners	BMP installation	In-Kind
City of Elizabethton	Technical assistance (Engineering and Construction) Guidance brochure for developers	In-Kind
City of Elizabethton	Printing	Cash

Table 7. Responsibilities of Boone Lake Partnership-Led Project #1.

A tour of the restoration sites was conducted by Boone Partnership volunteers, City of Elizabethton stormwater department personnel, TDEC Water Pollution Control Environmental Field Office staff (now called Division of Water Resources), and landowners affected. At the end of the project, a survey of work performed was conducted to confirm successful BMP implementation, and additional trees were planted and stream banks stabilized by landowners where needed.

This site of 140’ in length was originally a 6’ high, eroded, undercut bank. It required sloping and rock in the toe. Matting was secured along with grass and tree plantings. (Photo taken shortly after construction work was completed in 2012.)

This site of 25’ in length was a 3’ high, eroded, bank. It required sloping along with matting, grass and tree plantings.

Section of the restored streambank showing tree and other vegetation growth

The 319 program funded a follow-up project in 2014.

Grant #2. Proposed Activities.

The Boone Partnership again took the lead in the second grant. The Boone Partnership proposed to administer the project as well as coordinate work of cooperating partners, develop educational materials, conduct outreach activities (public meetings, BMP tours), and coordinate monitoring aspects of the project. The proposal continued the practice of turning to TDA for technical assistance for agricultural BMP implementation and to the City of Elizabethton to provide engineering technical assistance.

As a first step, the Boone Partnership again proposed to ask the City of Elizabethton for engineering and planning technical assistance, followed by technical assistance from a private engineering firm. Applicants proposed to follow that up with land owner contact for technical assistance and cost-share opportunities. The focus was on a 22-unit trailer park which is built in Gap Creek's flood plain adjacent to 1000 feet of Gap Creek where septic drain fields are old and close to the creek. The landowner, a certified contractor, had already expressed an interest in doing the construction himself. The proposed project included installation of a private outfall line to enable sewer service to each trailer in the park. This part of the project would be overseen by the City of Elizabethton. The Boone Partnership planned to ask TDEC to monitor Gap Creek according to their watershed approach schedule. Finally, Boone Partnership proposed to place signs at BMP sites and schedule a BMP tour to inform the public about the project at the end of the project.

The Boone Partnership used the same 9-element approach to restoration in their work plan as they did for Project #1:

- Identification of causes and sources of impairment
- Estimation of load reductions needed
- Description of the NPS management measures needed
- Estimation of financial and technical assistance needed
- Development of an information/education component
- Schedule for implementing NPS management measures
- Description of interim measurable milestones
- Criteria development to determine if reduction targets are being met
- Inclusion of a monitoring component

In the proposal, the Boone Partnership identified specific activities still needed to restore Gap Creek:

DESCRIPTION OF BMP	UNITS	ESTIMATED COST ($)
Tap into city sewer	22	30,800
Engineering and surveying	1	3,000
Septic tank elimination	22	8,000
Private outfall line	1	39,000
Man holes	3	10,500
BMP tour	1	200

Table 8. Activities Identified by Stakeholders as Necessary to Restore Gap Creek Under Project #2.

Landowners not involved in Project #1 were scheduled to be contacted to plan and install BMPs and to discuss financial and technical assistance available. The Boone Partnership proposed to engage stakeholders at public meetings, at Boone Partnership meetings, and in other community settings. Additional public involvement was proposed through news articles and signage at BMP sites explaining the project.

Grant #2 Accomplishments (05/01/2014-04/31/2017).

MILESTONE	COMPLETED
Secure Technical Assistance (Landowner secured engineering firm to develop project design)	√
Initiate/Coordinate Monitoring (with TDEC)	√
Complete Initial Public Outreach Meetings (Used contact list from Project #1)	√
Develop/Distribute Educational Materials (Used materials from Project #1)	√
Complete Planning and Engineering Designs	√
Complete Septic System to Sewer Transition	√
Install BMPs	√
Install Signs at BMP Sites	√
Conduct Final Public Meeting and Tour of BMPs	√

Table 9. Tasks and Status of Boone Partnership-Led Project #2.

PARTNER	ACTIVITY	CONTRIBUTION
Boone Partnership	Project management	In-Kind
TDEC	Water quality monitoring	In-Kind
TDA	BMP technical assistance	In-Kind
Land Owners	Cost share	Cash
Land Owners	BMP installation	In-Kind
City of Elizabethton	Technical assistance (Engineering and Construction) Guidance brochure for developers	In-Kind

***Table 10. Responsibilities of* Boone Partnership-Led Project #2.**

Septic system replacement in the trailer park was delayed for technical engineering reasons (the trailer park was not easily connected to the existing sewerage system). The solution was for the stakeholders to contract for a new main line on the opposite side of the trailer park and tie it into the city sewer system. Septic replacement was completed in April 2017 (note: this is after the most recent stream monitoring data were collected).

Mobile home next to Gap Branch (After stream stabilization in previous project and before current project of septic system removal & sewer connections).

Sewer line installed, not yet connected to mobile home.

Sewer line installed, not yet connected to mobile home.

Sewer lines connected to city sewer system.

A tour of the restoration sites was conducted by Boone Partnership volunteers, City of Elizabethton stormwater department personnel, TDEC Water Pollution Control Environmental Field Office staff (now called Division of Water Resources), and landowners affected. A survey of work performed was conducted at the end of the project to confirm successful BMP implementation.

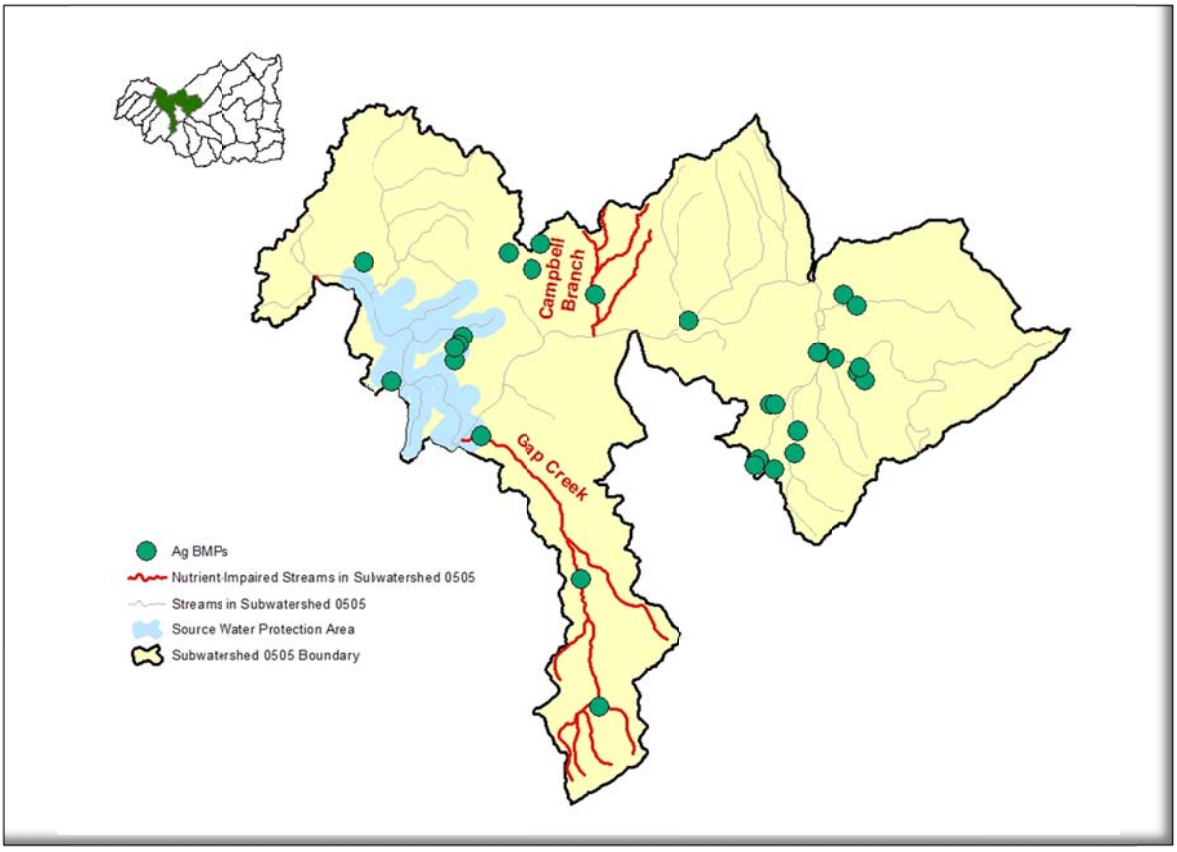


Figure 8. BMPs Installed in Gap Creek HUC-12 Subwatershed 060101030505 with Tennessee Department of Agriculture Funds from 2003 to 2018. *There are 39 BMPs installed using 319 or state (Agricultural Resource Conservation) funds from 2004 through 2017. USDA-NRCS has installed at least an additional 22 practices to reduce nutrient runoff in this subwatershed between 2009 and 2018. BMP, Best Management Practice, USDA-NRCS, US Department of Agriculture-Natural Resource Conservation Service. Ag, Agriculture; BMP, Best Management Practice.*

CODE	PRACTICE	NUMBER	UNITS
100	Comprehensive Nutrient Management Plan	2	Each
313	Waste Storage Facility	4	Each
340	Cover Crop	114.8	Acres
342	Critical Area Planting	2.3	Acres
360	Waste Facility Closure	1	Each
382	Fence	8849	Feet
390	Riparian Herbaceous Cover	12.5	Acres
484	Mulching	1.3	Acres
511	Forage Harvest Management	97.5	Acres
512	Forage and Biomass Planting	10	Acres
516	Livestock Pipeline	1916	Feet
528	Prescribed Grazing	29.7	Acres
561	Heavy Use Area Protection	0.1	Acres
578	Stream Crossing	1	Each
580	Streambank and Shoreline Protection	1700	Feet
584	Channel Bed Stabilization	50	Feet
590	Nutrient Management	178.8	Acres
614	Watering Facility	4	Each
620	Underground Outlet	1074	Feet
634	Waste Transfer	6	Each
666	Forest Stand Improvement	51.2	Acres
521D	Pond Sealing or Lining, Compacted Clay Treatment	1	Each

Table 11. Practices installed by NRCS in Subwatershed 060101030505 from 2004 to 2017.

The Tennessee Department of Agriculture has run EPA's STEPL spreadsheet tool for BMPs implemented as part of 319 and Agricultural Resource Conservation Funds in Subwatershed 060101030505.

RUNOFF REDUCTIONS DUE TO BMPs		
Nitrogen	Phosphorus	Sediment
1,042.3 lbs/yr	173.4 lbs/yr	77.1 tons/yr

Table 12. Nitrogen, Phosphorus, and Sediment Reductions due to BMPs Calculated Using EPA STEPL Model. *Additional reductions due to USDA-NRCS-implemented BMPs are not shown.*

The 319 program continues to accept projects in Gap Creek Subwatershed. The next project submittal deadline is December 1, 2019.

III. Nonpoint Source Funding Opportunities and Commitment of Partners.

Project funding was by a contract administered by TDA/Land and Water Stewardship Program to the Boone Lake Partnership ($85,444.97 total)).

Boone Lake Partnership budget for Grant #1 (11/01/2009-10/03/2013):

ITEM	DIRECT	MATCH	TOTAL
Salaries/Benefits	2,000	2,000	4,000
Professional Fees/Grant and Award	14,500	9,892	24,392
Supplies/Travel/etc.	1,500	500	2,000
TOTAL	**$18,000**	**$12,392**	**$30,392**

Table 13. Budget for Boone Lake Partnership Gap Creek Project #1*. In this report, line items are omitted if no money was requested.*

Match sources for Gap Creek Project #1:

- Boone Watershed Partnership
- Tennessee Department of Agriculture
- City of Elizabethton
- Tennessee Valley Authority

Boone Lake Partnership budget for Grant #2 (05/01/2014-04/31/2017):

ITEM	DIRECT	MATCH	TOTAL
Salaries	4,000	2,000	6,000
Professional Fees/Grant Awards	62,385.09	44,400	106,785.09
Supplies/Travel/etc.	300	200	500
Conferences and Meetings	500		500
Indirect Cost	259.88		259.88
TOTAL	**$67,444.97**	**$46,600**	**$11,4044.97**

Table 14. Budget for Boone Lake Partnership Gap Creek Project #2*. In this report, line items are omitted if no money was requested.*

Match sources for Gap Creek Project #2:

- Boone Watershed Partnership
- Land Owner Contributions (Cash)
- Land Owner Contributions (In-Kind)
- City of Elizabethton

IV. Date When Water Quality Standards are Expected to be Achieved.

According to our watershed approach schedule, water quality assessment for the Watauga River Watershed, which includes the Gap Creek subwatershed, is scheduled for 2023. Comments from the most recent water quality assessment of Gap Creek (2019) do not include any discussion about stream improvements.

The most recent data (see next section) shows a Tennessee Macroinvertebrate Index (TMI) score below passing (the score was 28 and passing is 32), had a low %EPT-Cheum score (the score was 2.3 and a reference site value is expected to be greater than 43.5), and a nutrient tolerant score just failing (the score was 35.6 and a reference site value is expected to be less than 33.2). However, the site had a good habitat score (the score was 143 and passing is 132) suggesting that it could support a balanced benthic community.

Gap Creek has shown improvement in chemistry—but not biology—in the last assessment. With enough time for the recently installed BMPs to make a difference, Gap Creek may come off the list of impaired waters in the 2023 assessment if the benthic macroinvertebrate community recovers. Alternatively—if the benthic community recovers by the 2023 assessment—Gap Creek may continue to be assessed as impaired for one more assessment cycle in order to confirm those assessment results.

V. Effectiveness Monitoring.

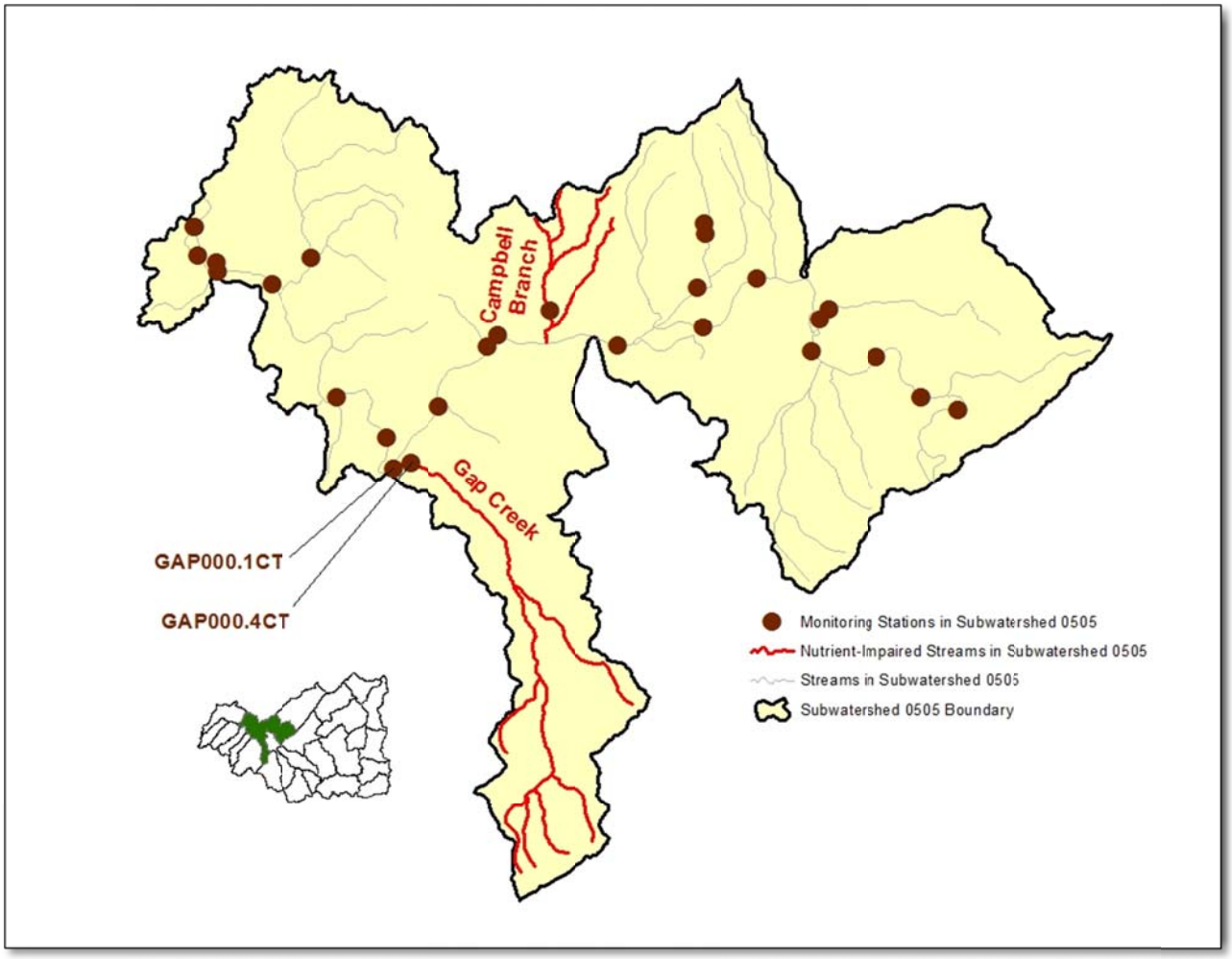


Figure 9. Illustration of TDEC Monitoring Sites in HUC-12 Subwatershed 060101030505.

Of the twenty-nine monitoring sites in the Gap Creek Subwatershed, two are on the Gap Creek nutrient-impaired segments:

MONITORING SITE	LOCATION	COUNTY
GAP000.1CT	Gap Creek @RM0.1	Carter
GAP000.4CT	Gap Creek @RM0.4	Carter

Table 15. Monitoring Sites on Nutrient-Impaired Waters in HUC-12 Subwatershed 060101030505. RM, River Mile.

One additional monitoring site in the subwatershed is located on a stream that is also impaired for nutrients (Campbell Branch), but is not addressed in this report.

MONITORING SITE	LOCATION	COUNTY
CAMPB000.7CT	Campbell Branch @ RM 0.7	Carter

Table 16. Monitoring Sites on Nutrient-Impaired Waters (Other than Gap Creek) in HUC-12 Subwatershed 060101030505. RM, River Mile.

Twenty-six monitoring sites in the subwatershed are located on streams that are not impaired by nutrients:

MONITORING SITE	LOCATION	COUNTY
WATAU015.6WN	Watauga River @ RM 15.6	Washington
WATAU015.6WNB	Watauga River @ RM 15.6	Washington
WATAU015.6WNS	Watauga River @RM 15.6	Washington
WATAU016.0WN	Watauga River @ RM 16.0	Washington
WATAU016.4CT	Watauga River @ RM 16.4	Carter
WATAU017.3CT	Watauga River @ RM 17.3	Carter
WATAU020.1CT	Watauga River @ RM 20.1	Carter
WATAU021.3CT	Watauga River @ RM 21.3	Carter
WATAU023.4CT	Watauga River @ RM 23.4	Carter
WATAU024.7CT	Watauga River @ RM 24.7	Carter
WATAU025.1CT	Watauga River @ RM 25.1	Carter
WATAU026.9CT	Watauga River @ RM 26.9	Carter
WATAU028.3CT	Watauga River @ RM 28.3	Carter
WATAU029.5CT	Watauga River @ RM 29.5	Carter
WATAU031.0CT	Watauga River @ RM 31.0	Carter
WATAU031.5CT	Watauga River @ RM 31.5	Carter
WATAU032.5CT	Watauga River @ RM 32.5	Carter
WATAU034.0CT	Watauga River @ RM 34.0	Carter
WATAU034.0CTB	Watauga River @ RM 34.0	Carter
WATAU034.6CT	Watauga River @ RM 34.6	Carter
WATAU034.6CTB	Watauga River @ RM 34.6	Carter
BSPRI000.2CT	Big Spring @ RM 0.2	Carter
LICK000.9CT	Lick Creek @ RM 0.9	Carter
DAVIS000.9CT	Davis Creek @ RM 0.9	Carter
DAVIS002.0CT	Davis Creek @ RM 2.0	Carter
DAVIS002.2CT	Davis Creek @ RM 2.2	Carter

Table 17. Additional Monitoring Sites in HUC-12 Subwatershed 060101030505. *RM, River Mile; WNB, Washington Bottom; WNT, Washington Surface.*

Only monitoring sites that are on Gap Creek (Table 15) will be discussed in remainder of this report.

Monitoring data from nutrient-impaired waters in Gap Creek HUC-12 Subwatershed.

Nitrogen

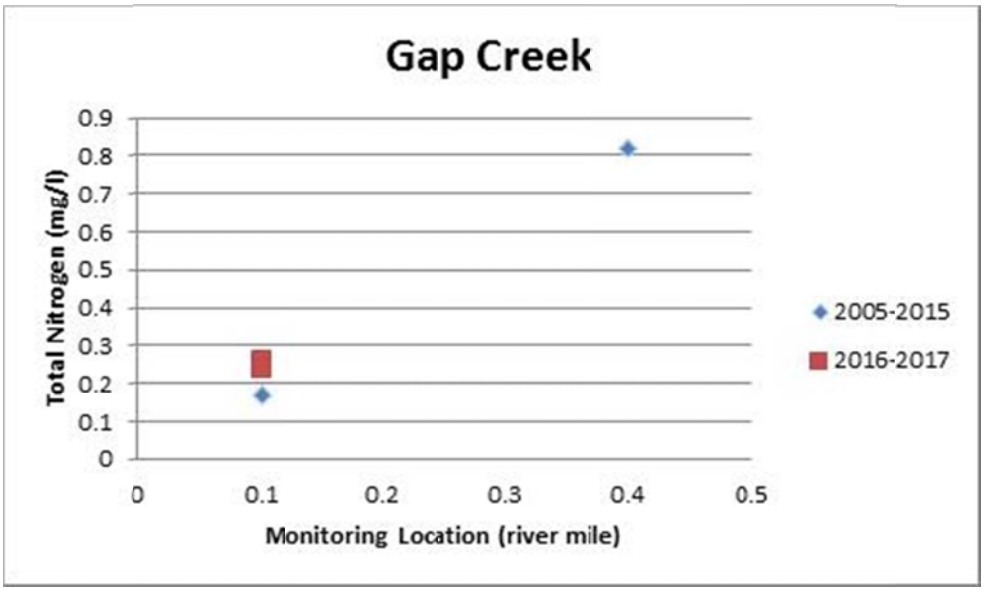


Figure 10. Comparison of Total Nitrogen at Gap Creek Monitoring Sites Between 2005-2015 and 2016-2017 Monitoring Seasons.

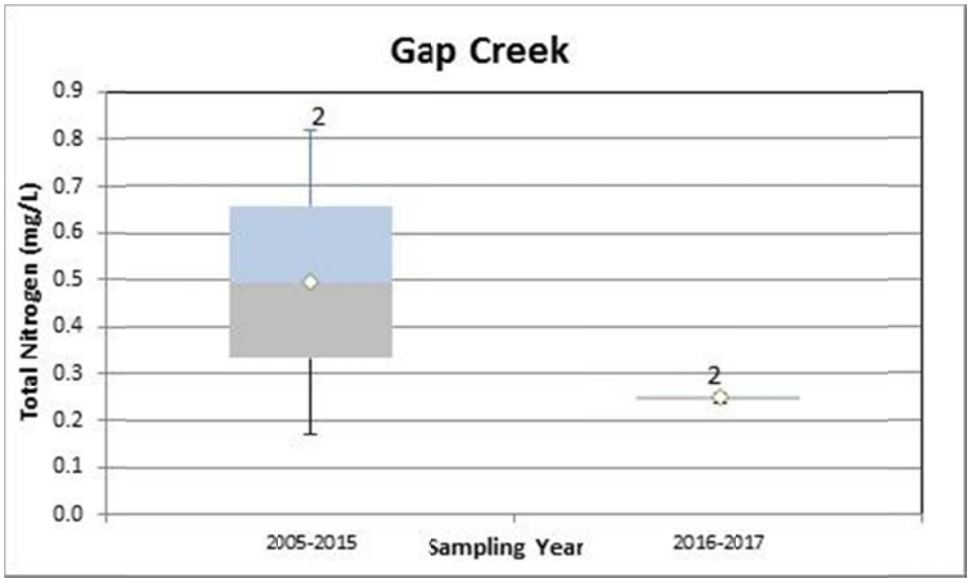


Figure 11. Comparison of Total Nitrogen at Gap Creek Monitoring Sites Between 2005-2015 and 2016-2017 Monitoring Seasons. *Numbers indicate number of samples in the analysis (n).*

Figures 10 and 11 illustrate that there were reductions in instream nitrogen concentrations at Gap Creek monitoring stations from 2005-2015 and 2016-2017 sampling seasons. More data are needed to confirm this observation.

Phosphorus

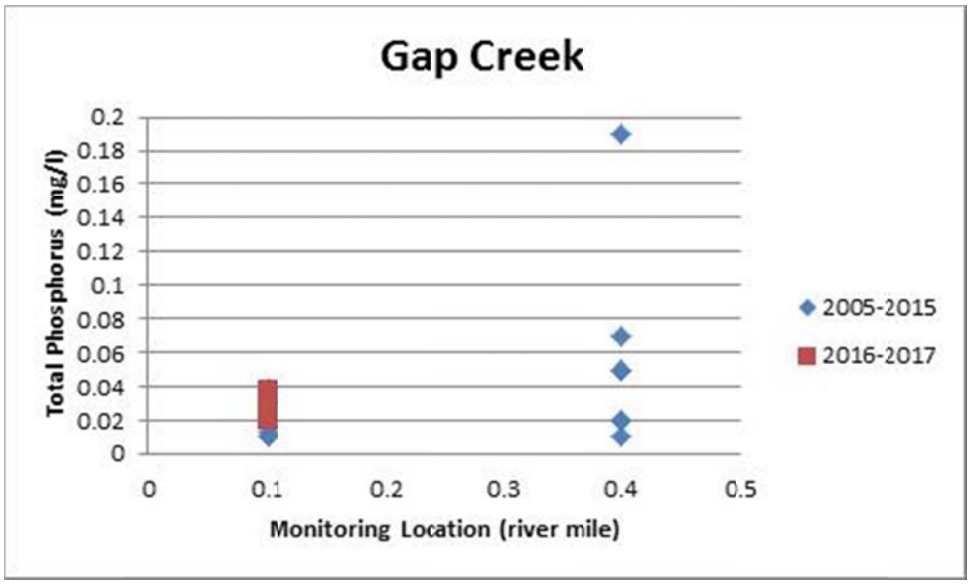


Figure 12. Comparison of Total Phosphorus at Gap Creek Monitoring Sites Between 2005-2015 and 2016-2017 Monitoring Seasons.

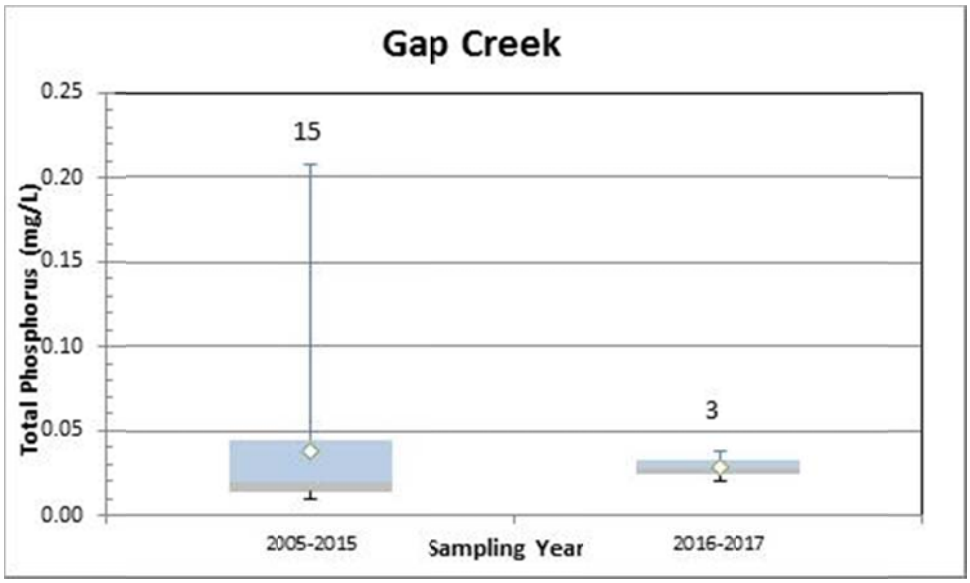


Figure 13. Comparison of Total Phosphorus at Gap Creek Monitoring Sites Between 2005-2015 and 2016-2017 Monitoring Seasons. *Numbers indicate number of samples in the analysis (n).*

Figures 14 and 15 illustrate that there were reductions in instream phosphorus concentrations at Gap Creek monitoring stations from 2005-2015 and 2016-2017 sampling seasons. More data are needed to confirm this observation.

Tennessee's nutrient water quality standards are narrative and have both a chemical (nutrients) and biological (*e.g.*, benthic macroinvertebrates) component. Benthic macroinvertebrate data were collected from two sites on a nutrient-impaired water (Gap Creek at River Mile 0.1 and at River Mile 0.4). Monitoring data from other streams are not shown.

SITE	DATE	TMI	TOTAL TAXA	%EPT-CHEUM	% NUTRIENT TOLERANT	NCBI	HABITAT SCORE
GAP000.1CT	08/29/2007	24	31	2.3	41.3	6.39	122
GAP000.1CT	08/04/2010	34	29	4.4	31.9	5.34	117
GAP000.1CT	10/26/2011	32	25	5.9	16.8	4.92	85
GAP000.1CT	04/04/2017	24	21	1.4	30	5.65	113

Table 18. Benthic Macroinvertebrate Data from Monitoring Site on Gap Creek at RM 0.1. *RM, River Mile; TMI, Tennessee Macroinvertebrate Index; EPT, Ephemeroptera, Plecoptera, Trichoptera; Cheum, Cheumatopsyche; NCBI, North Carolina Biotic Index. Data were collected by semi-quantitative kick sampling in Ecoregion 67f in a drainage greater than 2.5 square miles.*

SITE	DATE	TMI	TOTAL TAXA	%EPT-CHEUM	% NUTRIENT TOLERANT	NCBI	HABITAT SCORE
GAP000.4CT	11/28/2006	28	30	2.3	35.6	4.91	143

Table 19. Benthic Macroinvertebrate Data from Monitoring Site on Gap Creek at RM 0.4. *RM, River Mile; TMI, Tennessee Macroinvertebrate Index; EPT, Ephemeroptera, Plecoptera, Trichoptera; Cheum, Cheumatopsyche. Data were collected by semi-quantitative kick sampling in Ecoregion 67f in a drainage greater than 2.5 square miles. Monitoring at GAP000.4CT has ceased and been replaced with monitoring at GAP000.1CT. The data are presented for completeness only.*

Data Summary for Gap Creek Monitoring Site:

- TMI data from GAP000.1CT site shows improving scores through 2011, then a decline in 2017 (passing score is 32).
- % EPT-Cheum shows the stream benthic community is depressed (a reference site value is expected to be greater than 43.5% Ephemeroptera, Plecoptera, and Tricoptera).
- % Nutrient Tolerant shows improvement in stream benthic grazing community from 2011 through 2017, even though there was an increase in 2017 (a reference site value is expected to be less than 33.2).
- NCBI scores show improvement from 2007 through 2011 and a decline in 2017.
- Habitat scores from 2007 through 2017 indicate that habitat does not yet support a future balanced macroinvertebrate community (for this ecoregion, size, and monitoring season, reference site value is be expected to be greater than 135).
- More information about Tennessee's TMI score is in TDEC's Benthic macroinvertebrate SOP at: https://www.tn.gov/content/dam/tn/environment/water/documents/DWR-PAS-P-01-Quality_System_SOP_for_Macroinvertebrate_Stream_Surveys-081117.pdf.

Biological data indicate there was some improvement from 2007 through 2011 and that the poor benthic community may be the result of depressed habitat which is what the BMPs described in these projects are designed to address. Chemical data have shown an improvement over this same time period. It's important to note that these data were collected as BMPs were being implemented, or shortly after some were implemented, suggesting that more time post-BMP implementation is needed before additional improvement is documented. The next water quality assessment is scheduled for 2023.

VI. Current and Future Activities.

The current 319 grant to the Boone Lake Partnership for work in Gap Creek Subwatershed has expired. The 319(h) program is accepting additional proposals designed to improve water quality in Gap Creek Subwatershed. Proposals for the next round of grants are due December 1, 2019.

USDA-NRCS continues to fund projects through the Environmental Quality Incentives Program (EQIP), and other qualifying Farm Bill Conservation Title programs.

VIII. Further Information.

For further information about TMDLs and 5-alt documents in Tennessee, visit the TDEC/DWR web site: https://www.tn.gov/environment/program-areas/wr-water-resources/watershed-stewardship/tennessee-s-total-maximum-daily-load--tmdl--program.html

Technical questions regarding this 5-alt report should be directed to:

David M. Duhl, Ph.D.
Manager, Watershed Unit
david.duhl@tn.gov

LIST of INITIALS and ACRONYMS USED

303(d). Section 303(d) of the Clean Water Act that addresses impaired waters.

ARCF. Agricultural Resources Conservation Fund.

BMP. Best Management Practice.

CFS. Cubic Feet per second.

Cheum. Cheumatopsyche insect Genus.

CWA. Clean Water Act.

DMR. Discharge Monitoring Report.

DWR. Division of Water Resources.

EF. Enrichment Factor.

EPA. Environmental Protection Agency.

EPT. Ephemeroptera, Plecoptera, Trichoptera insect Orders.

EQIP. Environmental Quality Incentives Program.

ES. Elementary School.

FY. Fiscal Year.

HUC. Hydrologic Unit Code.

HUC-8, Eight-Digit Hydrologic Unit Code.

HUC-10. Ten-Digit Hydrologic Unit Code.

HUC-12. Twelve-Digit Hydrologic Unit Code.

LWSS. Land and Water Stewardship Section.

MGD. Million Gallons per Day.

NCBI. North Carolina Biotic Index.

NPDES. National Pollutant Discharge Elimination System.

NA. Not Applicable.

NPS. Nonpoint Source.

STEPL. Spreadsheet Tool for Estimating Pollutant Load.

USDA-NRCS. Natural Resources Conservation Service.

RC&D. Resource Conservation and Development.

RFP. Request for Proposals.

RM. River Mile.

SCD. Soil Conservation District.

SPARROW. Spatially Referenced Regression on Watershed attributes.

STP. Sewage Treatment Plant.

TDA. Tennessee Department of Agriculture.

TDEC. Tennessee Department of Environment and Conservation.

TMDL. Total Maximum Daily Load.

TMI. Tennessee Macroinvertebrate Index.

TVA. Tennessee Valley Authority.

UD. Utility District.

USDA. United States Department of Agriculture.

UT-Ext. University of Tennessee Extension.

WECO. Call letters for a radio station in Wartburg, Tennessee.

WWTP. Wastewater Treatment Plant.

REFERENCES CITED

A Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program" (December 2013)
https://www.epa.gov/sites/production/files/2015-07/documents/vision_303d_program_dec_2013.pdf

Illicit Discharge Detection and Elimination: A Guidance manual for Program Detection and Technical Assistance (2004).
https://www3.epa.gov/npdes/pubs/idde_manualwithappendices.pdf.

Tennessee Prioritization of TMDLs document under the New Vision
https://www.tn.gov/content/dam/tn/environment/water/tmdl-program/wr-ws_tmdl-priority-framework-101415.pdf

TDEC Watershed Approach
https://www.tn.gov/environment/program-areas/wr-water-resources/watershed-stewardship/watershed-management-approach.html

C. Jerry Nelson (editor). Conservation Outcomes from Pastureland and Hayland Practices: Assessment, Recommendations, and Knowledge Gaps. Chapter 5: Nutrient Management on Pastures and Haylands (Wood, C.W., Moore, P.A., Joern, Brad C., Jackson, R.D., and Cabrera, M.L.). 2012. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1080496.pdf