TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Siltation

In The

Upper Clinch River Watershed (HUC 06010205)

Anderson, Campbell, Claiborne, Grainger, Hancock, Hawkins, and Union Counties, Tennessee

FINAL

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LIST OF ABBREVIATIONS

ADB	Assessment Database
ARS	Agricultural Research Station
AWC	Available Water-holding Capacity
BASINS	Better Assessment Science Integrating point & Nonpoint Sources
BM	Benchmark
BMP	Best Management Practices
CFR	Code of Federal Regulations
CN	Curve Number
CPCRI	Clinch-Powell Clean Rivers Initiative
CSW	Construction Stormwater
DEM	Digital Elevation Model
DWR	Division of Water Resources
EFO	Environmental Field Office
EPA	Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, and Trichoptera
FG	Future Growth
GI	Green Infrastructure
GIS	Geographic Information System
GWLF	Generalized Watershed Loading Function
HSG	Hydrologic Soil Group
HSPF	Hydrologic Simulation Program - Fortran
HUC	Hydrologic Unit Code
LA	Load Allocation
LER	Lateral Erosion Rate
LID	Low Impact Development
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NCDC	National Climatic Data Center
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NRI	National Resources Inventory
PAM	Polyacrylamide
RC&D	Resource Conservation and Development
RMCF	Ready Mixed Concrete Facility

LIST OF ABBREVIATIONS (Cont.)

SABS	Suspended and Bedded Sediments
SBE	Streambank Erosion
SCS	Soil Conservation Service
SDR	Sediment Delivery Ratio
SQSH	Semi-Quantitative Single Habitat
STATSGO	State Soil and Geographic Database
STP	Sewer Treatment Plant
SW	Stormwater
SWMP	Storm Water Management Program
SWPPP	Storm Water Pollution Prevention Plan
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMI	Tennessee Macroinvertebrate Index
TMSP	Tennessee Storm Water Multi-Sector General Permit
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

UPPER CLINCH RIVER WATERSHED (HUC 06010205)

Total Maximum Daily Load for Siltation in Waterbodies Identified on the State of Tennessee's Final 2014 303(d) List

Impaired Waterbody Information:

State: Tennessee
Counties: Campbell and Union
Watershed: Upper Clinch River Watershed (HUC 06010205)
Constituents of Concern: Siltation

Impaired Waterbodies: Final 2014 303(d) List:

Waterbody ID	Waterbody	Miles Impaired
06010205001T_0200	Cuckle Creek	6.89
06010205001T_1400	Fall Creek	5.6

Designated Uses: Fish & aquatic life, irrigation, livestock watering & wildlife, and recreation.

Water Quality Targets (Siltation):

Derived from *State of Tennessee Water Quality Standards, Chapter 0400-04-03, General Water Quality Criteria* (TDEC, 2015a); most stringent narrative criteria applicable to fish & aquatic life use classification:

Biological Integrity: The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or, in the case of wadeable streams, substantially different from conditions in reference streams in the same ecoregion. The parameters associated with this criterion are the aquatic biota measured. These are response variables.

Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.

Interpretation of this provision for all other wadeable streams, lakes, and reservoirs may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) or Lake and Reservoir Bioassessment and Biocriteria (EPA 841-B-98-007), and/or other scientifically defensible methods. Interpretation of this provision for wetlands or large rivers may be made using scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same bioregion if upstream conditions are determined to be degraded.

Habitat: The quality of stream habitat shall provide for the development of a diverse aquatic community that meets regionally-based biological integrity goals. Examples of parameters associated with this criterion include but are not limited to: sediment deposition, embeddedness of riffles, velocity/depth regime, bank stability, and vegetative protection. Types of activities or conditions which can cause habitat loss include, but are not limited to: channel and substrate alterations, rock and gravel removal, stream flow changes, accumulation of silt, precipitation of metals, and removal of riparian vegetation. For wadeable streams, the in stream habitat within each subecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.

TMDL Development

General Analysis Methodology (Siltation):

- Analysis was performed using the Generalized Watershed Loading Function (GWLF) Model (based on Universal Soil Loss Equation for rural land uses, the RUNQUAL method for urban land uses, and a streambank erosion routine) applied to impaired subwatershed areas to calculate existing sediment loads.

- Target sediment loads (lbs/acre/year) are equal to average annual instream sediment loads from biologically healthy watersheds (Level IV Ecoregion reference sites).

- TMDLs are expressed as the percent reduction in average annual sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate reference target load.

- Since the Total Suspended Solids (TSS) component of municipal Sewage Treatment Plant (STP) discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes, TSS discharges from STPs were <u>not</u> considered in the TMDL analysis.

- WLAs for existing NPDES permitted Ready Mixed Concrete Facilities (RMCFs) in impaired subwatersheds are based on existing permit requirements for these facilities.

- WLAs for existing NPDES permitted Tennessee Storm Water Multi-Sector General (TMSPs) and individual industrial facilities in impaired subwatersheds are based on existing permit requirements for these facilities.

- WLAs for existing NPDES permitted mining activities are based on existing permit requirements for these facilities.

- WLAs for existing NPDES permitted construction site discharges will be implemented through appropriate erosion prevention and sediment controls and BMPs. Due to permit provisions for post-construction stormwater, requiring control of runoff volume and pollutant loading, WLAs for restored post-construction areas are equal to WLAs for MS4s and/or LAs for non-MS4 nonpoint source (NPS) areas.

- 5% of subwatershed target loads are reserved to account for future growth for Ready Mixed Concrete Facilities (RMCFs), Tennessee Storm Water Multi-Sector Permitted Facilities (TMSPs), individually-permitted industrial facilities, and regulated mining sites.

- WLAs for Municipal Separate Storm Sewer Systems (MS4s), and LAs for nonpoint sources are expressed as the percent reduction in average annual sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate reduced target load (target load minus WLAs for RMCFs, TMSPs, industrial facilities, and mining sites).

- 10% of subwatershed target loads are reserved to account for Margin of Safety (MOS) which takes into account any uncertainty concerning the relationship between effluent limitations and water quality.

- The TMDLs, WLAs, and LAs for siltation are summarized in the following tables**.**

Critical Conditions: Methodology takes into account all flow conditions.

Seasonal Variation: Methodology addresses all seasons.

Margin of Safety (MOS): Explicit MOS = 10% of the reference target load for each impaired subwatershed.

TMDLs/Allocations

Summary of Siltation TMDLs, WLAs for MS4s, & LAs for Nonpoint Sources for Impaired Waterbodies in the Upper Clinch River Watershed (HUC 06010205):

Waterbody ID	Waterbody Impaired by Siltation	Level IV Ecoregion	TMDL (Required Overall Load Reduction)	Required Load Reduction	
				WLA (MS4s)	LA (Nonpoint Sources)
			[%]	[%]	[%]
06010205001T_0200	Cuckle Creek	67f	54.1	62.4	62.4
06010205001T_1400	Fall Creek		8.4	22.2	22.2

WLAs for Mining Sites, TMSPs, and RMCFs:

WLAs for NPDES-regulated mining sites, TMSPs, and RMCFs located in impaired subwatersheds are equal to existing permit limits for total suspended solids (TSS).

Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds

Waterbody ID	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit
			[mg/l]
Cuckle	TN0029262	Rogers Group, Inc.	40
	TN0063606	Campbell County Highway Department	

TMSPs Permitted to Discharge TSS and Located in Impaired Subwatersheds

Waterbody ID	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit	TSS Benchmark Conc. (SW Discharge)
			[mg/l]	[mg/l]
Cuckle	TNR058911	BSH Home Appliance Corp.	50	150
	TNR054593	Jacksboro Metals, LLC		
	TNR110057	Creative Tubes		

RMCFs Permitted to Discharge TSS and Located in Impaired Subwatersheds

Waterbody ID	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit	TSS Benchmark Conc. (SW Discharge)
			[mg/l]	[mg/l]
Cuckle	TNG110288	C & C Concrete Products, LP	50	150

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR SILTATION UPPER CLINCH RIVER WATERSHED (HUC 06010205)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not attaining water quality standards. State water quality standards consist of designated use(s) for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources (USEPA, 1991).

2.0 SCOPE OF DOCUMENT

This document presents details of TMDL development for waterbodies in the Upper Clinch River watershed, identified on the Final 2014 303(d) List (TDEC, 2016) as not supporting designated uses due to loss of biological integrity due to siltation. Although the Upper Clinch River watershed is located in both Tennessee and Virginia, this document addresses only impaired waterbodies in Tennessee.

3.0 WATERSHED DESCRIPTION

The Upper Clinch River watershed, designated by the Hydrologic Unit Code (HUC) 06010205 by the U. S. Geological Survey (USGS), is located in East Tennessee (ref.: Figure 1), in Anderson, Campbell, Claiborne, Grainger, Hancock, Hawkins, and Union Counties. The Tennessee portion of the Upper Clinch River watershed lies within two Level III ecoregions (Ridge and Valley and Central Appalachians) and contains five Level IV subecoregions as shown in Figure 2 (USEPA, 1997):

- **Southern Limestone/Dolomite Valleys and Low Rolling Hills (67f)** form a heterogeneous region composed predominantly of limestone and cherty dolomite. Landforms are mostly low rolling ridges and valleys, and the soils vary in their productivity. Landcover includes intensive agriculture, urban and industrial uses, as well as areas of thick forest. White oak forest, bottomland oak forest, and sycamore-ash-elm riparian forests are the common forest types. Grassland barrens intermixed with cedar-pine glades also occur here.

- The **Southern Sandstone Ridges (67h)** ecoregion encompasses the major sandstone ridges, but these ridges also have areas of shale and siltstone. The steep, forested ridges have narrow crests, and the soils are typically stony, sandy, and of low fertility. The chemistry of streams flowing down the ridges can vary greatly depending on the geologic material. The higher elevation ridges are in the north, including Wallen Ridge,

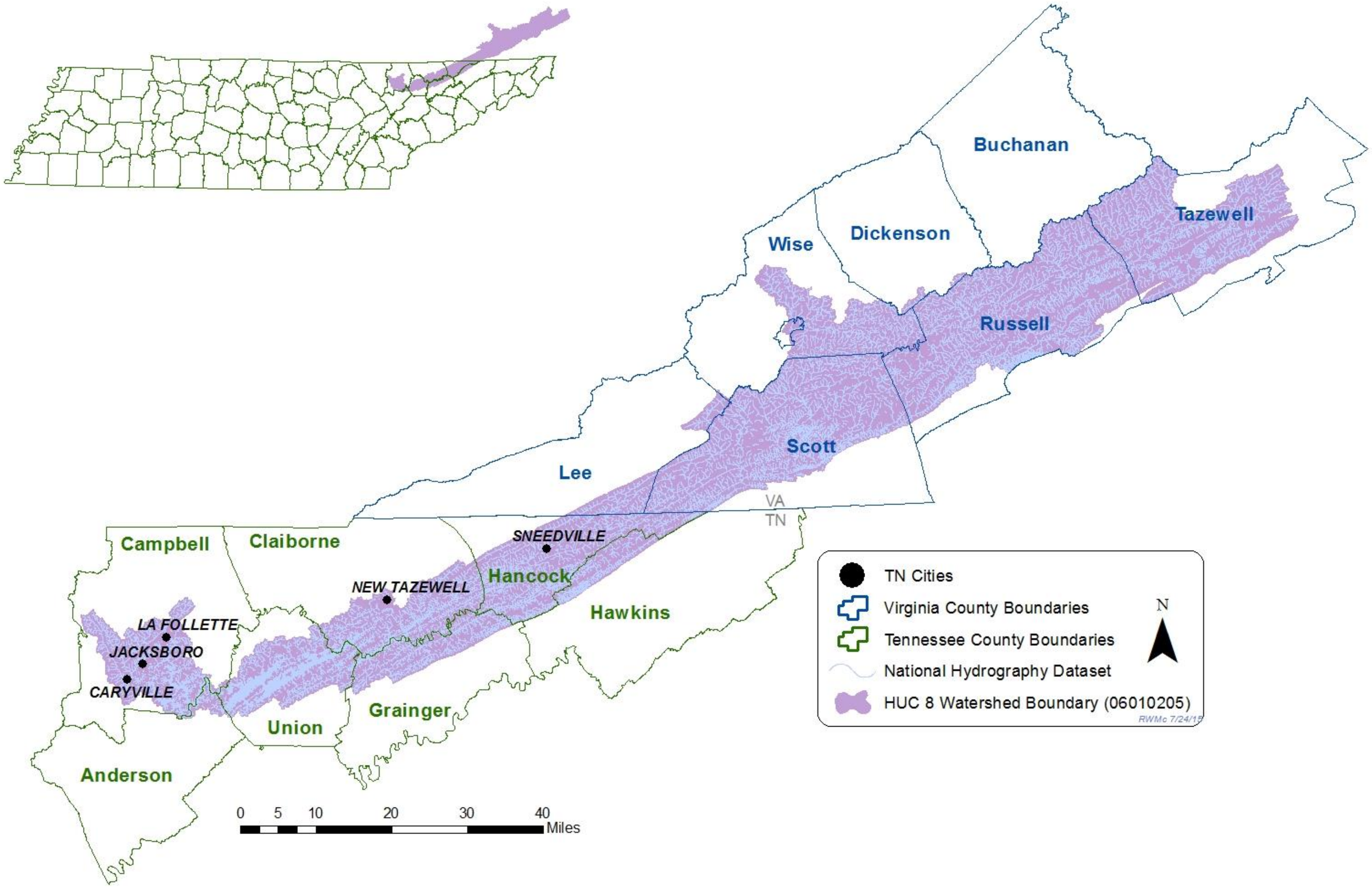

Figure 1. Location of the Upper Clinch River Watershed.

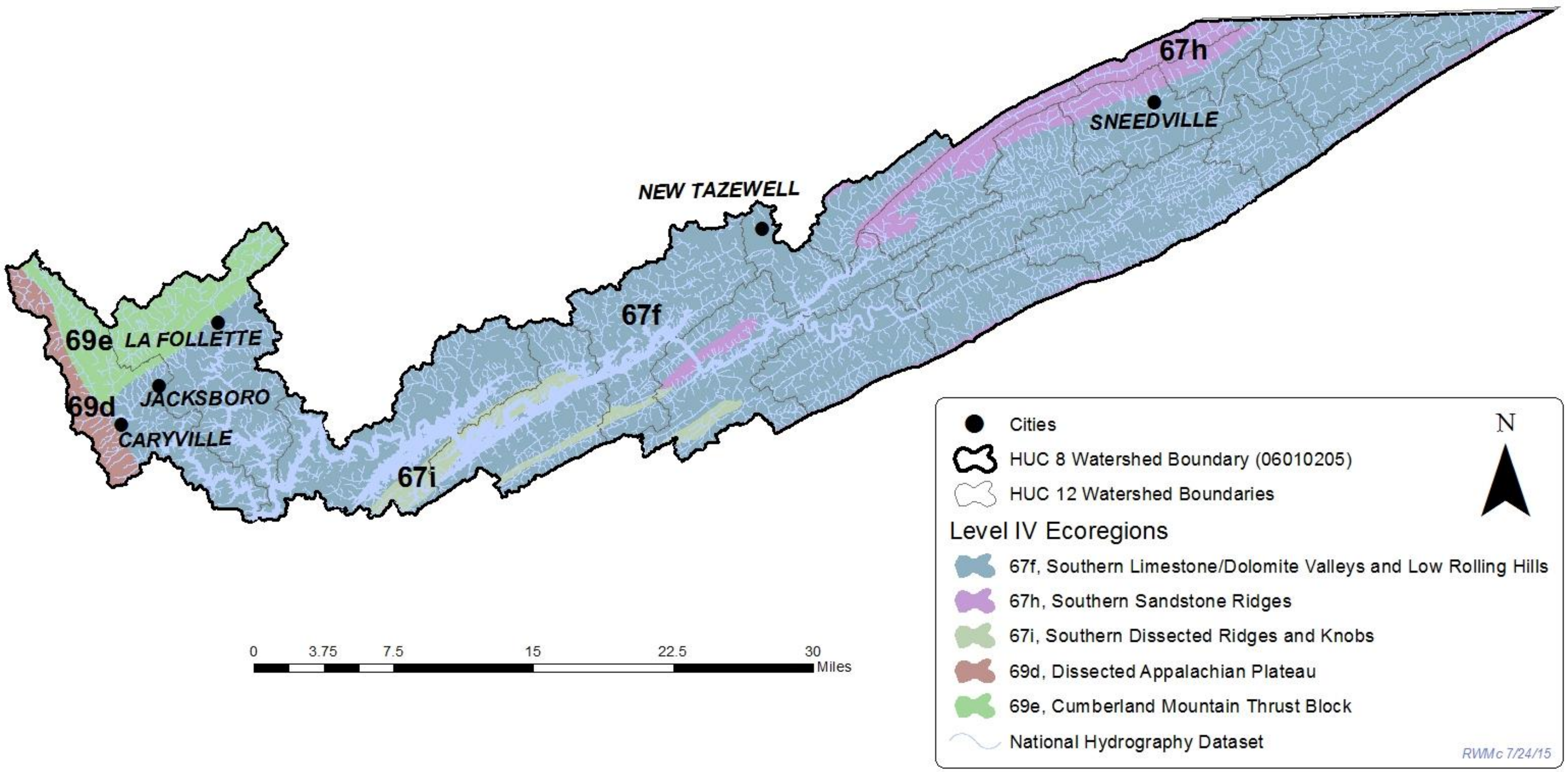

Figure 2. Level IV Ecoregions in the Tennessee Portion of the Upper Clinch River Watershed.

Powell Mountain, Clinch Mountain, and Bays Mountain. White Oak Mountain in the south has some sandstone on the west side, but abundant shale and limestone as well. Grindstone Mountain, capped by the Gizzard Group sandstone, is the only remnant of Pennsylvanian-age strata in the Ridge and Valley of Tennessee.

- **Southern Dissected Ridges and Knobs (67i)** contain crenulated, broken, or hummocky ridges. The ridges on the east side of Tennessee's Ridge and Valley tend to be associated with the Ordovician Sevier shale, Athens shale, and Holston and Lenoir limestones. These can include calcareous shale, limestone, siltstone, sandstone, and conglomerate. In the central and western part the shale ridges are associated with the Cambrian-age Rome Formation: shale and siltstone with beds of sandstone. Chestnut oak forests and pine forests are typical for the higher elevations of the ridges, with white oak, mixed mesophytic forest, and tulip poplar on the lower slopes, knobs, and draws.

- The **Dissected Appalachian Plateau (69d)**, in contrast to the sandstone-dominated Cumberland Plateau (68a) to the west and southwest, is more highly dissected, with narrow-crested steep slopes, and younger Pennsylvanian-age shales, sandstones, siltstones, and coal. Narrow, winding valleys separate the mountain ridges, and relief is often 2,000 feet. Soils are generally well-drained, loamy, and acidic, with low fertility. The natural vegetation is a mixed mesophytic forest, although composition and abundance vary greatly depending on aspect, slope position, and degree of shading from adjacent land masses. Large tracts of land are owned by lumber and coal companies, and there are many areas of stripmining.

- **Cumberland Mountain Thrust Block (69e)** is the eastern portion of the former Cumberland Mountain subecoregion (69d), redelineated after completion of Kentucky's ecoregion delineation work (TDEC, 2007). Narrow, winding valleys separate the mountain ridges, and relief is often 2,000 feet. Soils are generally well-drained, loamy, and acidic, with low fertility. The Cumberland Thrust Block is usually comprised of more mesophytic forests, has lower nutrient levels, cooler temperatures, and less diverse fish populations. Large tracts of land are owned by lumber and coal companies.

The Upper Clinch River watershed (HUC 06010205) has approximately 34,681 lake acres and 754 miles of streams (NHD) as catalogued in the EPA/TDEC Assessment Database (ADB) and drains 707 square miles in Tennessee. Watershed land use distribution is based on the National Land Cover Database (NLCD) derived from Landsat Thematic Mapper digital images from approximately 2011. Land use for the Tennessee portion of the Upper Clinch River watershed is summarized in Table 1 and shown in Figure 3.

Table 1. Land Use Distribution - Upper Clinch River Watershed in Tennessee.

Land Use	Area	
	[acres]	[%]
Open Water	24,919	5.5
Developed, Open Space	24,991	5.5
Developed, Low Intensity	10,612	2.3
Developed, Medium Intensity	2,511	0.6
Developed, High Intensity	702	0.2
Barren Land	1,664	0.4
Deciduous Forest	240,808	53.2
Evergreen Forest	11,786	2.6
Mixed Forest	28,367	6.3
Shrub/Scrub	4,237	0.9
Herbaceous	60,832	13.4
Pasture/Hay	40,328	8.9
Cultivated Crops	137	0.0*
Woody Wetlands	485	0.1
Emergent Herbaceous Wetlands	105	0.0*
Total	452,486	100.0

* < 0.05%.

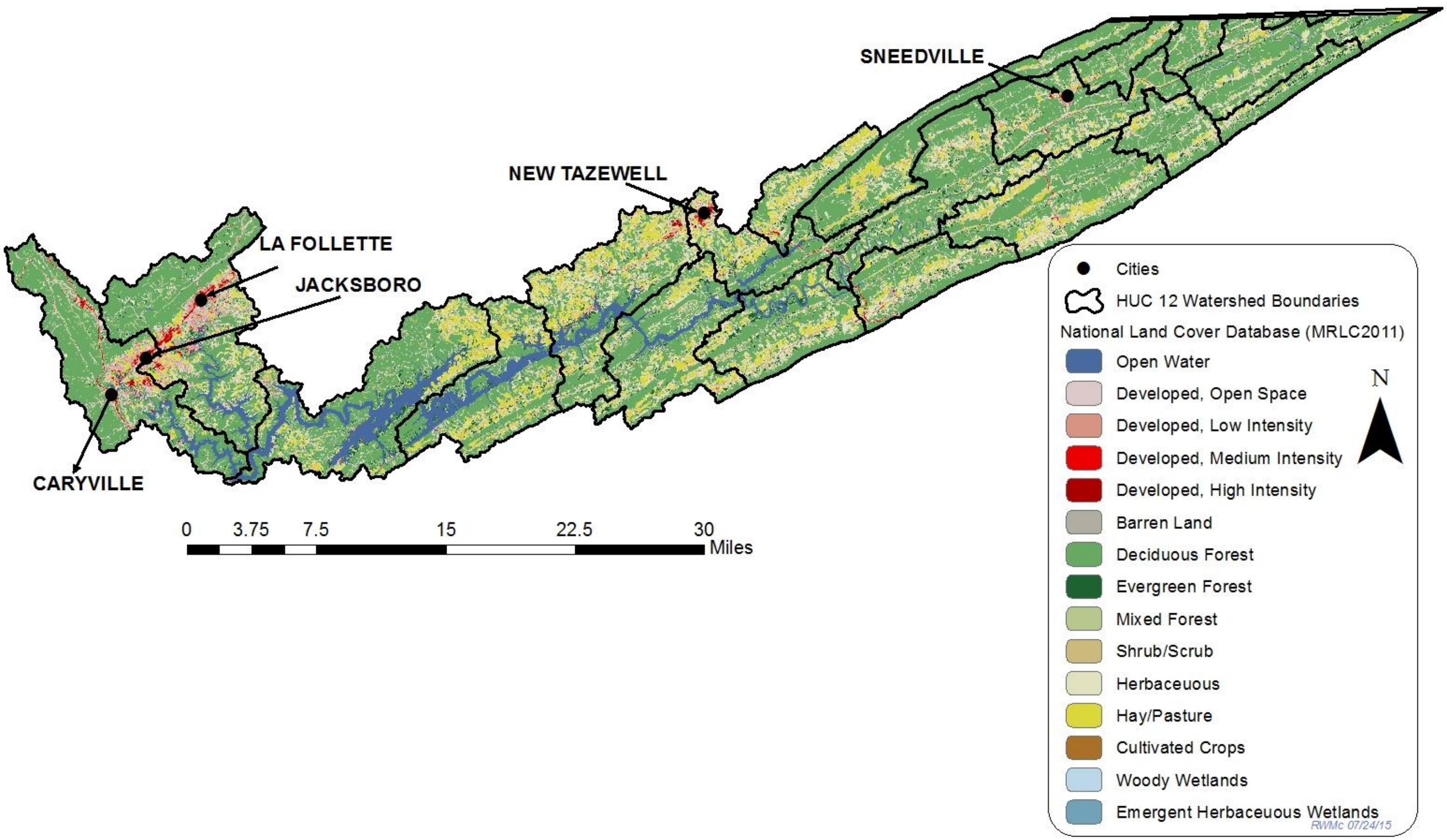

Figure 3. 2011 NLCD Land Use in the Tennessee Portion of the Upper Clinch River Watershed.

4.0 PROBLEM DEFINITION

The State of Tennessee's Final 2014 303(d) List (TDEC, 2016) identified a number of waterbodies in the Upper Clinch River watershed as not fully supporting designated use classifications due, in part, to loss of biological integrity due to siltation associated with pasture grazing and sand/gravel/rock quarry. These waterbodies are summarized in Table 2 and shown in Figure 4. The designated use classifications for the Upper Clinch River and its tributaries include fish & aquatic life, irrigation, livestock watering & wildlife, and recreation.

A description of the stream assessment process in Tennessee can be found in *2014 305(b) Report, The Status of Water Quality in Tennessee* (TDEC, 2014). This document states that "biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing support" of the fish & aquatic life designated use. The waterbody segments listed in Table 2 were assessed as impaired based primarily on biological surveys. The results of these assessment surveys are summarized in Table 3. The assessment information presented is excerpted from the EPA/TDEC Assessment Database (ADB) and is referenced to the waterbody IDs in Table 2. Assessment Database information may be accessed at:

http://tnmap.tn.gov/wpc/

Copies of stream surveys and habitat assessments for Cuckle Creek and Fall Creek, respectively, are presented in Appendix A.

Siltation is the process by which sediments are transported by moving water and deposited on the bottom of stream, river, and lake beds. Sediment is created by the weathering of host rock and delivered to stream channels through various erosional processes, including sheetwash, gully and rill erosion, wind landslides, dry gravel, and human excavation. In addition, sediments are often produced as a result of stream channel and bank erosion and channel disturbance. Movement of eroded sediments downslope from their points of origin into stream channels and through stream systems is influenced by multiple interacting factors (USEPA, 1999b).

Siltation (sedimentation) is the most frequently cited cause of waterbody impairment in Tennessee, impacting almost 6,200 miles of streams and rivers (TDEC, 2014). Unlike many chemical pollutants, sediments are typically present in waterbodies in natural or background amounts and are essential to normal ecological function. Excessive sediment loading, however, is a major ecosystem stressor that can adversely impact biota, either directly or through changes to physical habitat.

Excessive sediment loading has a number of adverse effects on fish & aquatic life in surface waters. As stated in excerpts from *Framework For Developing Suspended And Bedded Sediments (SABS) Water Quality Criteri*a (USEPA, 2006):

> In streams and rivers, fine inorganic sediments, especially silts and clays, affect the habitat for macroinvertebrates and fish spawning, as well as fish rearing and feeding behavior. Larger sands and gravels can scour diatoms and cause burying of invertebrates, whereas suspended sediment affects the light available for photosynthesis by plants and visual capacity of animals. Excessive suspended sediment in aquatic systems decreases light penetration, directly impacting

Table 2. Final 2014 303(d) List - Stream Impairment Due to Siltation in the Upper Clinch River Watershed.

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)[1]	Pollutant Source[2]
06010205001T - 0200	Cuckle Creek	6.89	Loss of biological integrity due to siltation	Pasture Grazing Sand/Gravel/Rock Quarry
06010205001T - 1400	Fall Creek	5.6	Loss of biological integrity due to siltation Alteration in stream-side or littoral vegetative cover	Pasture Grazing

[1] The pollutant or pollutants exceeding water quality standards.
[2] The general source of each pollutant exceeding water quality standards within the waterbody.

Note: For both causes and sources, the Division uses categories provided by EPA in order to be consistent with language used by other states.

Table 3. Water Quality Assessment of Waterbodies Impaired Due to Siltation in the Upper Clinch River Watershed.

Waterbody ID	Waterbody Name	Comments
06010205001T - 0200	Cuckle Creek	2003 Mining Section SQSH survey at mile 1.7 (near Jacksboro). 3 EPT genera, 20 total genera. Index score = 10. Habitat score = 153. Habitat score is good at sampling sites, but poor elsewhere.
06010205001T - 1400	Fall Creek	2010 TDEC SQSH at the Wadeable Stream station at mile 1.5 (Hwy 170 & Old Hwy 33). 14 EPT genera, 25 total genera. Index score = 30. Habitat score = 123. 2004 TDEC SQSH survey at EMAP station at mile 1.5 (Junction Hwy 170 & Old Hwy 33). 14 EPT genera, 27 total genera. Index score = 32. Habitat score = 112.

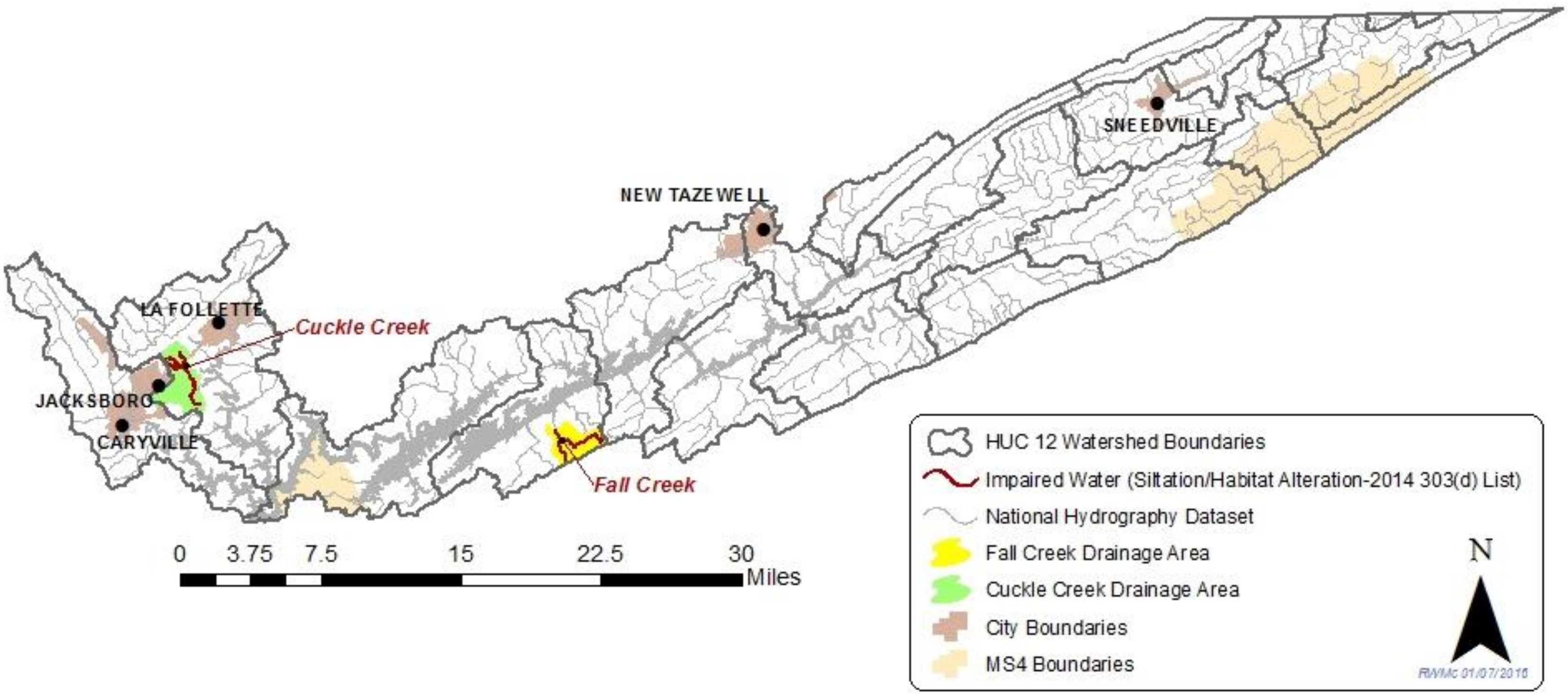

Figure 4. Waterbodies Impaired Due to Siltation (Documented on the Final 2014 303(d) List).

> productivity. Decreased water clarity impairs visibility and associated behaviors such as prey capture and predator avoidance, recognition of reproductive cues, and other behaviors that alter reproduction and survival. At very high levels, suspended sediments can cause physical abrasion and clogging of filtration and respiratory organs.
>
> In flowing waters, bedded sediments are likely to have a more significant impact on habitat and biota than suspended sediments; while most organisms can tolerate episodic occurrences of increased levels of suspended sediments, impacts can become chronic once the sediment is settled. When sediments are deposited or shift longitudinally along the streambed, infaunal or epibenthic organisms and demersal eggs are vulnerable to smothering and entrapment. In smaller amounts, excess fine sediments can fill in gaps between larger substrate particles, embedding the larger particles, and eliminating interstitial spaces that could otherwise be used as habitat for reproduction, feeding, and cover for invertebrates and fish. A noteworthy example of effects of bedded sediments in streams and rivers is the loss of spawning habitat for salmonid fishes due to increased embeddedness. Increased sedimentation can limit the amount of oxygen in the spawning beds, which can reduce hatching success, trap the fry in the sediment after hatching, or reduce the area of habitat suitable for development.

Historically, waterbodies in Tennessee have been assessed as not fully supporting designated uses due to siltation when the impairment was determined to be the result of excess loading of the inorganic sediment produced by erosional processes. In cases where impairment was determined to be caused by excess loading of the primarily organic particulate material found in sewage treatment plant (STP) effluent, the cause of pollution was listed as total suspended solids (TSS) or organic enrichment. In consideration of this practice, this document presents the details of TMDL development for waterbodies in the Upper Clinch River watershed listed as impaired due to siltation (excess inorganic sediment produced by erosional processes). The TSS in STP effluent is considered to be a distinctly different pollutant and, therefore, is excluded in sediment loading calculations.

Stressor Analysis

Division of Water Resources field biologists have noted excessive sediment deposits, significant landuse impacts, and loss of riparian and streambank vegetation in the Upper Clinch River impaired waterbodies (Appendix A). These impacts degrade the habitat (failed biocriteria) and inhibit the health of the aquatic community. In addition, sediment can fill the pores in cobble substrate, limiting macroinvertebrate habitat and resulting in loss of pollution-sensitive taxa. Sediment is identified as a stressor in the Upper Clinch River impaired waterbodies through (1) the decreased total number of taxa and EPT observed, (2) the abundance of oligochaetes and chironomids, (3) the poor scores for habitat metrics such as embeddedness, sediment deposition, bank stability, and vegetative protection (Appendix B), and (4) documented impacts due to siltation/sedimentation, urban and agricultural landuses, livestock, and riparian loss (Appendix A).

The Cuckle Creek (06010205001T-0200) stream segment is moderately impaired for its aquatic life use, with a recent individual Tennessee Macroinvertebrate Index (TMI) sample score of 22 (Table B-1), where a score of 32 or higher is considered to pass biocriteria guidelines for ecoregion 67f. Cuckle Creek is impacted by agricultural and urban land uses. Sediment was identified as the most probable stressor based on the marginal habitat scores given for embeddedness and bank stability due to the lack of riparian vegetation and livestock access to streams (Table B-2).

The Fall Creek (06010205001T-1400) stream segment is moderately impaired for its aquatic life use, with a recent individual TMI sample score of 30 (Table B-1), where a score of 32 or higher is considered to pass biocriteria guidelines for ecoregion 67f. In addition, impairment of the aquatic life use is also indicated by the most recent total habitat score of 123 (Table B-2) for Fall Creek, where a score of 140 or higher is considered to pass the regional habitat guidelines for ecoregion 67f. Fall Creek is impacted by agricultural land uses. Sediment was identified as the most probable stressor based on the marginal habitat scores for embeddedness and sediment (sand and silt) deposition, and the poor habitat scores for streambank vegetative protection (Table B-2).

Results of these analyses indicate that the Upper Clinch River waterbodies (above) are impaired due to sedimentation. Increased sediment from agricultural and urban landuse practices, livestock with access to streams, and unstable, unprotected stream banks degrade the habitat and inhibit the health of the aquatic community by diminishing the macroinvertebrate fauna. This can be seen in the low macroinvertebrate metric scores and habitat assessment (Tables B-1 and B-2, respectively) for these streams. Based on this information, it can be concluded that poor biological index scores and poor habitat scores are closely linked to sediment generated within these impaired waterbodies.

5.0 TARGET IDENTIFICATION

Siltation:

Several narrative criteria, applicable to siltation, are established in *Rules of the Tennessee Department of Environment and Conservation, Tennessee Board of Water Quality, Oil and Gas, Chapter 0400-40-03, General Water Quality Criteria, April, 2015* (TDEC, 2015a):

Applicable to all use classifications (Fish & Aquatic Life shown):

> Solids, Floating Materials, and Deposits – There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish & aquatic life.
>
> Other Pollutants – The waters shall not contain other pollutants that will be detrimental to fish or aquatic life.
>
> Turbidity, Total Suspended Solids, or Color – There shall be no turbidity, total suspended solids, or color in such amounts or of such character that will materially affect fish & aquatic life. In wadeable streams, suspended solid levels over time should not be substantially different than conditions found in reference streams.

Applicable to the Fish & Aquatic Life use classification:

> Biological Integrity - The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or, in the case of wadeable streams, substantially different from conditions in reference streams in the

same ecoregion. The parameters associated with this criterion are the aquatic biota measured. These are response variables.

Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.

Interpretation of this provision for all other wadeable streams, lakes, and reservoirs may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) or Lake and Reservoir Bioassessment and Biocriteria (EPA/841-B-98-007), and/or other scientifically defensible methods. Interpretation of this provision for wetlands or large rivers may be made using scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same bioregion if upstream conditions are determined to be degraded.

Habitat - The quality of stream habitat shall provide for the development of a diverse aquatic community that meets regionally-based biological integrity goals. Examples of parameters associated with this criterion include but are not limited to: sediment deposition, embeddedness of riffles, velocity/depth regime, bank stability, and vegetative protection. Types of activities or conditions which can cause habitat loss include, but are not limited to: channel and substrate alterations, rock and gravel removal, stream flow changes, accumulation of silt, precipitation of metals, and removal of riparian vegetation. For wadeable streams, the instream habitat within each subecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.

These TMDLs are being established to attain full support of the fish & aquatic life designated use classification. TMDLs established to protect fish & aquatic life will protect all other use classifications for the identified waterbodies from adverse alteration due to sediment loading.

In order for a TMDL to be established, a numeric "target" protective of the uses of the water must be identified to serve as the basis for the TMDL. Where State regulation provides a numeric water quality criterion for the pollutant, the criterion is the basis for the TMDL. Where State regulations do not provide numeric water quality criteria, as in the case of siltation, numeric interpretation of the narrative water quality standards must be determined. For the purpose of these TMDLs, the average annual sediment loading in lbs/acre/yr, from a biologically healthy watershed, located within the same Level IV ecoregion as the impaired subwatershed, is determined to be the appropriate numeric interpretation of the narrative water quality standard for protection of fish & aquatic life. Biologically healthy watersheds were identified from the State's ecoregion reference sites. These ecoregion reference sites have similar characteristics and conditions as the majority of streams within that ecoregion. Detailed information regarding Tennessee's ecoregions and ecoregion reference sites can be found in *Tennessee Ecoregion Project, 1994-1999* (TDEC, 2000) and *Revision of Tennessee's Level IV Ecoregions* (TDEC, 2007). In general, land use in ecoregion reference watersheds contains more forested areas and less pasture, cropland, and urban areas than impaired watersheds. The biologically healthy (reference) watersheds are considered the "least impacted" in an ecoregion and, as such, sediment loading from these watersheds may serve as an appropriate target for the TMDL.

Using the methodology described in Appendix C, the Generalized Watershed Loading Function (GWLF) model was used to calculate the average annual sediment load for each of the reference (biologically healthy) subwatersheds in Level IV ecoregion 67f selected as target sites. Since the impairment of biological integrity due to sediment build-up is generally a long-term process, using an average annual load is considered appropriate. The reference site selection process is described in Section 6. Average annual sediment loads for the selected reference sites (representing TMDL target values) and the corresponding impaired waterbodies in Level IV ecoregion 67f) are summarized in Section 7. Reference subwatershed locations are shown in Figure 5.

6.0 REFERENCE WATERSHED SELECTIONS

A reference watershed approach was used to estimate the necessary load reductions needed to restore a healthy aquatic community and allow Cuckle Creek and Fall Creek to achieve their designated uses. This approach is based on selecting a non-impaired (biologically healthy) watershed that has similar soils, watershed characteristics, area (preferably not to exceed double or not to be less than half the size of the impaired watershed), and located in the same ecoregion as the impaired watershed. The modeling process uses average annual sediment loading in the reference watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current average annual loading and establish the reductions necessary to meet the loading rate of the non-impaired watershed.

See Appendix D for a description of the reference watershed selection methodology for Cuckle Creek and Fall Creek.

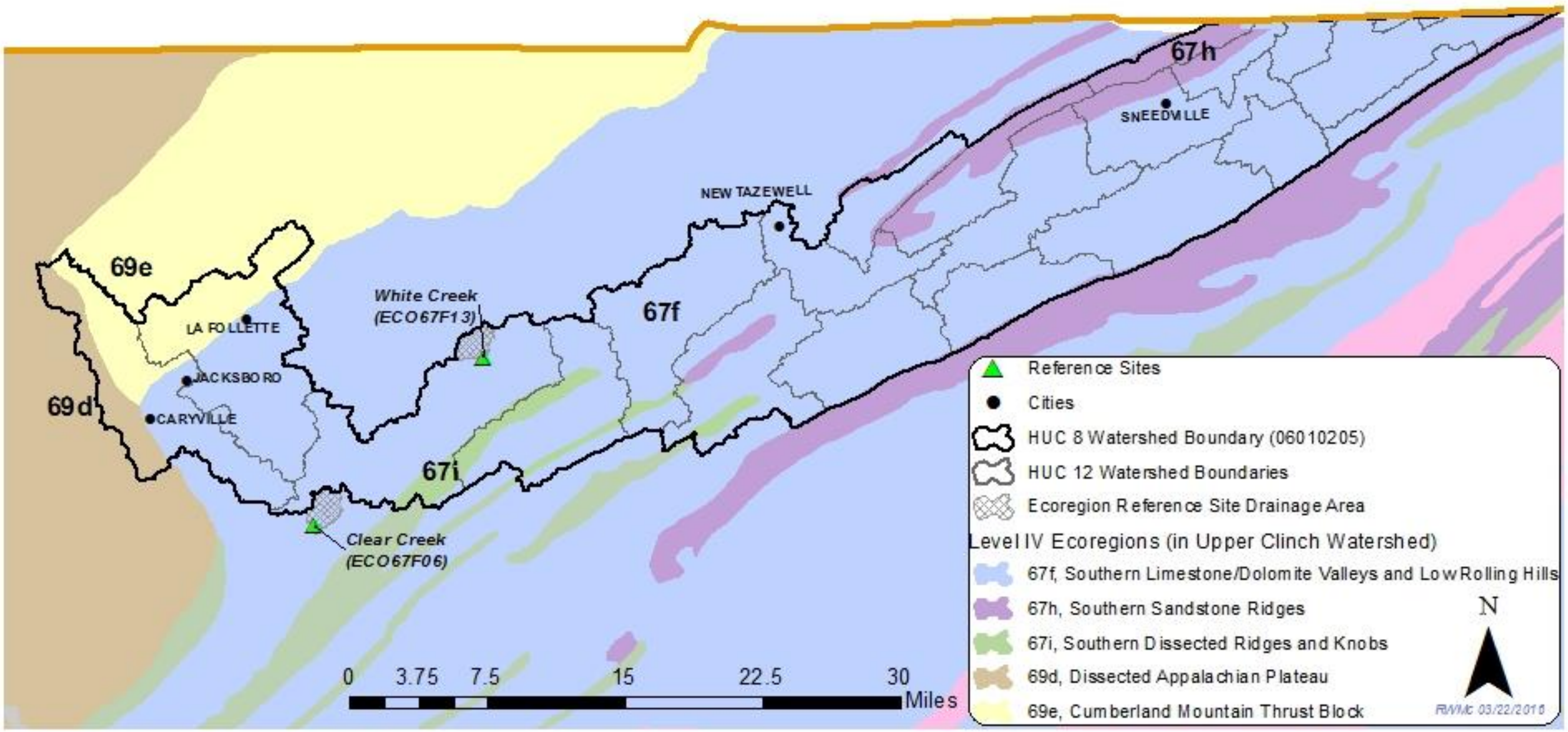

Figure 5. Reference Sites in Level IV Ecoregion 67f.

7.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

The Division of Water Resources (DWR) has experimented with multiple ways to determine if a stream, river, or reservoir is impaired due to silt (TDEC, 2014). These methods include visual observations, chemical analyses (total suspended solids), and macroinvertebrate/habitat surveys. The most satisfactory method for identification of impairment due to silt has been biological surveys that include habitat assessments.

Biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing use support. Two standardized biological methods, biorecons and semi-quantitative samples, are used to conduct macroinvertebrate surveys for assessing biological integrity of streams. These methods are described in *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (TDEC, 2011a) and are referenced in the water quality criteria.

The more definitive of the two biological methods is the semi-quantitative, single-habitat (SQSH) method. The TMI, based on seven biological metrics, is used for comparison to reference streams. Streams are considered impaired if the biological integrity falls below the target score for that region. Target scores were set at 75% of the reference score for each bioregion. For ecoregion 67f, the target score is 32.

DWR uses an EPA method to score the stream or river habitat by evaluating ten components of habitat stability (TDEC, 2011a). This is a standardized approach to identify and quantify impacts to stream habitat. Habitat scores calculated by DWR biologists are compared to the ecoregion reference stream database. Streams with habitat scores less than 75 percent of the median reference score for the ecoregion are considered impaired, unless biological integrity meets expectations. For ecoregion 67f, the target habitat score for high gradient streams (e.g., Cuckle Creek and Fall Creek) is 140.

There are multiple water quality monitoring stations that provide biological data for waterbodies in the Upper Clinch River watershed, identified as impaired for siltation. The locations of these monitoring stations are shown in Figure 6. Biological index (TMI) scores and habitat scores for the Upper Clinch River impaired waterbody monitoring stations are tabulated in Appendix B. Examination of these data shows habitat and/or biological index (TMI) scores in the impaired range for each station with biological data.

Using the methodology described in Appendix C, the GWLF Model was used to determine the average annual sediment load, due to precipitation-induced sources, for all impaired subwatersheds in the Upper Clinch River watershed and selected reference subwatersheds in ecoregion 67f (Figures 4 and 5). Existing precipitation-induced sediment loads for subwatersheds with waterbodies listed on the Final 2014 303(d) List as impaired for siltation (Cuckle Creek and Fall Creek), and the target sediment loads for their reference subwatersheds (Clear Creek and White Creek, respectively), are summarized in Table 4.

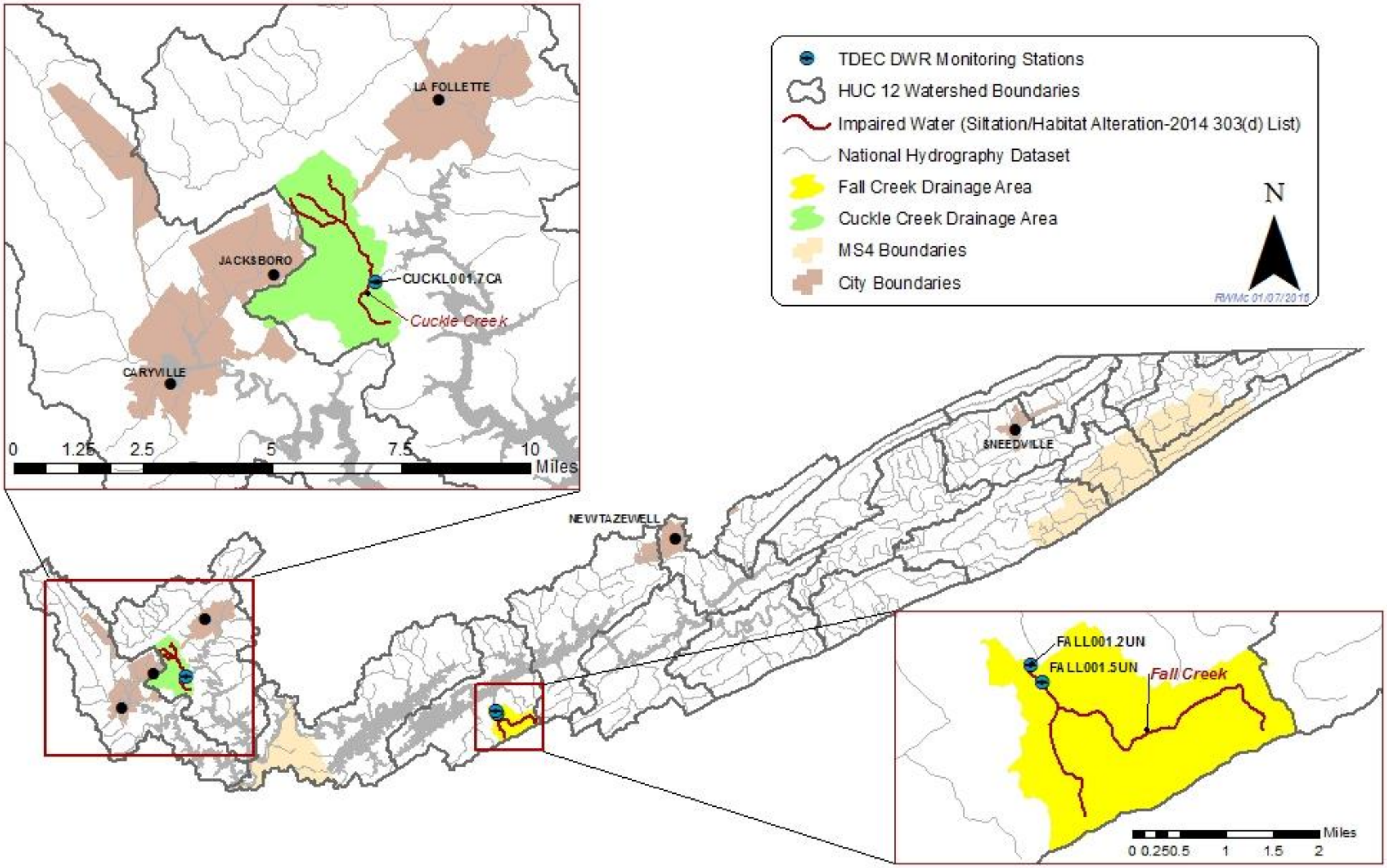

Figure 6. Upper Clinch River Watershed Monitoring Stations.

Table 4. Existing and Target Sediment Loads for Subwatersheds with Impaired Waterbodies in the Upper Clinch River Watershed.

Impaired Subwatershed	Reference Subwatershed	Ecoregion Reference Site	Existing Sediment Load [lbs/ac/yr]	Target Sediment Load [lbs/ac/yr]
Cuckle Creek	Clear Creek	ECO67F06	358.5	164.6
Fall Creek	White Creek	ECO67F13	214.5	196.4

8.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of siltation in the watershed and the amount of pollutant loading contributed by each of these sources. Under the Clean Water Act, sources are broadly classified as either point or nonpoint sources. Under 40 CFR 122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Regulated point sources include: 1) municipal and industrial wastewater treatment facilities (WWTFs), 2) stormwater discharges associated with industrial activity (which includes construction activities), and 3) certain discharges from Municipal Separate Storm Sewer Systems (MS4s). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES-regulated point sources. For the purposes of these TMDLs, all sources of sediment loading not regulated by NPDES are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

8.1 Point Sources

8.1.1 NPDES-Regulated Wastewater Treatment Facilities

As stated in Section 4.0, waterbodies in Tennessee have historically been assessed as not fully supporting designated uses due to siltation when the impairment was determined to be the result of the excess loading of inorganic sediment predominantly produced by erosional processes. In cases where impairment was determined to be caused by excess loading of the primarily organic particulate material found in sewage treatment plant (STP) effluent, the cause of pollution was listed as total suspended solids (TSS) or organic enrichment. In view of this practice, only the TSS loading from industrial wastewater or stormwater discharges was considered in the development of TMDLs for waterbodies in the Upper Clinch River watershed listed as impaired due to siltation.

8.1.2 NPDES-Regulated Ready Mixed Concrete Facilities

Discharges from regulated Ready Mixed Concrete Facilities (RMCFs) may contribute sediment to surface waters as TSS (TSS discharged from RMCFs is composed of primarily inorganic material and is therefore included as a source for TMDL development). Most of these facilities obtain coverage under NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2012a). This permit establishes a daily maximum TSS concentration limit of 50 mg/l on process wastewater effluent and specifies monitoring procedures for stormwater discharges. Facilities are also required to develop and implement stormwater pollution prevention plans

(SWPPPs). Discharges from RMCFs are generally intermittent, and contribute a small portion of total sediment loading to subwatersheds. In some cases, for discharges into waterbodies impaired for siltation as indicated on the Final 2014 303(d) List, sites may be required to obtain coverage under an individual NPDES permit. As of January 7, 2016, there is only one permitted RMCF in the Upper Clinch River watershed located in an impaired subwatershed. This facility is listed in Table 5 and shown in Figure 7.

Note: Benchmark concentrations are guidelines (not limits) for facilities to measure their stormwater monitoring results. If benchmarks are exceeded, permittees typically must notify the Division's local Environmental Field Office, describe likely causes of exceedances, review and modify SWPPPs, and implement BMPs to reduce concentrations below the established values.

Table 5. NPDES-Regulated Ready Mixed Concrete Facilities Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of January 7, 2016).

Waterbody Name	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit	TSS Benchmark Conc.
			[mg/l]	[mg/l]
Cuckle Creek	TNG110288	C & C Concrete Products, LP	50	150

Note: The daily maximum limit applies to process wastewater and the benchmark applies to stormwater.

8.1.3 NPDES-Regulated Tennessee Storm Water Multi-Sector and Individual Industrial Facilities

Discharges from regulated industrial activities may contribute sediment to surface waters as TSS (TSS discharged from industrial facilities is composed of primarily inorganic material and is therefore included as a source for TMDL development). Most of these facilities obtain coverage under NPDES Permit No. TNR050000, *Tennessee Storm Water Multi-Sector General Permit for Industrial Activities* (TDEC, 2015b). This permit establishes daily maximum TSS concentration limits for stormwater discharges. Facilities are also required to develop and implement SWPPPs. In some cases, for discharges into waterbodies impaired for siltation as indicated on the Final 2014 303(d) List, industrial sites may be required to obtain coverage under an individual NPDES permit. As of January 7, 2016, there are three permitted TMSPs in the Upper Clinch River watershed located in an impaired subwatershed (Table 6 and Figure 7). There were no industrial facilities with individual NPDES permits located in impaired subwatersheds in the Upper Clinch River watershed.

8.1.4 NPDES-Regulated Mining Sites

Discharges from regulated mining activities may also contribute sediment to surface waters as TSS (TSS discharged from mining sites is composed of primarily inorganic material and is therefore included as a source for TMDL development). Discharges from active mines may result from dewatering operations and/or in response to storm events, whereas discharges from permitted inactive mines are only in response to storm events. Inactive sites with successful surface reclamation contribute relatively little solids loading. As of January 7, 2016, there are two permitted mining sites in the Upper Clinch River watershed that have discharges to waterbodies in impaired subwatersheds. These two facilities are active limestone quarry and processing facilities. Mines permitted to discharge to waterbodies in impaired subwatersheds are listed in Table 7 and shown in Figure 7.

Table 6. NPDES-Regulated Tennessee Storm Water Multi-Sector Industrial Facilities Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of January 7, 2016).

Waterbody Name	NPDES Permit No.	Facility Name	TSS Benchmark Conc. [mg/l]
Cuckle Creek	TNR054593	Creative Tubes	150
	TNR058911	BSH Home Appliance Corp.	
	TNR058911	Jacksboro Metals, LLC	

Table 7. NPDES-Regulated Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of January 7, 2016).

Waterbody Name	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit [mg/l]	TSS Benchmark Conc. [mg/l]
Cuckle Creek	TN0029262	Rogers Group, Inc.	40	NA*
	TN0063606	Campbell County Highway Department		

* For stormwater outfalls only. Not applicable to TN0029262 and TN0063606.

8.1.5 NPDES-Regulated Construction Activities

Discharges from NPDES-regulated construction activities are considered point sources of sediment loading to surface waters and occur in response to storm events. Currently, discharges of storm water from construction activities disturbing an area of one acre or more must be authorized by an NPDES permit. Most of these construction sites obtain coverage under NPDES Permit No. TNR10-0000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b). Since construction activities at a site are transient in nature and typically represent land disturbance activities of short duration, the number of construction sites covered by the general permit at any instant of time varies. In addition, due to permit provisions for post-construction stormwater (Section 9.3.4), requiring control of runoff volume and pollutant loading, restored post-construction areas are essentially equivalent to MS4s and/or non-MS4 nonpoint source (NPS) areas. Therefore, for the purpose of sediment loading, post-construction areas will have the same requirements for, and are equivalent to, sediment loading from MS4s or NPS areas.

8.1.6 NPDES-Regulated Municipal Separate Storm Sewer Systems

MS4s may discharge solids to waterbodies in response to storm events through road drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, and storm drains. These systems convey runoff from surfaces such as bare soil and wash-off of accumulated street dust and litter from impervious surfaces during rain events. Phase I of the EPA storm water program (http://www.epa.gov/npdes/stormwater-discharges-municipal-sources#overview) requires

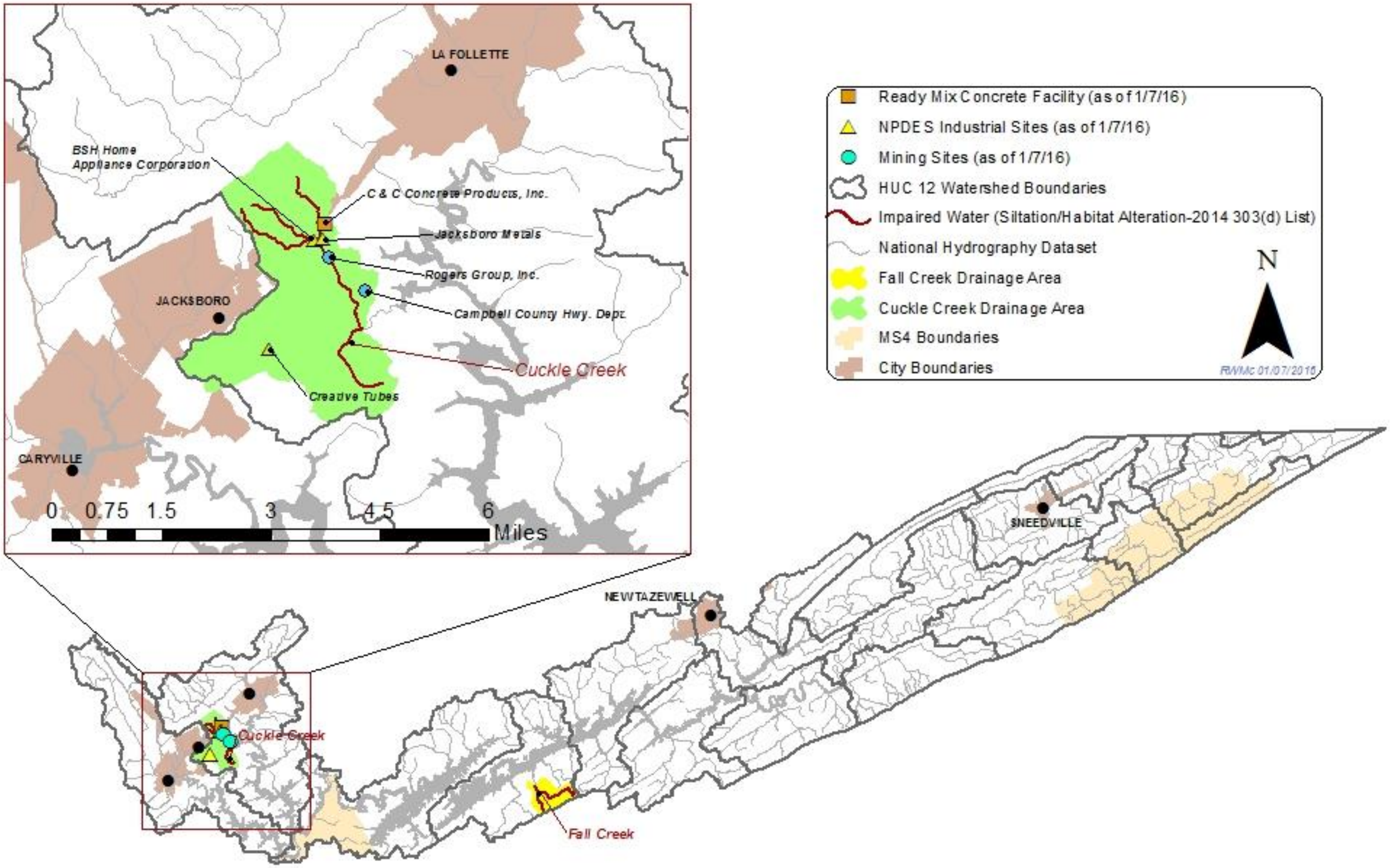

Figure 7. NPDES-Regulated Ready Mixed Concrete Facilities, Tennessee Multi-Sector Industrial Storm Water Facilities, and Mining Sites in Impaired Subwatersheds of the Upper Clinch River Watershed.

large and medium MS4s to obtain individual NPDES storm water permits. Large MS4s are those located in incorporated places or counties serving populations greater than 250,000 people. Medium MS4s are those located in incorporated places or counties serving populations greater than 100,000 people. At present, there are no large or medium MS4s in the Upper Clinch River watershed that discharge to impaired subwatersheds.

Small MS4s in Tennessee must also obtain NPDES permits in accordance with the Phase II storm water program (http://www.epa.gov/npdes/stormwater-discharges-municipal-sources#overview). A small MS4 is designated as *regulated* if: a) it is located within the boundaries of a defined urbanized area that has a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile; b) it is located outside of an urbanized area but within a jurisdiction with a population of at least 10,000 people, a population density of 1,000 people per square mile, and has the potential to cause an adverse impact on water quality; or c) it is located outside of an urbanized area but contributes substantially to the pollutant loadings of a physically interconnected MS4 regulated by the NPDES storm water program. Most regulated small MS4s in Tennessee obtain coverage under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* http://www.tn.gov/assets/entities/environment/attachments/permit_water_tns000000_ms4_phase_ii_2010.pdf (TDEC, 2010).

The Tennessee Department of Transportation (TDOT) has been issued an individual MS4 permit (TNS077585) that authorizes discharges of stormwater runoff from State road and interstate highway rights-of-way that TDOT owns or maintains, discharges of stormwater runoff from TDOT owned or operated facilities, and certain specified non-stormwater discharges. This permit covers all eligible TDOT discharges statewide, including those located outside of urbanized areas. The TDOT individual permit covers TDOT roads and/or facilities discharging to the Cuckle Creek and Fall Creek subwatersheds.

Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at http://www.tn.gov/environment/article/permit-stormwater-discharges-permitting.

8.2 Nonpoint Sources

In general, non-regulated, nonpoint sources account for the vast majority of sediment loading to surface waters. These sources include:

- Natural erosion occurring from the weathering of soils, rocks, and uncultivated land; geological abrasion; and other natural phenomena.

- Erosion from agricultural activities can be a major source of sedimentation due to the large land area involved and the land-disturbing effects of cultivation. Grazing livestock can leave areas of ground with little vegetative cover. Unconfined animals with direct access to streams can cause streambank damage.

- Urban erosion from bare soil areas under construction and washoff of accumulated street dust and litter from impervious surfaces.

- Erosion from unpaved roadways can be a significant source of sediment to rivers and streams. It occurs when soil particles are loosened and carried away from the roadway, ditch, or road bank by water, wind, or traffic. The actual road construction (including erosive road-fill soil types, shape and size of coarse surface aggregate, poor subsurface and/or surface drainage, poor road bed construction, roadway shape, and inadequate runoff discharge outlets or "turn-outs" from the roadway) may aggravate roadway erosion. In addition, external factors such as roadway shading and light exposure, traffic patterns, and road maintenance may also affect roadway erosion. Exposed soils, high runoff velocities and volumes, and poor road compaction all increase the potential for erosion.

- Runoff from abandoned mines may be significant sources of solids loading. Mining activities typically involve removal of vegetation, displacement of soils and other significant land disturbing activities.

- Soil erosion from forested land that occurs during timber harvesting and reforestation activities. Timber harvesting includes the layout of access roads, log decks, and skid trails; the construction and stabilization of these areas; and the cutting of trees. Established forest areas produce very little soil erosion.

- Channelization and channel modification include activities such as straightening, widening, deepening, and clearing of channels of debris and sediment (USEPA, 2007a). Channelization activities can play a critical role in NPS pollution by increasing the timing and delivery of sediment that enters the water. Channelization can also be a cause of higher flows during storm events, increasing the erosive power and carrying capacity of the waterbody.

- Streambank erosion is the wearing away of material in the area landward of the bank along streams and rivers (USEPA, 2007a). Streambank erosion occurs when the force of flowing water in a river or stream exceeds the ability of soil and vegetation to hold the banks in place. Eroded material is carried downstream and redeposited in the channel bottom or in point bars located along bends in the waterway. It is important to note that streambank erosion is a natural process and that natural background levels of erosion exist. However, human activities along or adjacent to streambanks may increase erosion.

For the listed waterbodies within the Upper Clinch River watershed, the primary sources of nonpoint sediment loads come from agriculture, roadways and streambank erosion (urban sources). The watershed land use distribution based on the 2011 NLCD satellite imagery databases is shown in Appendix E for impaired subwatersheds.

9.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS) which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) (http://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol22/pdf/CFR-2011-title40-vol22-sec130-2.pdf) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

This document describes TMDL, Waste Load Allocation (WLA), Load Allocation (LA), and Margin of Safety (MOS) development for waterbodies identified as impaired due to siltation on the Final 2014 303(d) List. Impaired subwatershed boundaries are shown in Figures 4 and 7.

9.1 Sediment Loading Analysis Methodology

Sediment loading analysis for impaired subwatersheds in the Upper Clinch River watershed was conducted utilizing the GWLF-E plug-in included with BASINS 4.1 (Evans, 2011). GWLF-E is a GIS-based watershed modeling tool that essentially duplicates the functionality of AVGWLF, an ArcView GIS-based model that facilitates watershed characterization and TMDL development. Using the BASINS 4.1 MapWindow GIS-application, the GWLF-E plug-in utilizes available GIS coverages (land use, soils, elevations, roads, etc.); the Universal Soil Loss Equation (USLE) to calculate potential erosion (for rural sources); a sediment delivery ratio to calculate sediment yield (for rural sources); the RUNQUAL model to calculate accumulation and washoff (for urban sources); and a Lateral Erosion Rate (LER) to calculate streambank and channel erosion. Combined, these factors comprise total sediment delivery to the stream network (see Appendix C).

Using the GWLF Model, the existing average annual instream sediment load of each impaired subwatershed was determined. This value was compared to the appropriate ecoregion reference site target load specified in Section 7 and the overall required percent reduction in instream sediment loading calculated (see Table 8). Portions of the target load were reserved as an explicit margin of safety (MOS); to account for discharges from NPDES permitted RMCFs, TMSPs and individually-permitted industrial facilities, and mining sites; and a provision for future growth (applicable to non-MS4 NPDES permitted facilities); with the remainder allocated to MS4s and nonpoint loading sources. Daily expressions of allowable loads were developed for impaired subwatersheds and precipitation-induced sources by dividing the calculated average annual target load by the average annual precipitation for each subwatershed.

The sediment loading analysis methodology is described in detail in Appendix F.

9.2 TMDLs for Impaired Subwatersheds

For each impaired subwatershed, the TMDL consists of: a) the required overall percent reduction in instream sediment loading and b) the allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation).

TMDLs for siltation impaired subwatersheds are summarized in Table 8.

9.3 Waste Load Allocations

9.3.1 Waste Load Allocations for NPDES-Regulated Ready Mixed Concrete Facilities

WLAs for existing NPDES permitted Ready Mixed Concrete Facilities (RMCFs) were specified for impaired subwatersheds in the Upper Clinch River watershed (ref.: Table 5). Since sediment loading from RMCFs is small (ref.: Appendix G) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing permit requirements for these facilities. For each impaired subwatershed, the WLA consists of two parts: a) an allowable average annual load and b) a daily expression (derived from site permit limits and volumes of discharge).

WLAs are developed in Appendix G and are summarized in Table 9.

9.3.2 Waste Load Allocations for NPDES-Regulated Tennessee Stormwater Multi-Sector and Individual Industrial Facilities

WLAs for existing NPDES permitted Tennessee Storm Water Multi-Sector General (TMSPs) and individual industrial facilities were specified for impaired subwatersheds in the Upper Clinch River watershed (ref.: Table 6). Since sediment loading contributed by these facilities is small compared to the total loading in these subwatersheds (ref.: Appendix G), WLAs are considered to be equal to the existing NPDES permit requirements for these facilities. For each impaired subwatershed, the WLA consists of two parts: a) an allowable average annual load and b) a daily expression (derived from site permit limits and volumes of discharge).

WLAs are developed in Appendix G and are summarized in Table 9.

9.3.3 Waste Load Allocations for NPDES-Regulated Mining Activities

WLAs for existing NPDES permitted mining activities were specified for impaired subwatersheds in the Upper Clinch River watershed (ref.: Table 7). Since sediment loading contributed by these mining sites is small (ref.: Appendix G) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing NPDES permit requirements for these sites. For each impaired subwatershed, the WLA consists of two parts: a) an allowable average annual load and b) a daily expression (derived from site permit limits and volumes of discharge).

WLAs are developed in Appendix G and are summarized in Table 9.

9.3.4 Waste Load Allocations for NPDES-Regulated Construction Activities

WLAs for existing NPDES permitted construction site discharges (Appendix G) will be implemented through appropriate erosion prevention and sediment controls and BMPs as specified in NPDES Permit No. TNR100000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b). This permit requires development and implementation of site-specific Storm Water Pollution Prevention Plans (SWPPPs) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2012b) and must identify potential sources of pollution at a construction site that would affect the quality of stormwater discharges and describe practices to be used to reduce pollutants in those discharges. In addition, the permit specifies a number of special requirements for discharges entering Tennessee Exceptional Waters or waters identified as impaired due to siltation. The permit

Table 8. Sediment TMDLs for Subwatersheds with Waterbodies Impaired for Siltation.

Waterbody ID	Waterbody Impaired by Siltation	Level IV Ecoregion	Existing Sediment Load [lbs/ac/yr]	Target Load [lbs/ac/yr]	TMDL (Required Load Reduction) [%]
06010205001T_0200	Cuckle Creek	67f	358.5	164.6	54.1
06010205001T_1400	Fall Creek		214.5	196.4	8.4

Note: Calculations were conducted for all subwatersheds containing waterbodies identified as impaired for siltation.

Table 9. Summary of WLAs for RMCFs, TMSPs, and Mining Sites.

Subwatershed	MOS [lbs/yr]	Future Growth [lbs/yr]	WLAs					
			RMCFs[a]		TMSPs[b]		Mining[c]	
			Annual Average Load [lbs/yr]	Daily Maximum Load [d] [lbs/day]	Annual Average Load [lbs/yr]	Daily Maximum Load [e] [lbs/day]	Annual Average Load [lbs/yr]	Daily Maximum Load [f] [lbs/day]
Cuckle Creek	59,305	29,653	1871[g]	$417(\Sigma Q_p) + 1{,}251(\Sigma Q_{sw})$[d,g]	10,630[g]	$1{,}251(\Sigma Q_{SW})$[e,g]	14,603.8[g]	$333.6(\Sigma Q_P) + 1{,}251(\Sigma Q_{SW})$[f,g]
Fall Creek	51,928	25,964	(See Note g)	(See Note g)	(See Note g)	(See Note g)	(See Note g)	(See Note g)

Notes:
a. Values shown are overall WLAs for all permitted RMCFs in the subwatershed.
b. Values shown are overall WLAs for all permitted TMSPs in the subwatershed.
c. Values shown are overall WLAs for all permitted mining sites in the subwatershed.
d. ΣQ_P = Sum of all permitted RMCF process wastewater discharges in the subwatershed [MGD].
ΣQ_{SW} = Sum of all permitted RMCF stormwater discharges in the subwatershed [MGD].
e. ΣQ_{SW} = Sum of all permitted TMSP stormwater discharges in the subwatershed [MGD].
f. ΣQ_P = Sum of all permitted mining process wastewater discharges in the subwatershed [MGD].
ΣQ_{SW} = Sum of all permitted mining stormwater discharges in the subwatershed [MGD].
ΣQ_M = Sum of all permitted mining discharges in the subwatershed [MGD].
g. Allocations for future permitted discharges are provided in the future growth term.

does not authorize discharges that would result in a violation of a State water quality standard.

Construction activities are transient in nature and typically represent land disturbance activities of short duration. In addition, due to permit provisions for post-construction stormwater, requiring control of runoff volume and pollutant loading, restored post-construction areas are essentially equivalent to WLAs for MS4s and/or LAs for non-MS4 nonpoint source (NPS) areas. Therefore, for the purpose of sediment loading analysis calculations, post-construction areas have the same requirements for sediment loading as, and the WLAs are equivalent to, WLA_{MS4} or LA_{NPS}.

Unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (or any applicable individual permit) is considered to be consistent with the WLAs described in Appendix G of this TMDL document. The WLAs are considered to be equal to the existing NPDES permit requirements for these construction sites. The construction general permit does not specify numeric limits for sediment concentration or loading; therefore, WLAs should not be interpreted as numeric limits.

9.3.5 Waste Load Allocations for NPDES-Regulated Municipal Separate Storm Sewer Systems

WLAs for Municipal separate storm sewer systems (MS4s) are calculated in Appendix F for impaired subwatersheds and apply to MS4 discharges into waterbodies located in the impaired subwatershed for which the WLA was developed. WLAs for impaired subwatersheds are expressed as: a) a required percent reduction in the average annual instream sediment loading and b) an allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation).

Instream sediment loads are evaluated at the pour point of the subwatershed drainage area. WLAs for MS4s are tabulated in Table 10. WLAs will be implemented as Best Management Practices (BMPs) as specified in Phase I and II MS4 permits. MS4 permits do not specify numeric limits for sediment concentration or loading; therefore, WLAs should not be interpreted as numeric limits.

9.4 Load Allocations for Nonpoint Sources

All sources of sediment loading to surface waters not covered by the NPDES program are provided a Load Allocation (LA) in these TMDLs. LAs are established for each subwatershed containing a waterbody identified on the Final 2014 303(d) List as impaired due to siltation (ref.: Table 10). LAs are expressed as: a) a required percent reduction in the average annual instream sediment loading and b) an allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation).

Instream sediment loads are evaluated at the pour point of the subwatershed drainage area. LAs for nonpoint sources are tabulated in Table 10.

9.5 Future Growth

A provision for Future Growth (FG) is allocated as 5% of the total ecoregion reference site target load for each impaired subwatershed in the Upper Clinch River watershed (ref.: Table 10). Allocations for future permitted discharges are provided in the FG term. The FG term is applicable to combined loading from all non-MS4 WLAs (including RMCF, TMSP, Mining, and individually permitted facilities) (see Appendix F).

Table 10. Summary of Siltation MOS, FG, WLAs for MS4s, & LAs for Nonpoint Sources.

Subwatershed	MOS	FG	WLAs *		LAs *	
			MS4			
			Required Reduction	Daily Maximum Load	Required Reduction	Daily Maximum Load
	[lbs/yr]	[lbs/yr]	[%]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]
Cuckle Creek	59,305	29,653	62.4	2.56	62.4	2.56
Fall Creek	51,928	25,964	22.2	3.44	22.2	3.44

* Applicable as instream sediment reduction at the pour point of the subwatershed.

Future Growth for MS4s is accounted for in the allocation of loading for MS4s (WLA_{MS4}) and nonpoint source areas (LA_{NPS}). Because the allocation for these loading components is equivalent (equal on a unit area basis), the combined total loading of the two allocations is constant. Future growth in terms of newly designated MS4s or expansion (growth) of existing MS4s would change the relative distribution of loading (increasing WLA_{MS4} and decreasing LA_{NPS}) while leaving the combined total loading unchanged.

9.6 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, an explicit MOS of 10% of the total ecoregion reference site target load is allocated for each impaired subwatershed in the Upper Clinch River watershed (ref.: Table 10). In addition, some measure of implicit MOS is realized due to the use of conservative modeling assumptions, including target values based on Level IV ecoregion reference sites. These sites represent the least impacted streams in the ecoregion.

9.7 Seasonal Variation

Models developed for hydrologic representation of Upper Clinch River watershed flow conditions used a 10-year period including all seasons and a full range of flow and meteorological conditions. Development of the HSPF and GWLF-E hydrologic models (Appendices H and I, respectively) utilized continuous precipitation and meteorological data for hydrologic calibration and simulation.

Sediment loading is expected to fluctuate according to the amount and distribution of rainfall. The determination of sediment loads on an average annual basis accounts for these differences through the rainfall erosivity index (ref.: Section C.2). This is a statistic calculated from the annual summation of rainfall energy in every storm and its maximum 30-minute intensity. In GWLF-E, rainfall erosivity coefficients are utilized to estimate the rainfall intensity factor used in the USLE algorithm, and vary with season and geographic location.

10.0 IMPLEMENTATION PLAN

The TMDLs, WLAs, and LAs developed in Section 9 are intended to be the first phase of a long-term effort to restore the water quality of impaired waterbodies in the Upper Clinch River watershed through reduction of sediment loading. Adaptive management methods, within the context of the State's rotating watershed management approach, will be used to modify TMDLs, WLAs, and LAs as required to meet water quality goals.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref: http://www.tn.gov/environment/article/watershed-management-approach). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. It relies on participation at the federal, state, local and non-governmental levels to be successful.

Implementation Overview

The goal of this TMDL is to restore the Upper Clinch River impaired subwatersheds to a condition of compliance with all applicable water quality criteria, including support of a diverse aquatic community that meets regionally-based (eco-region) biological integrity goals. Impairments observed in the aquatic communities in Cuckle Creek and Fall Creek have been attributed to stressors associated with agriculture, urban sources (both point and non-point), roadways, and streambank erosion. An implementation plan, such as adopting a low impact development (LID) strategy and green infrastructure (GI) for future growth in urban areas and implementation of agricultural BMPs, should be designed with input from multiple stakeholders. The fundamental objective is control of excessive siltation and habitat alteration from both point and non-point sources. The negative impacts to water quality can be minimized and water quality improved by adhering to strict compliance with all provisions of NPDES permits and implementing best management practices (BMPs) and restoration efforts using the following adaptive management approach:

- Establish education and/or community outreach programs. In the most highly developed watersheds, the level of public interest is likely to be highest, streamside residents have greater direct individual influence over whether healthy stream conditions are maintained, and much of the riparian corridor is not under public ownership or control (Booth, et al., 2001);
- Conduct periodic biological surveys to assess habitat and biological recovery;
- Identify and preserve healthy, high-quality watershed areas such as open space, wetlands, and riparian areas;
- Maintain and restore buffers along sensitive waterbodies;
- Minimize disturbance of soils and native vegetation;
- Minimize impervious surfaces and directly connected impervious areas;
- In sensitive (high-impact) areas, implement BMPs strategically through a phased program which focuses on achieving the highest levels of reduction for the least cost;
- Adjust and/or modify BMP implementation in an adaptive manner until water

quality standards are met;

- Compare monitoring and biological survey (biocriteria and habitat assessment) results to numeric interpretations of water quality standards (fish and aquatic life criteria); and
- If results of monitoring and assessment activities indicate restoration efforts during the first (and subsequent) watershed cycle(s) have failed to accomplish quantifiable water quality improvements or indicate further degradation, more aggressive implementation of BMPs and erosion prevention and sediment control practices must be adopted.

The Implementation strategy for this TMDL is based on erosion prevention and sediment control mitigation methods to reduce siltation and habitat alteration stressors associated with urban sources (both point and non-point), agriculture, streambank erosion, and roadways for impaired waterbodies. Additional general information concerning mitigation measures and BMPs can be found in Appendix H.

10.1 Point Sources

Federal regulations require that all new or revised National Pollutant Discharge Elimination System (NPDES) permits must be consistent with the assumptions and requirements of any applicable TMDL WLA (40 CFR §122.44 (d)(1)(vii)(B)).

10.1.1 NPDES-Regulated Ready Mixed Concrete Facilities

There is one RMCF in the Upper Clinch River watershed, located in the impaired Cuckle Creek subwatershed (ref.: Table 5). WLAs will be implemented through permit requirements established by NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2012a) for this sites.

10.1.2 NPDES-Regulated Storm Water Discharges from Industrial Activities

There are three industrial stormwater facilities located in the Upper Clinch River impaired subwatersheds (ref.: Table 6). WLAs will be implemented through permit requirements established by NPDES Permit No. TNR050000, *Tennessee Storm Water Multi-Sector General Permit for Industrial Activities* (TDEC, 2015b) for these sites.

10.1.3 NPDES-Regulated Mining Sites

There are two mining sites located in the Upper Clinch River watershed impaired subwatersheds (ref.: Table 7). WLAs will be implemented through the existing individual permit requirements for these sites.

10.1.4 NPDES-Regulated Construction Stormwater

The WLAs provided to existing and future NPDES-regulated construction activities will be implemented through Best Management Practices (BMPs) as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b). The permit requires the development and implementation of a site-specific Storm Water Pollution Prevention Plan (SWPPP) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2012b) and must identify potential sources of pollution at a construction site that would affect the quality of stormwater discharges and describe practices to be used to reduce pollutants in those discharges. At a minimum, the SWPPP must include the following elements:

- Site description
- Description of stormwater runoff controls
- Erosion prevention and sediment controls
- Stormwater management
- Description of other items needing control
- Approved local government sediment and erosion control requirements
- Maintenance
- Inspections
- Pollution prevention measures for non-stormwater discharges
- Documentation of permit eligibility related to TMDLs

The SWPPP must include documentation supporting a determination of permit eligibility with regard to waters that have an approved TMDL for a pollutant of concern, including:

- identification of whether the discharge is identified, either specifically or generally, in an approved TMDL and any associated wasteload allocations, site-specific requirements, and assumptions identified for the construction stormwater discharge;
- summaries of consultation with the division on consistency of SWPPP conditions with the approved TMDL; and
- measures taken to ensure that the discharge of TMDL identified pollutants from the site are consistent with the assumptions and requirements of the approved TMDL, including any specific wasteload allocation that has been established that would apply to the construction stormwater discharge.

The permit does not authorize stormwater or other discharges that would result in a violation of a State water quality standard. With respect to discharge quality, the permit states:

> The construction activity shall be carried out in such a manner that will prevent violations of water quality criteria as stated in the TDEC Rules, Chapter 1200-4-3-.03 (*replaced by Chapter 0400-40-03*). This includes but is not limited to the prevention of any discharge that causes a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the uses designated for that water body by TDEC Rules, Chapter 1200-4-4 (*replaced by Chapter 0400-40-04*). Construction activity carried out in the manner required by this permit shall be considered in compliance with the TDEC Rules, Chapter 1200-4-3-.03 (*replaced by Chapter 0400-40-03*).

In addition, a number of special requirements are specified for discharges entering Exceptional Tennessee waters or waters identified as impaired due to siltation/habitat alteration. These additional requirements include:

- The SWPPP must certify that erosion and sediment controls used at the site are designed to control storm runoff generated by a 5-year, 24-hour storm event.
- The SWPPP must be prepared by a person who, at a minimum, has completed the department's Level II Design Principles for Erosion Prevention and Sediment Control for Construction Sites course.
- More frequent (twice weekly) inspections of erosion and sediment controls.
- The permittee must certify whether or not all planned and designed erosion prevention and sediment controls have been installed and in working order.
- If a discharger is complying with the SWPPP, but is contributing to the impairment of a receiving stream, the SWPPP must be revised and implemented to eliminate further impairment to the stream. If these changes are not implemented within 7 days of receipt of notification, coverage under the general permit will be terminated and continued discharges covered under an individual permit. The construction project must be stabilized immediately until the revised SWPPP is implemented or an individual permit issued. No earth disturbing activities, except for stabilization, are authorized until the individual permit is issued.
- For an outfall in a drainage area of a total of 5 or more acres, a minimum temporary (or permanent) sediment basin volume that will provide treatment for a calculated volume of runoff from a 5-year, 24-hour storm and runoff from each acre drained, or equivalent control measures, as specified in the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2012b), shall be provided until final stabilization of the site.
- For sites that contain or are adjacent to a receiving stream designated as impaired or Exceptional Tennessee waters, a 60-foot natural riparian buffer zone adjacent to the receiving stream shall be preserved, to the maximum extent practicable, during construction activities at the site.

Strict compliance with the provisions of the *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b) can reasonably be expected to achieve reduced sediment loads to streams. The primary challenge for the reduction of sediment loading from construction sites to meet TMDL WLAs is in the effective compliance monitoring of all requirements specified in the permit and timely enforcement against construction sites not found to be in compliance with the permit.

10.1.5 NPDES-Regulated Municipal Separate Storm Sewer Systems

For existing and future regulated discharges from municipal separate storm sewer systems, WLAs will be implemented through Phase I & II MS4 permits. These permits will require the development and implementation of a Storm Water Management Program (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. The *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2010) requires SWMPs to include six minimum control measures:

- Public education and outreach on stormwater impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site stormwater runoff control
- Post-construction stormwater management in new development and re-development
- Pollution prevention/good housekeeping for municipal operations

For discharges into impaired waters, the Small MS4 General Permit (ref.: http://www.tn.gov/assets/entities/environment/attachments/permit_water_tns000000_ms4_phase_ii_2010.pdf) requires an MS4 to determine whether stormwater discharges from any part of the MS4 contribute pollutants of concern to an impaired waterbody. For those impaired waters, the MS4 must determine whether or not a TMDL has been established and approved by EPA.

For discharges of pollutants of concern into an impaired waterbody with EPA-approved or established TMDLs, the MS4 must implement stormwater pollutant reductions consistent with assumptions and requirements of any applicable wasteload allocation(s) in the TMDLs. If an MS4 discharges into a waterbody with an approved or established TMDL, the SWMP must include BMPs specifically targeted to achieve the wasteload allocations prescribed by the TMDL. The SWMP must include a schedule for installation of such BMPs.

Not later than 6 months following the TMDL adoption, or designation as a newly-permitted MS4, the SWMP shall be revised to meet the implementation of waste load allocations (WLA) as specified in the TMDL. If the source of the impairment has been determined, management measures specific for reducing pollutants of concern from that specified source shall be included.

In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs. Instream monitoring, at locations selected to best represent the effectiveness of BMPs, must include analytical monitoring of pollutants of concern as well as stream surveys to evaluate biological integrity. A detailed plan describing the monitoring program must be submitted to the appropriate Environmental Field Office (EFO) of the Division of Water Resources within 12 months of the approval date of this TMDL or designation as a newly-permitted MS4. The appropriate EFO can be determined based on the region or county (ref.: http://www.tn.gov/environment/article/contacts-by-region).

Implementation of the monitoring program must commence within 6 months of plan approval by the EFO. The monitoring program shall comply with the monitoring, record keeping, and reporting requirements of *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2010).

10.2 Nonpoint Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most nonpoint source discharges. Reductions of sediment loading from nonpoint sources (NPS) will be achieved using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired waters. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. There are links to a number of publications and information resources on EPA's Nonpoint Source Pollution website (http://water.epa.gov/polwaste/nps/) relating to the implementation and evaluation of nonpoint source pollution control measures.

The actions of local government agencies and watershed stakeholders should be directed to accomplish the goal of a reduction of sediment loading in the watershed. There are a number of measures that are particularly well-suited to action by local stakeholder groups. These measures include, but are not limited to:

- Detailed surveys of impaired subwatersheds to identify additional sources of sediment loading.
- Advocacy of local area ordinances and zoning that will minimize sediment loading to waterbodies, including establishment of buffer strips along streambanks, reduction of activities within riparian areas, and minimization of road and bridge construction impacts.
- Educating the public as to the detrimental effects of sediment loading to waterbodies and measures to minimize this loading.
- Advocacy of agricultural BMPs (e.g., riparian buffer, animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment protection, livestock exclusion, etc.) and practices to minimize erosion and sediment transport to streams. The Tennessee Department of Agriculture (TDA) keeps a database of BMPs implemented in Tennessee. Out of approximately 1000 BMPs installed in the Upper Clinch River watershed from October, 2005 to November, 2015, at least 34 are in sediment-impaired subwatersheds (see Figure 8).

BMPs have been utilized in the Upper Clinch River watershed to reduce the amount of sediment transported to surface waters from agricultural sources. These BMPs may have contributed to reductions in sediment loading in one or more sediment-impaired waterbodies. Agricultural BMPs known to have been utilized in the Cuckle Creek and Fall Creek subwatersheds include heavy use area treatment, pasture or hayland renovation, fencing, and alternative watering systems. It is recommended that additional information (e.g., erosion and transport rates, conservation practices, effectiveness of management measures, etc.) be provided and evaluated to better identify and quantify agricultural sources of sediment loading in order to minimize uncertainty in future TMDL analysis efforts.

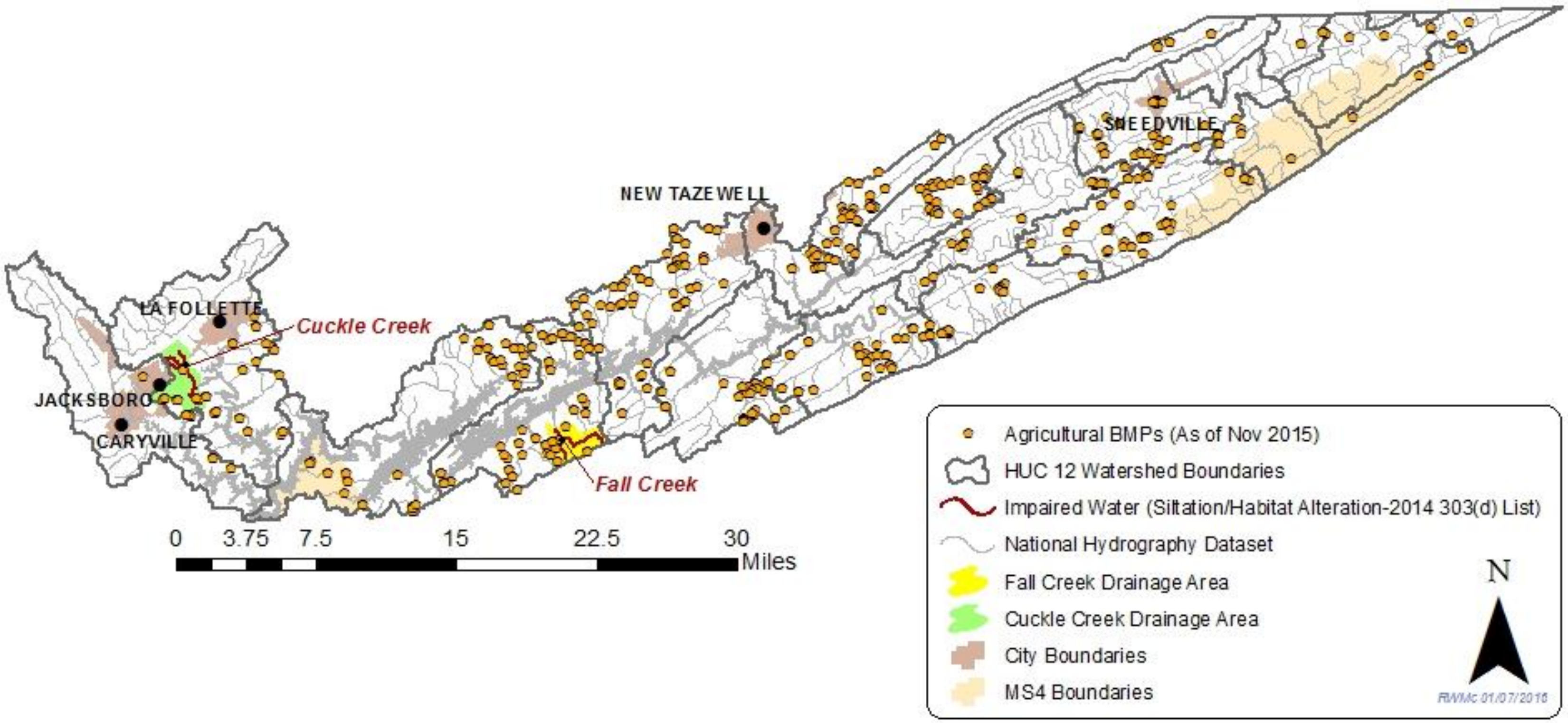

Figure 8. Location of Agricultural Best Management Practices in the Upper Clinch River Watershed.

For additional information on agricultural BMPs in Tennessee, see: https://tn.gov/assets/entities/agriculture/attachments/AgFarBMPsAgricultural.pdf. An additional agricultural nonpoint source resource provided by EPA is *National Management Measures to Control Nonpoint Source Pollution from Agriculture* (http://water.epa.gov/polwaste/nps/agriculture/agmm_index.cfm): a technical guidance and reference document for use by State, local, and tribal managers in the implementation of nonpoint source pollution management programs. It contains information on the best available, economically achievable means of reducing pollution of surface and groundwater from agriculture (EPA 841-B-03-004, July 2003).

An excellent example of stakeholder involvement and action for the protection and restoration of impaired waters is the Clinch-Powell Clean Rivers Initiative (CPCRI).

The CPCRI is a two-state river coalition that works to protect and restore water quality for rare and imperiled freshwater animals in one of North America's most important river systems. The CPCRI protects and restores water quality in the Clinch-Powell river system by:

- conducting cutting-edge science and river monitoring;
- using science and monitoring results to help people, communities, governments, and industries take better care of the river;
- fostering increased coordination among state and federal agencies responsible for protecting water quality in Virginia and Tennessee;
- making strategic investments in freshwater conservation and restoration projects; and
- raising awareness of the Clinch-Powell River system as a national model for collaborative and effective environmental management.

The initiative unites a broad array of groups and agencies working in both Tennessee and Virginia. Working as partners with shared goals and commitments, these agencies, non-profit organizations, and industry leaders have an unprecedented opportunity to help conserve and connect people to these rivers. CPCRI capitalizes on the expertise of biologists, hydrogeologists, water quality specialists, stream restoration practitioners, education and outreach professionals, coal mining reclamation professionals and coal mining process professionals.

CPCRI is a forum to develop a common understanding of aquatic species and water quality trends in the Clinch-Powell system. The CPCRI incorporates input from multiple working groups, including:

- Science Team: Conducts studies to address critical knowledge gaps about water quality, pollutants, and the health of river species. CPCRI conducts the scientific research needed to identify critical pollutants and other factors which affect the health of rare mussels and other aquatic species. This research supports science-based conservation efforts and decision making in the Clinch-Powell watershed.
- Healthy Watersheds Team: CPCRI is collaborating with the U.S. EPA Office of Water to utilize existing partner data sets to identify the healthiest sections of the Clinch-Powell River System. Once identified, these areas will become priorities for increased protection through both regulatory and non-regulatory tools.

- Conservation and Restoration Team: Collaborates to implement strategic land and water protection and restoration. CPCRI partners work in partnership to protect significant natural areas, restore streams, assist willing landowners with best agricultural practices, reclaim abandoned mined lands, and conserve key cave and karst features that provide water quality benefits to the Clinch-Powell River system.

For additional information on the CPCRI, see: http://cpcri.net/.

10.3 Evaluation of TMDL Effectiveness

The effectiveness of the TMDL implementation will be assessed within the context of the State's rotating watershed management approach. Watershed monitoring and assessment activities will provide information by which the effectiveness of sediment loading reduction measures can be evaluated. Additional monitoring data, including BMP effectiveness, ground-truthing, and source identification actions are recommended to enable implementation of particular types of BMPs to be directed to specific areas in impaired subwatersheds. This will optimize utilization of resources to achieve maximum reductions to excessive siltation. This TMDL will be re-evaluated during subsequent watershed cycles and revised as required to assure compliance with applicable water quality standards.

Evaluation of the effectiveness of TMDL implementation strategies should be conducted on multiple levels, as appropriate:

Waterbody drainage area (i.e., TMDL analysis location)

Subwatersheds or intermediate sampling locations

Specific landuse areas (urban, pasture, etc.)

Specific facilities (Mining, TMSP, RMCF, uniquely identified portion of MS4, etc.)

Individual BMPs

In order to conduct an implementation effectiveness analysis on measures to reduce sediment source loading, monitoring results should be evaluated in one of several ways. Sampling results can be compared to water quality standards (e.g., biological integrity goals) for determination of impairment status, results can be compared on a before and after basis (temporal), or results can be evaluated both upstream and downstream of source reduction measures or source input (spatial). Considerations include period of record, data collection frequency, representativeness of data, and sampling locations.

In general, periods of record greater than 5 years (given adequate sampling frequency) can be evaluated for determination of relative change (trend analysis). For watersheds in second or successive TMDL cycles, data collected from multiple cycles can be compared. If implementation efforts have been initiated to reduce loading, evaluation of routine monitoring data may indicate improving or worsening conditions over time and corresponding effectiveness of implementation efforts.

11.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed sediment TMDLs for the Upper Clinch River watershed were placed on Public Notice for a 35-day period and comments solicited. Steps that were taken in this regard include:

1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website. The notice invited public and stakeholder comments and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in the appropriate NPDES permit Public Notice mailing, which was sent to over 190 interested persons or groups who have requested this information.

3) Letters were sent to point source facilities in the Upper Clinch River watershed, permitted to discharge total suspended solids (TSS) and located in impaired subwatersheds, advising them of the proposed sediment TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided on request. Letters were sent to the following facilities:

TN0029262	Rogers Group, Inc.
TNR054265	BSH Home Appliance Corporation
TNR054593	Creative Tubes
TNR058911	Jacksboro Metals, LLC
TN0063606	Campbell County Highway Department
TNG110057	C & C Concrete Products, Inc.

4) Letters were sent to local interagency and stakeholder groups in the Upper Clinch River watershed advising them of the proposed sediment TMDLs and their availability on the TDEC website. The letters also stated that a written copy of the draft TMDL document would be provided upon request. Letters were sent to the following interagency and local stakeholder groups (list continued on next page):

Clinch-Powell Clean Rivers Initiative
Clinch Powell Resource Conservation and Development (RC&D) Council
Clinch River Chapter of Trout Unlimited
Cumberland Mountain Resource Conservation and Development (RC&D) Council
Natural Resources Conservation Service
The Nature Conservancy
Tennessee Citizens for Wilderness Planning
Tennessee Department of Agriculture
Tennessee Valley Authority
Tennessee Wildlife Resources Agency
USDA – Forest Service
USGS Water Resource Programs

Virginia Department of Environmental Protection

5) A draft copy of the proposed sediment TMDLs was sent to the following MS4:

TNS077585 Tennessee Department of Transportation (TDOT)

12.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

http://www.tn.gov/environment/article/wr-ws-tennessees-total-maximum-daily-load-tmdl-program

Technical questions regarding these TMDLs should be directed to the following members of the Division of Water Resources staff:

Dennis Borders, P.E., Watershed Management Unit
e-mail: Dennis.Borders@tn.gov

David M. Duhl, Ph.D., Manager, Watershed Management Unit
e-mail: David.Duhl@tn.gov

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APPENDIX A

Stream Survey and Habitat Assessment Field Sheets (Cuckle Creek and Fall Creek)

WPC STREAM SURVEY FIELD SHEET (Front)

STREAM SURVEY INFORMATION

Station ID: CUCKL001.7CA	Assessors: DRM, CRG(intern)	
Stream Name: Cuckle Creek	Date: 6/4/2013	Time: 1430
Station Location: Upstream of Tow String RD	Stream Order:	RM:
County: Claiborne	Drainage Area (sq mi):	Watershed Group #
WBID/HUC: 06010205	Ecoregion: 67F	U/S Eco:
Latitude DEC/DEG: 36.32739	TOPO:	Gaz. Page:
Longitude DEC/DEG: -84.14619	Drainage (Basin)	

PROJECT/PURPOSE (circle): Watershed 303(d) Antideg Reference Other (describe)__________

SAMPLES COLLECTED

Biorecon EFO Log #		Periphyton EFO Log #	
SQKICK EFO Log #	S1306005	Fish EFO Log #	
SQBANK EFO Log #		Other	Log #

CHEM/BACTI (circle): None Routine Nutrients Metals Bacti Other__________

FIELD MEASUREMENTS **Meters Used: Manta 2**

pH (su)	8.2		Dissolved Oxygen (ppm)	8.7	
Conductivity (umhos)	445				
Temperature (°C)	20.6				

Meter problems/comments: __________

Previous 48 hrs precipitation: Unknown None Slight (Moderate — circled) Heavy Flooding

Ambient Weather: (Sunny — circled) Cloudy Breezy Rain Snow Air temp (°F):______

WATERSHED CHARACTERISTICS **Approx. % of Watershed Observed:**

Upstream surrounding land use (estimated %):

Pasture	20	Residential	20	Industry				
Crops		Commercial	20	Mining	20			
Forest		Urban	20	Impoundment				

PHYSICAL STREAM CHARACTERISTICS **Approx Length of Stream Assessed (m):**

Surrounding land use (estimated %):

	RDB	LDB		RDB	LDB		RDB	LDB	OTHERS	RDB	LDB
Pasture	80	5	Residential	10	5	Industry					
Crops			Commercial			Mining					
Forest	5	10	Urban	5	80	Wetland					

Observed Human Disturbance to Stream: S (slight) M (moderate) H (high) Blank = not observed

ATV/OHV		Construction		Livestock	H	Residential	S
Industrial		Impoundment		STP/WWTP		Riparian Loss	M
Logging		Row Crop		Mining		Water withdrawal	
Urban:	M	Road/Hwy	M	Dredging			
Other (describe):							

% Canopy Cover: Estimated reach average: Open (0-10) Partly Shaded (11-45) (Mostly Shaded (46-80) — circled) Shaded (> 80)

Measured mid reach: ____ U/S ____ D/S ____ LB ____ RB ____ Total/384*100

Sediment Deposits: None Slight (Moderate — circled) High Excessive Blanket

Sediment Type: Sludge Mud (Sand — circled) (Silt — circled) None Other__________

Turbidity: Clear (Slight — circled) Moderate High Opaque **Color**__________

Surface Sheen/foam: Bacteria Nutrient Surfactant Other__________

Algae Present? None Slight (Moderate — circled) High Choking **Type**: Diatom Green Filamentous Blue-green

Comments:

Figure A-1. Cuckle Creek Stream Survey, page 1 – June 4, 2013.

WPC STREAM SURVEY FIELD SHEET (Back) [redacted]

Station ID		**Date**		**Assessors**	
	Riffle	**Run**	**Pool**	Staff Gauge/Bench Ht	
Depth (m)	6"-12"		24"	Flow (cfs)	
Width (m)	20'			High Water Mark (m)	
Reach Length (m)				Bank Height (m)	

Flow Conditions: Dry Isolated Pools Low (Moderate) High Bankfull Flooding Other ________

Gradient (sample reach): Flat Low (Moderate) High Cascade Other ________

Size (stream width): V. small (< 1.5m) Small (1-5.3 m) (Med. (3-10 m)) Large (10-25 m) V. Lrge (> 25m)

Substrate Percent (visual estimates):

	Riffle	**Run**	**Pool**		**Riffle**	**Run**	**Pool**
Boulder (> 10")	20			Clay (Slick)			
Cobble (2.5-10")	10			Silt			
Gravel (0.1-2.5")	10			Detritus (CPOM)			
Bedrock	50			Muck-Mud (FPOM)			
Sand (Gritty)	10			Marl (Shell frags.)			

Field Based Assessment	**Info from other field sheets (optional)**
Biorecon Score if Applicable ________ **Indicate level:** Family Genus	**BR TR**____ **EPT** ____ **INTOL**____
If SQSH not collected does benthic community appear impaired? Yes No	**Habitat Score HG**______ **LG**______

Describe basis for determination including possible sources of impairment: ________

Additional Stream Information ________

Photos? (Yes) No **ID and Description** ________

Stream Sketch: (include flow direction, reach distance, distance from bridge, nearest road, sampling points, tribs, outfalls, livestock access, riparian area, potential impacts, etc. Use additional sheet if needed).

Figure A-2. Cuckle Creek Stream Survey, page 2 – June 4, 2013.

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)
(See Protocol E for detailed descriptions and rank information)

STATION ID: CUCKL001.7CA		HABITAT ASSESSED BY: DRM	
STREAM NAME: Cuckle Creek		DATE: 6/4/13	TIME: 1430
STATION LOCATION: Upstream of Tow String RD		ECOREGION:	QC: Consensus Duplicate
WBID/HUC: 06010205	GROUP:	ASSOCIATED LOG #:	

	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.	Natural stable habitat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal.)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present. (If near 40% and more than 2 go to suboptimal.)	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle not layered cobble.	Gravel, cobble and boulders 25-50% surrounded by fine sediment. Niches in bottom layers of cobble compromised. If near 50% & riffles not layered cobble drop to marginal.	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment. Niche space in middle layers of cobble is starting to fill with fine sediment.	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime. Others regimes too small or infrequent to support aquatic populations.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.	Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
5. Channel Flow Status. .	Water reaches base of both lower banks and streambed is covered by water throughout reach. Minimal productive habitat is exposed.	Water covers > 75% of streambed or 25% of productive habitat is exposed.	Water covers 25-75% of streambed and/or productive habitat is mostly exposed.	Very little water in channel and mostly present as standing pools. Little or no productive habitat due to lack of water.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

Figure A-3. Cuckle Creek Habitat Assessment Field Data Sheet, front – June 4, 2013.

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

Station ID_____ CUCKL001.7CA _____ Date_____ Initials_DRM_____

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal or 4-wheel activity (past or present) absent or minimal; natural meander pattern. NO artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. If larger reach, channelization is historic and stable. Artificial structures in or out of reach do not affect natural flow patterns.	Channelization, dredging or 4-wheel activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Artificial structures have greatly affected flow pattern.
SCORE 15	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7:1.	Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15.	Occasional re-oxygenation area. The distance between areas divided by average stream width is over 15 and up to 25.	Generally all flat water or flat bedrock; little opportunity for re-oxygenation. Distance between areas divided by average stream width >25.
SCORE 19	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods. If approaching 60% score poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE_5_ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE_8_ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally. All plants are native.	70-90% of the bank covered by undisturbed vegetation. One class may not be well represented. Disruption evident but not effecting full plant growth. Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation. Two classes of vegetation may not be well represented. Non-native vegetation may be common (30-50%).	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped. Non-native vegetation may dominate (> 50%)
SCORE_5_ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE_5_ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank.	Average width of riparian zone > 18 meters. Unpaved footpaths may score 9 if run-off potential is negligible.	Average width of riparian zone 12-18 meters. Score high if areas < 18 meters are small or are minimally disturbed.	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed.	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.
SCORE_8_ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE_8_ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score __141__ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW

If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance

Figure A-4. Cuckle Creek Habitat Assessment Field Data Sheet, back – June 4, 2013.

STREAM SURVEY WORKSHEET

STREAM SURVEY INFORMATION Fill out all header information for new stations and shaded fields for existing stations.

STATION ID:	FALL001.5UN	**ASSESSORS:**	PDS/TJM
STREAM NAME:	Fall Creek	**DATE:**	8/4/10
STATION LOCATION:	Junction Hwy 170 & old Hwy 33 @ Luks Killet	**TIME:**	0800
COUNTY:	87 (Union)	**STREAM ORDER:**	3rd
WBID#/HUC:	TN 06010205	**DRAINAGE AREA**	
WATERSHED GROUP #	4	**ECOLOGICAL SUBREGION:**	67F **U/S ECO**
LATITUDE DEC/DEG	N 36.28727	**GAZETTEER PAGE**	60
LONGITUDE DEC/DEG	W 83.80013	**USGS QUAD**	145SE

PROJECT/PURPOSE: Watershed **303(d)** **Antideg** **Reference** **Other** EMPWSA 10

SAMPLES COLLECTED

Biorecon EFO Log #: ______ Periphyton EFO Log # ______
* SQKICK EFO Log # B1008006 Fish EFO Log # ______
SQBANK EFO Log # ______ Other ______ EFO Log # ______
CHEMICALS/BACTI (Circle) (Routine) (Nutrients) (Metals) ~~Bacti~~ Other TOC

FIELD MEASUREMENTS

METERS USED: Minisonde

pH	8.02/8.00 SU	DISSOLVED OXYGEN	8.70/8.60 PPM
CONDUCTIVITY	431.6/433.2 UMHOS	TIME	
TEMPERATURE	20.20/20.08 °C	OTHERS	

Meter Problems/Comments ______

Previous 48 hours Precip: UNKNOWN (NONE) LITTLE MODERATE HEAVY FLOODING
Ambient Weather: (SUNNY) CLOUDY BREEZY RAIN SNOW AIR TEMP: ~84° F

WATERSHED CHARACTERISTICS **App. % of watershed observed:**

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	30	URBAN		RESID	30
CROPS		INDUSTRY		OTHER	20 ungrazed fields
FOREST	20	MINING			

Point Source Discharge Upstream ______ Distance ______

Potential Impacts: rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES				SOURCES			
		Flow Alter.				Unknown	
Pesticides		Habitat Alt.		Industrial		Municipal	
Metals		Thermal Alt.		Logging		Mining	
Ammonia		Pathogens		Construction;Land Devel		Road /bridge	
Chlorine		Oil & grease		U/S Dam		Urban Runoff	
Nutrients		Unknown		Riparian loss		Bank destabilization	
pH		Siltation	X	Row Crop		Intensive Feedlot	
Organic Enrichment / Low D.O.				Livestock grazing		Dredging	
Other:				Other:			

PHYSICAL STREAM CHARACTERISTICS **LENGTH OF STREAM AREA ASSESSED (m):**

SURROUNDING LAND USE :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE			URBAN			RESID.	50	20
CROPS			INDUSTRY			OTHER		80 Roadside
FOREST	50		MINING					

% CANOPY COVER: Estimated: ______ Open(0-10) Partly Shaded(11-45) Mostly Shaded(46-80) Shaded(>80)
Measured: 53.6% U/S 46/45 D/S 78/74 LB 66/21 RB 60/82
BANK HEIGHT (m): 2 ft **HIGH WATER MARK** (m): none apparent

SEDIMENT DEPOSITS: NONE SLIGHT (MODERATE) EXCESSIVE BLANKET
TYPE: SLUDGE MUD (SAND) (SILT) NONE OTHER ______
TURBIDITY (CLEAR) SLIGHT MODERATE HIGH OPAQUE

ALGAE PRESENT? NONE SLIGHT (MODERATE) CHOKING TYPE diatoms – where no canopy
AQUATIC VEGET. ROOTED FLOATING TYPE ______
ADDITIONAL COMMENTS:(oil sheen, odor, colors) ______

Figure A-5. Fall Creek Stream Survey, page 1 – August 4, 2010.

STREAM SURVEY WORKSHEET

Station ID | **Date** | **Assessors**

	RIFFLE	RUN	POOL
DEPTH ~~(m)~~	3"	10"	10"
WIDTH ~~(m)~~	5'	14'	4'
REACH LENGTH ~~(m)~~	7'	35yd	8'

Staff Gauge/Bench Ht:
FLOW (CFS) 1.41
Habitat Score 123 (HG) or LG

Flow Conditions: Dry Isolated Pools Low (Moderate) High Bankfull Flooding Other
Gradient (sample reach): Flat Low (Moderate) High Cascade Other
Size (stream width) : V. Small (<1.5m) Small (1.5-3m) (Med (3-10m)) Large (10-25m) Very Lrg (>25m)
SUBSTRATE (%) **(Visual estimates)**

	RIFFLE	RUN	POOL		RIFFLE	RUN	POOL
BOULDER (> 10")	20 %	5 %	%	CLAY (slick)	%	%	%
COBBLE (2.5-10")	35 %	5 %	%	SILT	~~10~~ %	%	10 %
GRAVEL (0.1-2.5")	15 %	20 %	20 %	DETRITUS (CPOM)	%	%	%
BEDROCK	20 %	%	%	MUCK-MUD (FPOM)	%	%	%
SAND (gritty) coarse	10 %	70 %	70 %	MARL (shell frags.)	%	%	%

Overall Assessment

Biorecon Score if Applicable

If Ambiguous was SQSH collected to confirm? If no, does benthic community appear impaired?

Describe basis for determination include impacts and possible sources:

Additional Stream Information

Photos ? (Y) or N ID and Description #11 D/S, #12 U/S

STREAM SKETCH (include flow direction, reach distance, distance from bridge, sampling points, tribs, outfalls, livestock access, riparian area potential impacts etc.)

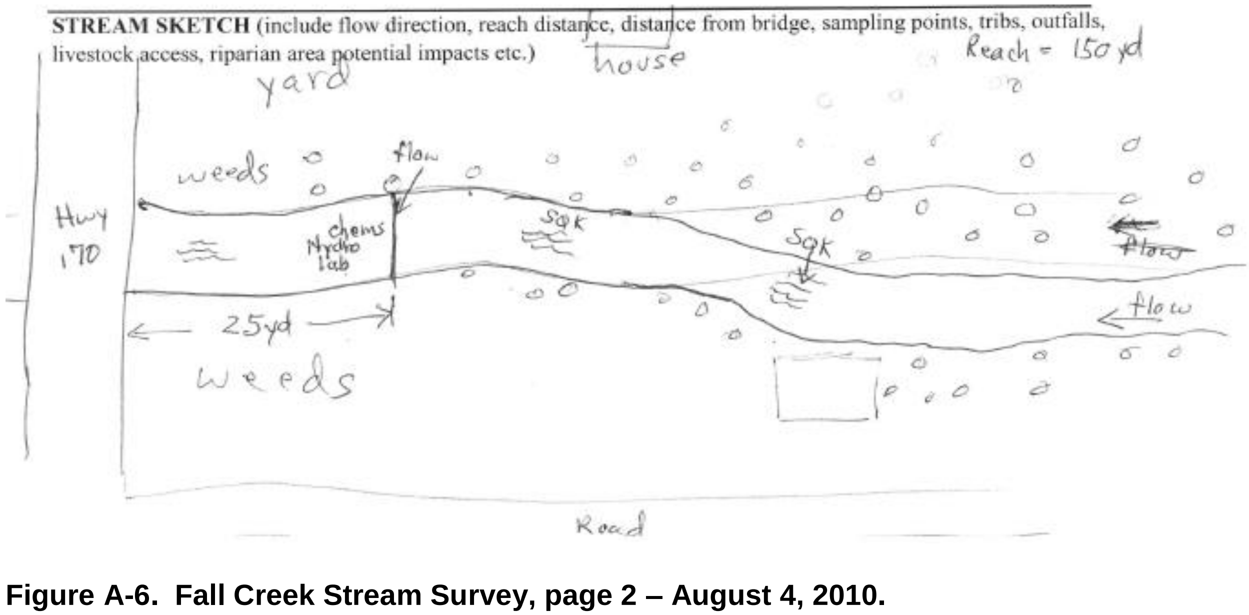

Figure A-6. Fall Creek Stream Survey, page 2 – August 4, 2010.

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Fall Creek	LOCATION Junction Hwy 170 & old Hwy 33 @ Lickskillet
STATION # FALL001.5UN	ECOREGION 67F
LAT N36.28727 LONG W83.80013	WATERSHED GROUP 4
WBID/HUC TN06010205	INVESTIGATORS PDS/TJM
FORM COMPLETED BY PDS	DATE 8/4/10 TIME 0910

	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates. Four or more productive habitats are present.	Natural stable habitrat covers 40-70% of stream reach. Three or more productive habitats present. (If near 70% and more than 3 go to optimal)	Natural stable habitat covers 20 -40% of stream reach. Two or more productive habitats present. (If near 40% and more than 2 go to suboptimal)	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 14	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
2. Embeddedness of Riffles	Gravel, cobble, and boulder s are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. If near 25% drop to suboptimal if riffle is not layerd cobble.	Gravel, cobble and boulders are 25-50% surrounded by fine sediment. Niches in slower areas of riffle and in bottom layers of cobble have become compromised. If nearing 50% and riffles are not layered cobble drop to marginal.	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment. Nich space in middle layers of cobble is starting to fill with fine sediment.	Gravel, cobble, and boulder s are more than 75% surrounded by fine sediment. Niche space is reduced to a single layer or is absent.
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1
Comments	Found cobble and boulders to have less than 50% of fine sediment around			
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower). If slow-deep missing score 15.	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime. Others reimes too small or infrequent to support aquatic populations.
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1
Comments	No deep.			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas. New deposition on islands and point bars is absent or minimal.	Sediment deposition affects 5-30% of stream bottom. Slight deposition in pool or slow areas. Some new deposition on islands and point bars. Move to marginal if build-up approaches 30%.	Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 (7) 6	5 4 3 2 1
Comments				
5. Channel Flow Status. Do not evaluate in area of reach that is backed up by obstructions.	Water reaches base of both lower banks, and minimal amount of productive habitat is exposed.	Water fills> 75% of the available channel; or 25 % of productive habitat is exposed.	Waters fills 25-75 % of the available channel, and/or stable habitat is mostly exposed.	Very little water in channel and mostly present as standing pools.. Little or no productive habitat due to lack of water.
Comments				
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Figure A-7. Fall Creek Habitat Assessment Field Data Sheet, front – August 4, 2010.

HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Station ID FALL001.5LW   Date 8/4/10

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization , dredging or 4-wheel activity absent or minimal; stream with natural meander pattern. NO bridges, culverts, shoring or artificial structures in reach. Upstream or downstream structures do no affect reach	Channelization, dredging or 4-wheel activity up to 40%. Channel has stabilized. NO bridges, culverts, shoring or artificial structures in reach. Upstream or downstream structures do not affect reach.	Channelization, dredging or 4-wheel activity 40-80% or any amount of channelization that has not stabilized. Bridges, culverts, shoring or other artificial structures may be within reach. Upstream or downstream structures may have affected flow pattern.	Over 80% of the stream reach channelized, dredged or affected by 4-wheelers. Instream habitat greatly altered or removed. Shoring structures may be common. Artificial structures upstream or downstream of reach may have greatly affected flow patterns in reach.
Comments	Bridge just D/S site. Old tire depression tracks to stream. No evidence rock removal			
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of riffles, bends or other re-oxygenation zones. Use frequency for category. Rank by quality.	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by width of the stream <7:1.	Occurrence of re-oxygenation zones infrequent; distance between areas divided by the width of the stream is between 7 to 15.	Occasional re-oxygenation area. The distance between areasdivided by the width of the stream is over 15 and up to 25.	Generally all flat water or flat bedrock little opportunity for re-oxugenation. Distance between areas divided by the width of the stream is a ratio of >25.
Comments				
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank) Determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods. If approaching 60% score poor if banks steep.	Unstable; many eroded area; raw areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars
Commments				
SCORE 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank. Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed native vegetation. All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally.	70-90% of the bank covered by native vegetation. If higher, than one class not well represented. Disruption evident but not effecting full plant growth.	50-70% of the bank covered by native vegetation. If more than two classes of vegetation missing. Non-native vegetation or closely cropped vegetation may be common.	Less than 50% of the bank covered by native vegetation or more than 2 classesare not well represented or most vegetation has been cropped..
Comments				
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 7 (RB)	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank. Zone begins at top of bank.	Width of riparian zone > 18 meters throughout reach. Unpaved footpaths may score 9 if run-off potential is neglible.	Width of riparian zone 12-18 meters throughout reach. Score high if areas < 18 meters are small or are minimally disturbed.	Width of riparian zone 6-11 meters throughout reach. Score high if areas less than 12 meters are small or are minimally disturbed.	Width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed.
Comments				
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 7 (RB)	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0

TOTAL SCORE (123)   **Comparison to Ecoregional Guidelines** below

If Score low, result of: ______ **Natural Conditions or** X **Human Disturbance**

Figure A-8. Fall Creek Habitat Assessment Field Data Sheet, back – August 4, 2010.

APPENDIX B

Water Quality Monitoring Data

Table B-1. Biological Index Scores for Upper Clinch River Impaired Waterbodies.

Station ID	Date	Total Individuals	Total Taxa	EPT Taxa	% EPT	% OC	NCBI	% Clingers	% Nutrient Tolerant	TMI Score	Target TMI Score
CUCKL001.7CA	12-30-2003	202	20	3	2.5	77.7	5.62	11.4	54.5	**10**	32
CUCKL001.7CA	06-04-2013	205	34	2	16.1	53.7	5.27	27.8	22.9	**22**	32
FALL001.5UN	10-27-2004	209	27	14	29.7	7.7	3.32	51.7	43.1	32	32
FALL001.5UN	08-04-2010	168	25	14	30.4	3	3.82	35.7	60.1	**30**	32

Table B-2. Habitat Scores for Upper Clinch River Impaired Waterbodies.

Station ID	Date	Epifaunal Substrate*	Embeddedness of Riffles	Velocity/Depth Regime	Sediment Deposition	Channel Flow Status	Channel Alteration	Frequency of Riffles	Bank Stability (L)	Bank Stability (R)	Vegetative Protection (L)	Vegetative Protection (R)	Riparian Veg. Width (L)	Riparian Veg. Width (R)	Total Habitat Score	Target Habitat Score
CUCKL001.7CA	12-30-2003	15	18	13	15	16	15	18	6	9	6	6	8	8	153	140
CUCKL001.7CA	06-04-2013	13	10	16	13	16	15	19	5	8	5	5	8	8	141	140
FALL001.2UN	10-16-2002	10	11	6	15	11	16	19	9	9	9	8	9	2	**134**	140
FALL001.5UN	10-27-2004	11	9	11	6	17	15	7	8	9	2	7	2	8	**112**	140
FALL001.5UN	08-04-2010	14	11	10	7	19	17	10	9	8	2	7	2	7	**123**	140

* Available Cover

APPENDIX C

Watershed Sediment Loading Model

WATERSHED SEDIMENT LOADING MODEL

Determination of target average annual sediment loading values for reference watersheds and the sediment loading analysis of waterbodies impaired for siltation was accomplished utilizing the GWLF-E plug-in included with BASINS 4.1 (Evans, 2011). The core watershed simulation model used in the GWLF-E plug-in is based on the Generalized Watershed Loading Function (GWLF) model developed by Haith and Shoemaker (1987). GWLF-E is a GIS-based watershed modeling tool that essentially duplicates the functionality of AVGWLF, an ArcView GIS-based model. Though AVGWLF was initially developed for use in Pennsylvania, new functionality has been added to the GWLF-E Plug-in to allow for the use of data sets in areas outside of Pennsylvania as well. The GWLF model has been endorsed by the U.S. EPA as a good "mid-level" model that contains algorithms for simulating most of the key mechanisms controlling sediment fluxes within a watershed (Evans, 2011).

C.1 Sediment Analysis

A reference watershed approach was used in this study to develop siltation TMDLs for sediment for Cuckle and Fall Creeks. As noted in Section 5, average annual sediment loading in lb/ac/yr, from a biologically healthy watershed, located in the same level IV ecoregion as the impaired subwatershed, is determined to be the appropriate numeric interpretation of the narrative water quality standard for protection of fish and aquatic life for the impaired waterbodies. The GWLF model was used to simulate sediment loads from potential sources in these watersheds and in the reference watersheds. Numeric endpoints were based on unit-area loading rates calculated for the reference subwatersheds. The TMDLs were then developed for the impaired subwatersheds based on the existing sediment loading conditions.

The GWLF model provides the ability to simulate runoff and sediment loads from a watershed given variable-size source areas (e.g., agricultural, forested, and urban land) (Evans, 2011). It is a continuous simulation model that uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment loads based on the daily water balance accumulated to monthly values.

GWLF simulates surface runoff using the Soil Conservation Service Curve Number (SCS-CN) approach with daily weather (temperature and precipitation) inputs (Evans, 2011). Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation (USLE) algorithm (with monthly rainfall-runoff coefficients) and monthly KLSCP (land cover/soil type combination) values for each source. A sediment delivery ratio based on watershed size and a transport capacity based on average daily runoff is then applied to the calculated erosion to determine sediment yield for each source area.

Since its initial incorporation into AVGWLF, the GWLF model has been revised to include a number of routines and functions not found in the original model. A significant change is an improvement in the simulation of hydrology and sediment loading from urban areas (Evans, 2011). In earlier versions of GWLF, such simulations could only be conducted for two basic types of urban land uses (low intensity and high intensity development). However, in developed watersheds with multiple urban land use classes, it is generally more appropriate to use more complex routines to represent the wider range of urban landscape conditions. Consequently, additional modeling routines are included with the BASINS GWLF-E plug-in to address these more complex urban conditions. These new routines are based on the RUNQUAL model developed by Haith (1993).

Another significant revision is the inclusion of a streambank erosion routine (Evans, 2011). The routine is based on an approach often used in the field of geomorphology in which monthly streambank erosion is estimated by calculating an average watershed-specific lateral erosion rate (LER). The total streambank erosion is calculated by multiplying the LER by the total stream length, the average streambank height, and an average soil bulk density.

C.2 Universal Soil Loss Equation

Erosion potential is based on the Universal Soil Loss Equation (USLE), developed by Agriculture Research Station (ARS) scientists W. Wischmeier and D. Smith. It has been the most widely accepted and utilized soil loss equation for over 35 years. The USLE is a method to predict the average annual soil loss on a field slope based on rainfall pattern, soil type, topography, crop system and management practices. The USLE only predicts the amount of soil loss resulting from sheet or rill erosion on a single slope and does not account for soil losses that might occur from gully, wind, or tillage erosion. Designed as a model for use with certain cropping and management systems, it is also applicable to non-agricultural situations (OMAFRA, 2000). While the USLE can be used to estimate long-term average annual soil loss, it cannot be applied to a specific year or a specific storm. Based on its long history of use and wide acceptance by the forestry and agricultural communities, the USLE was considered to be an adequate tool for estimating the relative long-term average annual soil erosion of watersheds and evaluating the effects of land use changes and implementation of BMP measures.

Soil loss from sheet and rill erosion is primarily due to detachment of soil particles during rain events. It is the cause of the majority of soil loss for lands associated with crop production, grazing areas, construction sites, mine sites, logging areas, and unpaved roads. In the USLE, five major factors are used to calculate the soil loss for a given area. Each factor is the numerical estimate of a specific condition that affects the severity of soil erosion in that area. The USLE for estimating average annual soil erosion is expressed as:

$$A = R \times K \times LS \times C \times P$$

where:

A = average annual soil loss in tons per acre
R = rainfall erosivity index
K = soil erodibility factor
LS = topographic factor - L is for slope length and S is for slope
C = crop/vegetation & management factor
P = conservation practice factor

Evaluating the factors in USLE:

<u>R - Rainfall Erosivity Index</u>

The rainfall erosivity index describes the kinetic energy generated by the frequency and intensity of the rainfall. It is statistically calculated from the annual summation of rainfall energy in every storm, which correlates to the raindrop size, times its maximum 30-minute intensity. This index varies with geography.

K - Soil Erodibility Factor

This factor quantifies the cohesive or bonding character of the soil and its ability to resist detachment and transport during a rainfall event. The soil erodibility factor is a function of soil type.

LS - Topographic Factor

The topographic factor represents the effect of slope length and slope steepness on erosion. Steeper slopes produce higher overland flow velocities. Longer slopes accumulate runoff from larger areas and also result in higher flow velocities. For convenience L and S are frequently lumped into a single term.

C – Crop/Vegetation & Management Factor

The crop/vegetation and management factor represents the effect that ground cover conditions, soil conditions and general management practices have on soil erosion. It is the most computationally complicated of USLE factors and incorporates the effects of: tillage management, crop type, cropping history (rotation), and crop yield.

P - Conservation Practice Factor

The conservation practice factor represents the effects on erosion of Best Management Practices (BMPs) such as contour farming, strip cropping and terracing.

Estimates of the USLE parameters, and thus the soil erosion as computed from the USLE, are provided by the Natural Resources Conservation Service's (NRCS) National Resources Inventory (NRI) 2010 (USDA, 2013). The NRI database contains information on the status, condition, and trends of soil, water, and related resources collected from approximately 800,000 sampling points across the country.

The soil losses from the erosion processes described above are localized losses and not the total amount of sediment that reaches the stream. The fraction of the soil lost in the field that is eventually delivered to the stream depends on several factors. These include the distance of the source area from the stream, the size of the drainage area, and the intensity and frequency of rainfall. Soil losses along the riparian areas will be delivered into the stream with runoff-producing rainfall.

C.3 RUNQUAL

RUNQUAL is a continuous simulation model which may be used to estimate runoff volumes and quality from development sites (Haith, 1993). The model provides daily simulation of surface runoff and sediment loads from the pervious and impervious surfaces of the various land uses in urban watersheds. The pervious and impervious portions of each land use are modeled separately and runoff and sediment loads from the various surfaces are aggregated to provide daily totals. It is assumed that the site is small enough so that surface travel times are smaller than the model's one-day time step.

Runoff Volumes:

Runoff volumes are calculated from procedures given in the U.S. Soil Conservation Service's Technical Release 55 (SCS, 1986):

$$Q_t = \frac{(R_t + M_t - 0.2\ W_t)^2}{R_t + M_t + 0.8\ W_t} \quad (1)$$

For $Q_t > R_t + M_t - 0.2\ W_t$. In this equation, Q_t = runoff on day t (cm), R_t = rain on day t (cm), M_t = snowmelt water on day t (cm) and W_t = detention parameter for day t (cm), given by:

$$W_t = \frac{2540}{CN_t} - 25.4 \quad (2)$$

where CN_t = curve number for day t.

Water Pollutants in Runoff

The water quality model is based on general accumulation and washoff relationships proposed by Amy et al. (1974) and Sartor and Boyd (1972).

Accumulation:

Pollution loads in runoff are based on daily accumulations of contaminants on urban surfaces. If L(t) is the accumulated load on day t (kg/ha), then the rate of accumulation during dry periods is:

$$\frac{dL}{dt} = m - \beta L \quad (3)$$

where m is a constant mass accumulation rate (kg/ha-day) and β is a depletion rate constant (1/day). Solving the previous equation:

$$L(t) = L_0\ e^{-\beta t} + (m/\beta)\ (1 - e^{-\beta t}) \quad (4)$$

In which L_0 = L(t) at time t = 0. Equation 3 approaches an asymptotic value L_{max}:

$$L_{max} = \lim_{t \to \infty} L(t) = m/\beta \quad (5)$$

Data given in Sartor and Boyd (1972) and shown in Figure C-1 indicate that L(t) approaches its maximum value in approximately 12 days. Conservatively assuming that L(t) reaches 90% of L_{max} in 20 days, then for $L_0 = 0$:

$$0.9\ (m/\beta) = (m/\beta)\ (1 - e^{-20\beta})$$

$$e^{-20\beta} = 0.1;\ \beta = -0.05\ \mathrm{Ln}\ (0.1) = 0.12$$

Equation 4 can also be written for a time interval $\Delta t = t_2 - t_1$ as

$$L(t_2) = L(t_1)\ e^{-0.12\Delta t} + (m/0.12)\ (1 - e^{-0.12\Delta t}) \quad (6)$$

or, for a time interval of one day:

$$L_{t+1} = L_t e^{-0.12} + (m/0.12)(1 - e^{-0.12}) \quad (7)$$

where L_t is the accumulation at the beginning of day t (kg).

<u>Washoff</u>:

Equation 7 can be modified to include the effects of washoff by runoff:

$$L_{t+1} = L_t e^{-0.12} + (m/0.12)(1 - e^{-0.12}) - X_t \quad (8)$$

in which X_t = runoff contaminant load on day t (kg/ha), given by:

$$X_t = w_t [L_t e^{-0.12} + (m/0.12)(1 - e^{-0.12})] \quad (9)$$

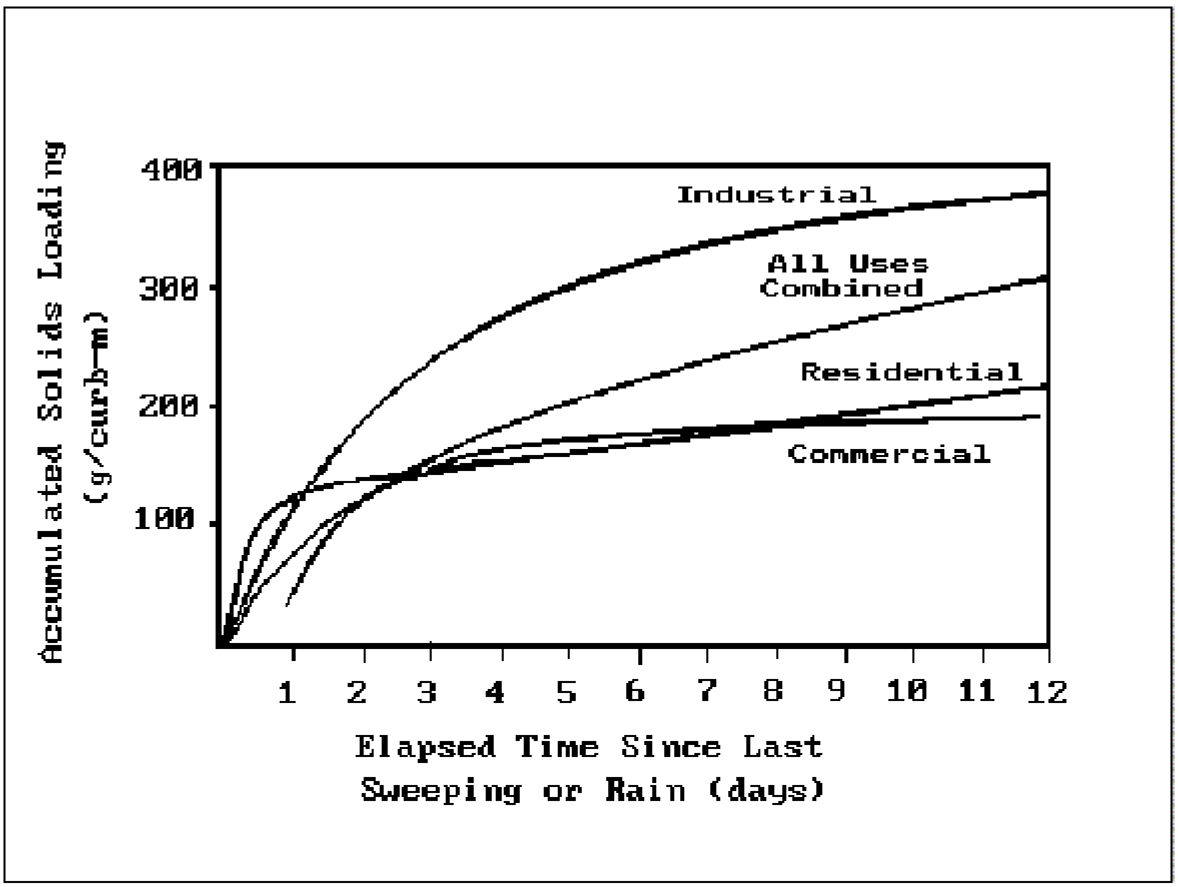

Figure C-1. Accumulation of Pollutants on Urban Surfaces (Sartor & Boyd, 1972)

where w_t is the first-order washoff function suggested by Amy et al. (1974):

$$w_t = 1 - e^{-1.81Q_t} \quad (10)$$

Equation 10 is based on the assumption that 0.5 in. (1.27 cm) of runoff will wash off 90% of the accumulated pollutants.

C.4 Lateral Erosion Rate

A streambank erosion routine is also included in the GWLF-E plug-in (Evans, 2011). This routine is based on an approach described by numerous researchers in the field of geomorphology in which monthly streambank erosion is estimated by first calculating a watershed-specific lateral erosion rate using some form of the equation:

$$LER = a * q^{0.6}$$

where: LER = an estimated lateral erosion rate in meters/month
a = an empirically-derived constant related to the mass of soil eroded from streambanks depending upon various watershed conditions, and
q = monthly stream flow in cubic meters per second

In a study described by Evans *et al*. (2002), the value for the "a" constant was found to be statistically related to five key watershed parameters, including animal density, curve number, soil erodibility (k factor), mean watershed slope, and percent of developed land in the watershed.

Within the GWLF-E plug-in, this constant is derived using the equation:

$$a = (0.00467 * PD) + (0.000863 * AD) + (0.000001 * CN) + (0.000425 * KF) + (0.000001 * MS) - 0.000036$$

where: PD = Percent developed land in the watershed
AD = Animal density of the watershed in animal equivalent units (AEUs)
CN = Average curve number value of the watershed
KF = Average soil "k" factor value for the watershed
MS = Mean topographic slope (%) for the watershed

After a value for LER has been computed, the total sediment load for the watershed generated via streambank erosion is then calculated by multiplying the LER value by the total length of streams in the watershed (in meters), the average streambank height (in meters), and the average soil bulk density (in kg/m^3). Within the GWLF-E plug-in, default values of 1.5 and 1500 are used for average streambank height (H) and soil bulk density (ρ_s), respectively. The total stream length is computed automatically using the digital stream layer supplied by the user. Total sediment load generated by streambank erosion for the subwatershed is represented by the equation:

$$Load_{SBE} = LER * L * \rho_s * H$$

where: $Load_{SBE}$ = Total sediment load generated by streambank erosion
L = Stream length
ρ_s = Soil bulk density
H = Streambank height

C.5 Hydrologic Modeling Methodology

Although the GWLF model was originally developed for predicting sediment loading to ungaged streams, hydrologic calibration was performed in order to minimize uncertainty in sediment simulations due to potential gross errors in hydrologic simulation. In addition, in order to improve the calibration process, a two-step hydrologic modeling approach was utilized, employing the HSPF model for calibration of observed flows at a USGS gage.

The GWLF model provides a simplified hydrologic modeling process capable of simulating monthly average flows (daily water balance accumulated to monthly values) and HSPF provides more complex hydrologic modeling processes capable of simulating hourly or daily timesteps. Therefore, an HSPF model was developed and calibrated to observed flow at a USGS gage that was chosen as the most representative of conditions at the selected TMDL locations. HSPF parameters from the calibrated model were applied to HSPF models developed at the selected sites (impaired and reference waterbodies) in order for subsequent simulations to serve as "observed" streamflows for the GWLF models developed for these sites. The GWLF models were then calibrated to the appropriate HSPF model output to provide a basis for the sediment loading models. See Appendix I for details of HSPF hydrologic calibration and Appendix J for details of GWLF hydrologic calibration.

C.6 Sediment Modeling Methodology

Using the BASINS 4.1 MapWindow GIS-application and the GWLF-E plug-in, average annual sediment loading to surface waters was modeled according to the following procedures:

1. A GWLF-E project was set up for each impaired subwatershed (the subjects of these TMDLs) as well as each reference subwatershed. Additional data layers required for sediment analysis were generated or imported into each project. These included:

   DEM (grid) - The Digital Elevation Model (DEM) layers that came with the original BASINS distribution system were shapefiles of coarse resolution (300x300m). A higher resolution DEM grid layer (30x30m) is required. This grid layer is available for download with BASINS 4.1.

   Basin Layer – The basin layer is required to represent the boundary of the watershed in which modeling is to be performed. This feature is delineated in BASINS 4.1 using digital elevation layers, the stream network, and the designated pour point. Two basin attributes, "ID" and "AREA", are specifically required by the GWLF-E plug-in. The "ID" value is used as an identification of each sub-basin if the shape file has more than one polygon. Another required attribute, "AREA" is used for area-based calculations by MapWindow, and the values must be in square meters. This attribute is calculated automatically via the delineation function in BASINS 4.1.

   Soil – The soils layer contains information pertaining to various soils-related properties required for estimation of potential erosion. State Soil and Geographic Database (STATSGO) Soil data with a scale of 1:250k are used. This dataset is available with the BASINS default setup. The specific attributes required for this layer include "AREA", "MU_AWC", "MU_KF", and "MU_HSG_DOM". The Area field is usually automatically created by ESRI software, and the other three attributes are obtained from the USGS STATSGO website: (http://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml).

As described previously, the "AREA" attribute specifies the area of each polygon in the layer in square meters. The "MU_AWC" field is used to represent available water-holding capacity of the soil, and generally varies by soil type. Values specified must be in centimeters, and must reflect the total water-holding capacity of the entire soil profile. Typical values for soils range from about 2-20 cm depending on soil depth and texture. The "MU_KF" field is used for estimates of the soil erodibility value for each soil unit. This is one of the factors used in the Universal Soil Loss Equation to estimate soil erosion due to rainfall in the GWLF-E model. The K-factor values typically range from about 0.1 to 0.5. The "MUHSG_DOM" field is used to specify the dominant soil hydrologic group class for each soil unit. Each soil polygon can only have a text value of "A", "B", "C", or "D", and fields for non-soil areas such as water may be left blank.

NLCD Land Use – The National Land Cover Database (NLCD) data set for the watershed must be imported into the project. The NLCD land use coverages for each subwatershed were available from the Multi-Resolution Land Characteristics Consortium (MRLC) web site: http://www.mrlc.gov/ (Homer et al, 2015) or as a download from BASINS.

Streams – The National Hydrography Dataset (NHD) from the USGS is used as the data layer to represent the stream segments for the subwatersheds of interest. This dataset has a nominal scale of 1:24,000, which provides sufficient accuracy and resolution for the estimation of streambank erosion and slope length factors as used in the USLE equation. Two attributes, "STRMID" and "LENGTH" are required by the GWLF-E plug-in. The "STRMID" is used as an identification of each stream segment. The "LENGTH" attribute is the length of each stream segment with units in meters.

Unpaved Roads – The unpaved road layer was obtained from the 2014 TIGERS/Line® road map from the U.S. Census Bureau (USCB, 2014), and is incorporated into the GWLF-E model to depict the location and length of unpaved roads within the watersheds of interest. Modeling erosion and sediment loads requires a road layer as a shape file. In the GWLF model, unpaved roads are treated as "non-vegetated" surfaces in the sense that surface erosion from these areas is similar to other non-vegetated or poorly-vegetated surfaces such as disturbed areas and cultivated land. Along with other GIS shape and grid files with watershed characteristics, monthly erosion and sediment loads from unpaved roads are determined by the USLE.

Weather – The weather file, in watershed data management (.wdm) format with location, time, daily temperature, and daily precipitation, is required to create the input file for GWLF-E. Four meteorological stations, each with 11 years of continuous daily data between the period October, 1998 and September, 2009, were used for hydrologic calibrations. Daily weather data from the Norris, TN National Climatic Data Center (NCDC) Coop station #406619 were available for the Clear, White, Cuckle, and Fall Creek subwatersheds.

2. Using the watershed delineation function in BASINS 4.1, impaired waterbodies and ecoregion reference sites were delineated into subwatersheds. These delineations are shown in Figures 4 and 5, respectively. Land use distribution for these subwatersheds is summarized in Appendix E. All of the sediment analyses were performed on the basis of these subwatershed drainage areas.

The following steps are accomplished using the GWLF-E model:

3. For the selected subwatershed, GIS layers described above were imported into the GWLF-E model to create a GWLF-E source file in .pms format to create the data layers that will subsequently be used to calculate daily streamflow, erosion, sediment delivery, accumulation, washoff, and streambank erosion.

4. Monthly water balance data generated in GWLF-E were calibrated to a calibrated HSPF watershed model developed as a flow reference. The flow reference site is a USGS gaging station with at least ten years of continuous daily flow data, and located in the same ecoregion, with similar watershed characteristics, as the targeted GWLF subwatershed. See Appendix I for details of HSPF hydrologic calibration and Appendix J for details of GWLF hydrologic calibration.

5. For each grid cell representing rural land uses within the watershed, the GWLF-E model calculated the total erosion based on the USLE method (Section C.2) and the rural land use characteristics of the specific cell. The model then calculates the potential sediment delivery to the stream grid network. Monthly total sediment load was calculated by multiplying the sediment delivery ratio by the monthly total erosion. The sediment delivery ratio (SDR) was calculated using the area-based equation below:

   $SDR = 0.451(b^{-0.298})$ (Evans et al., 2011)

   where: SDR = sediment delivery ratio
   b = size of the watershed (km^2)

   For urban land uses, soil erosion is not calculated. Instead, for each grid cell representing urban land uses, delivery of sediment to waterbodies is based on a first-order accumulation and washoff relationship. Sediment loads were calculated based on the RUNQUAL method (Section C.3) and the urban land use characteristics of the specific cell.

   A list of parameters, including sediment delivery ratios, from the GWLF model input files, representing existing conditions for each impaired subwatershed and their respective reference subwatersheds are presented in Tables C-1 and C-2.

6. The total sediment delivered upstream of each subwatershed “pour point” was calculated. The sediment analysis provided the calculations for the following parameters:

   - Rural Erosion – estimated erosion from each grid cell due to the rural land cover (includes unpaved roads); USLE calculation.
   - Urban Accumulation – estimated solids (sediment) accumulated on each grid cell for the urban land cover; RUNQUAL calculation.

Table C-1. GWLF Watershed Parameters in the Calibrated Cuckle Creek (Impaired) and Clear Creek (Reference) Subwatersheds.

GWLF Watershed Parameter	Units	Cuckle Creek	Clear Creek
Recession Coefficient	Day-1	0.14	0.037
Seepage Coefficient	Day-1	0	0.01
Sediment A Factor	---	1.40×10^{-4}	1.77×10^{-4}
Sediment Delivery Ratio	---	0.178	0.186
Available Water Capacity	(cm)	3.05	10.1
Rainfall Erosivity Coefficient (Apr - Sep)	---	0.28	0.28
Rainfall Erosivity Coefficient (Oct - Mar)	---	0.1	0.1
% Developed land	(%)	27.2	0.22
Area-Weighted Soil Erodibility (K)	---	0.24	0.31
Area-Weighted Curve Number	---	78.6	60.6
Total Stream Length	(m)	22048	9495
Mean Channel Depth	(m)	0.31	0.31

Table C-2. GWLF Watershed Parameters in the Calibrated Fall Creek (Impaired) and White Creek (Reference) Subwatersheds.

GWLF Watershed Parameter	Units	Fall Creek	White Creek
Recession Coefficient	Day^{-1}	0.072	0.14
Seepage Coefficient	Day^{-1}	0	0
Sediment A Factor	---	2.86×10^{-4}	1.75×10^{-4}
Sediment Delivery Ratio	---	0.22	0.187
Available Water Capacity	(cm)	5.70	3.0
Rainfall Erosivity Coefficient (Apr - Sep)	---	0.28	0.28
Rainfall Erosivity Coefficient (Oct - Mar)	---	0.10	0.10
% Developed land	(%)	2.98	0
Area-Weighted Soil Erodibility (K)	---	0.23	0.31
Area-Weighted Curve Number	---	76.1	60.6
Total Stream Length	(m)	24494	15289
Mean Channel Depth	(m)	0.23	0.31

- Rural Sediment – estimated fraction of the rural soil erosion with the incorporation of sediment delivery ratio from each grid cell that reaches the stream (USLE).

- Urban Sediment – estimated fraction of the urban solids (sediment) washed off from each grid cell that reaches the stream (RUNQUAL).

- Streambank Sediment – estimated total sediment eroded from streambanks from the entire stream network in a watershed; Lateral Erosion Rate calculation.

- Composite Sediment – composite of the rural, urban, and streambank sediment parameters.

  The sediment delivered to the "pour point" was calculated based on the composite loading from the three parameters described above (sum of rural sediment, urban sediment, and streambank sediment). Results were compiled into monthly average sediment loads for impaired and reference subwatersheds.

7. For each subwatershed of interest, the resultant monthly sediment load calculations are aggregated and expressed as a long-term average annual soil loss expressed in pounds per year at the pour point of the respective subwatershed.

   Calculated sediment loads delivered to surface waters and unit loads (per unit area) for subwatersheds that contain waters on the Final 2014 303(d) List as impaired for siltation are summarized in Tables C-3 and C-4, respectively. Similarly, calculated target sediment loads delivered to surface waters and unit loads for reference subwatersheds are summarized in Tables C-5 and C-6, respectively.

Table C-3. Calculated Sediment Delivery to Surface Waters - Subwatersheds with Waterbodies Impaired Due to Siltation (Documented on the Final 2014 303(d) List).

Impaired Subwatershed	***SEDIMENT LOAD***						
	Rural* [lb/yr]	**Urban [lb/yr]**	**Streambank [lb/yr]**	**Total [lb/yr]**	**Rural* [%]**	**Urban [%]**	**Streambank [%]**
Cuckle Creek	321,840	96,060	908,341	1,326,241	24.3	7.2	68.5
Fall Creek	423,400	3,160	155,159	587,235	72.1	0.5	27.4

* Rural includes agricultural land uses and unpaved roads.

Table C-4. Unit Area Loads - Subwatersheds with Waterbodies Impaired Due to Siltation (Documented on the Final 2014 303(d) List).

Impaired Subwatershed	Waterbody ID	Subwatershed Area [ac]	***UNIT AREA LOADS*** [lbs/ac/yr]
Cuckle Creek	06010205001T_0200	3603	358.5
Fall Creek	06010205001T_1400	2644	214.5

Table C-5. Calculated Sediment Delivery to Surface Waters – Target Reference Subwatersheds.

Reference Subwatershed	*TARGET SEDIMENT LOAD*						
	Rural* [lb/yr]	Urban [lb/yr]	Streambank [lb/yr]	Total [lb/yr]	Rural* [%]	Urban [%]	Streambank [%]
Clear Creek	329,404	431	28,706	358,828	91.8	0.12	8.0
White Creek	322,369	75	55,112	377,481	85.4	0.02	14.6

* Rural includes agricultural land uses and unpaved roads.

Table C-6. Unit Area Loads - Target Reference Subwatersheds.

Reference Subwatershed	Subwatershed Area [ac]	*UNIT AREA LOADS* [lbs/ac/yr]
Clear Creek	2180	164.6
White Creek	1922	196.4

APPENDIX D

Reference Watershed Selection

Potential reference watersheds were ranked based on quantitative and qualitative comparisons of watershed attributes and available data. Similarities in land use were not considered as a factor for selection of reference watersheds because land use changes often contribute to degradation and increased sediment loading in a watershed. A reference watershed will typically be dominated by forested land uses while an impaired watershed would not be expected to exhibit the same characteristics, and may be dominated by other land use types (e.g., urban and/or agricultural).

D.1 Reference Watershed Selection for Cuckle Creek

Four potential reference watersheds were selected from ecoregion watersheds for analyses that would lead to the selection of a reference watershed for Cuckle Creek. Table D-1 shows Cuckle Creek and the selected reference stream with information used for comparison. The bold values are those that deviate by less than 10% from the value for Cuckle Creek.

The Clear Creek watershed was selected as the reference watershed for Cuckle Creek due to the similarities in watershed characteristics (including size), soil characteristics, soil type and ecoregion. Of the two potential reference watersheds with drainage areas between half and double the size of the impaired watershed, Clear Creek has soil and watershed characteristics most similar to Cuckle Creek. Based on these comparisons, the Clear Creek watershed was selected as the reference watershed (Figure 5) for Cuckle Creek.

D.2 Reference Watershed Selection for Fall Creek

Four potential reference watersheds were selected from ecoregion watersheds for analyses that would lead to the selection of a reference watershed for Fall Creek. Table D-2 shows Fall Creek and the selected reference stream with information used for comparison. The bold values are those that deviate by less than 10% from the value for Fall Creek.

The White Creek watershed was selected as the reference watershed for Fall Creek due to the similarities in watershed characteristics, soil types, and ecoregion. Of the two potential reference watersheds with drainage areas between half and double the size of the impaired watershed, White Creek has soil and watershed characteristics most similar to Fall Creek. Based on these comparisons, the White Creek watershed was selected as the reference watershed (Figure 5) for Fall Creek.

Table D-1. Reference Watershed Selection for Cuckle Creek.

Watershed Properties	Cuckle Creek	Clear Creek (Reference)
Location		
County*	Campbell	Anderson
HUC	06010205	06010207
Land use		
Open Water	7.3	0
Developed, Open Space	592	132
Developed, Low Intensity	689	2.9
Developed, Medium Intensity	245	2.4
Developed, High Intensity	138	0
Barren Land	96.3	0
Deciduous Forest	640	1805
Evergreen Forest	74.5	11.6
Mixed Forest	117	102
Shrub/Scrub	11.1	43.8
Herbaceous	369	35.8
Pasture/Hay	621	14.5
Woody Wetlands	2.4	29.8
Total Area (ac)	3603	2180
Watershed Characteristics		
Drainage Area (sq. mi.)	5.63	3.41
Stream Order	1	**1**
Total Stream Length (mi.)	13.7	5.9
Slope (ft/mi.)	64.2	**70.4**
Effective width (mi.)	270	372
Shape Factor	0.679	0.933
g-factor (days)	64.6	37.9
Soil Characteristics		
STATSGO K-factor	0.24	0.31
AWC (in.)	3.01	3.9
HSG (avg)	2.57	2
Permeability (in/hr)	1.59	1.97
EcoRegion		
Southern Limestone/Dolomite (67f)	82.8 %	100 %
Southern Dissected Ridges/Knobs (67i)		
Cumberland Mountain Thrust Block (69e)	17.2 %	
Soil Type:		
TN095	16.4%	
TN110	67.1%	100%
TN118		
TN131		
TN138		
TN155	16.6%	
TN164		
KY817		
VA003		
VA016		
VA054		
VA078		

Table D-2. Reference Watershed Selection for Fall Creek.

Watershed Properties	Fall Creek	White Creek (Reference)
Location		
County*	Union	Union
HUC	06010205	06010205
Land use		
Open Water	0	0
Developed, Open Space	161	91.4
Developed, Low Intensity	84.7	1.3
Developed, Medium Intensity	5.6	0.7
Developed, High Intensity	0	0
Barren Land	8.2	0
Deciduous Forest	1268	1601
Evergreen Forest	133	2.7
Mixed Forest	233	88.7
Shrub/Scrub	19.8	40.7
Herbaceous	402	78.5
Pasture/Hay	327	5.1
Woody Wetlands	1.3	11.6
Total Area (ac)	2644	1922
Watershed Characteristics		
Drainage Area (sq. mi.)	4.13	3.0
Stream Order	2	**2**
Total Stream Length (mi.)	15.2	9.5
Slope (ft/mi.)	65	142
Effective width (mi.)	180	202
Shape Factor	0.453	0.508
g-factor (days)	65	38.4
Soil Characteristics		
STATSGO K-factor	0.233	0.31
AWC (in.)	5.7	3.9
HSG (avg)	2.73	2
Permeability (in/hr)	3.65	1.97
EcoRegion		
Southern Limestone/Dolomite (67f)	98.3 %	**100 %**
Southern Dissected Ridges/Knobs (67i)	1.7 %	
Cumberland Mountain Thrust Block (69e)		
Soil Type:		
TN110	61.2%	100%
TN118	33.4%	
TN131	5.4%	
TN138		
TN155		
TN164		
KY817		
VA003		
VA016		
VA054		
VA078		

APPENDIX E

NLCD Land Use of Impaired Subwatersheds and Ecoregion Reference Site Drainage Areas

Table E-1. 2011 NLCD Land Use Distribution of Impaired Subwatersheds of the Upper Clinch River Watershed.

Land Use	Subwatershed (06010205)			
	Cuckle Creek		Fall Creek	
	[acres]	[%]	[acres]	[%]
Open Water	7.3	0.2	0	0
Developed, Open Space	592	16.4	161	6.1
Developed, Low Intensity	689	19.1	84.7	3.2
Developed, Medium Intensity	245	6.8	5.6	0.2
Developed, High Intensity	138	3.8	0	0
Barren Land	96.3	2.7	8.2	0.3
Deciduous Forest	640	17.8	1268	48.0
Evergreen Forest	74.5	2.1	133	5.0
Mixed Forest	117	3.3	233	8.8
Shrub/Scrub	11.1	0.3	19.8	0.7
Herbaceous	369	10.2	402	15.2
Pasture/Hay	621	17.2	327	12.4
Woody Wetlands	2.4	0.1	1.3	0.1
Total	**3603**	**100.0**	**2644**	**100.0**

Table E-2. 2011 NLCD Land Use Distribution of Level IV Ecoregion Reference Site Drainage Areas.

Land Use	Ecoregion Reference Site Subwatershed			
	Clear Creek (Eco67f06)		White Creek (Eco67f13)	
	[acres]	[%]	[acres]	[%]
Open Water	0	0	0	0
Developed, Open Space	132	6.0	91.4	4.8
Developed, Low Intensity	2.9	0.1	1.3	0.1
Developed, Medium Intensity	2.4	0.1	0.7	0.0*
Developed, High Intensity	0	0	0	0
Barren Land	0	0	0	0
Deciduous Forest	1805	82.8	1601	83.3
Evergreen Forest	11.6	0.5	2.7	0.1
Mixed Forest	102	4.7	88.7	4.6
Shrub/Scrub	43.8	2.0	40.7	2.1
Herbaceous	35.8	1.6	78.5	4.1
Pasture/Hay	14.5	0.7	5.1	0.3
Woody Wetlands	29.8	1.4	11.6	0.6
Total	**2180**	**99.9**	**1922**	**100.0**

*Less than 0.05%

APPENDIX F

Sediment Loading Analysis Methodology for Development of TMDLs, WLAs, & LAs

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and instream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations) and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure. In addition, EPA has recommended that all TMDLs, WLAs, and LAs include "a daily time increment in conjunction with other temporal expressions that may be necessary to implement relevant water quality standards" (USEPA, 2007b). The TMDLs and allocations developed in this document are in accordance with this guidance.

TMDL analyses are performed on a unit area basis for subwatersheds containing waterbodies identified as impaired due to siltation on the Final 2014 303(d) List. Subwatershed boundaries are shown in Figure 4.

Sediment Loading Analysis

Sediment loading analysis for waterbodies impaired due to siltation in the Upper Clinch River watershed was conducted using the Generalized Watershed Loading Function (GWLF) Model. This geographic information system (GIS) based model is described in Appendix C and was utilized to develop TMDLs, WLAs for MS4s, and LAs for nonpoint sources according to the procedure described below:

<u>Development of TMDLs</u>

1. The GWLF Model was used to determine sediment loading to Level IV ecoregion reference site watersheds. These are considered to be biologically healthy watersheds and serve as appropriate targets for TMDL development (ref.: Table 4). The targets are expressed as average annual instream sediment loads per unit drainage area (lbs/ac/yr).

   Note: The overall allowable load in each impaired subwatershed is the product of the applicable target load and the subwatershed area. The overall allowable load is evaluated as instream sediment at the subwatershed pour point.

2. The GWLF Model was also used to determine the existing average annual instream sediment loads of subwatersheds containing waterbodies identified as impaired due to siltation on the State's Final 2014 303(d) List (ref.: Tables 4, C-3, & C-4). As with the ecoregion targets, the existing loads were normalized to subwatershed area.

3. The existing average annual instream sediment load of each impaired subwatershed was compared to the average annual instream sediment load of the appropriate reference (biologically healthy) watershed and an overall required percent reduction in instream sediment loading calculated. This required overall reduction is the TMDL for the impaired subwatershed.

$$\text{(Required Reduction)}_{\text{Overall}} = \frac{\text{(Existing Load) - (Target Load)}}{\text{(Existing Load)}} \times 100$$

<u>WLAs for NPDES Permitted Ready Mixed Concrete Facilities</u>

4. As of January 7, 2016, there was one NPDES permitted Ready Mixed Concrete Facility (RMCF) located in an impaired subwatershed (Cuckle Creek) of the Upper Clinch River watershed. In each impaired subwatershed, the waste load allocation for RMCFs is based on existing permitted facilities (see Appendix G). In addition, a provision for future growth is allocated as 5% of the total ecoregion-based target load. This future growth term is limited to combined loading from all non-MS4 WLAs (including RMCF, TMSP, Mining, and individually permitted facilities).

<u>WLAs for NPDES Permitted Tennessee Stormwater Multi-Sector Industrial Facilities and Individual Industrial Permits</u>

5. As of January 7, 2016, there were three NPDES permitted Tennessee Multi-Sector (TMSP) facilities located in an impaired subwatershed (Cuckle Creek) of the Upper Clinch River watershed. There were no individual industrial permits in the impaired subwatersheds of the Upper Clinch River watershed. In each impaired subwatershed, the waste load allocation for TMSPs is based on existing permitted facilities (see Appendix G). In addition, a provision for future growth is allocated as 5% of the total ecoregion-based target load. This future growth term is limited to combined loading from all non-MS4 WLAs (including RMCF, TMSP, Mining, and individually permitted facilities).

<u>WLAs for NPDES Permitted Mining Sites</u>

6. As of January 7, 2016, there were two NPDES permitted mining sites located in impaired subwatersheds (Cuckle Creek) of the Upper Clinch River watershed. In each impaired subwatershed, the waste load allocation for Mining sites is based on existing permitted facilities (see Appendix G). In addition, a provision for future growth is allocated as 5% of the total ecoregion-based target load. This future growth term is limited to combined loading from all non-MS4 WLAs (including RMCF, TMSP, Mining, and individually permitted facilities).

7. A provision for future growth equal to 5% of the ecoregion-based target load was used in the analyses. This future growth term is applicable to combined loading from all non-MS4 WLAs (including RMCF, TMSP, Mining, and individually permitted facilities).

<u>WLAs for NPDES Regulated Construction Stormwater (CSW) Discharges</u>

8. The WLAs provided to existing and future NPDES regulated construction activities will be implemented through appropriate erosion prevention and sediment controls and BMPs as specified in NPDES Permit No. TNR100000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b). This permit requires development and implementation of site-specific Storm Water Pollution Prevention Plans (SWPPPs) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2012b) and must identify potential sources of pollution at a construction site that would affect the quality of stormwater discharges and describe practices to be used to reduce pollutants in those discharges. In addition, the permit specifies a number of

special requirements for discharges entering Tennessee Exceptional Waters or waters identified as impaired due to siltation. The permit does not authorize discharges that would result in a violation of a State water quality standard.

Unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (or any applicable individual permit) is considered to be consistent with the WLAs described in Appendix G of this TMDL document.

Construction activities are transient in nature and typically represent land disturbance activities of short duration. In addition, due to permit provisions for post-construction stormwater, requiring control of runoff volume and pollutant loading, restored post-construction areas are essentially equivalent to WLAs for MS4s and/or LAs for non-MS4 nonpoint source (NPS) areas. Therefore, for the purpose of sediment loading analysis calculations, post-construction areas have the same requirements for, and are equivalent to, sediment loading as WLA_{MS4} or LA_{NPS}.

9. An explicit Margin of Safety equal to 10% of the ecoregion-based target load was used in the analyses.

WLAs for MS4s and LAs for Nonpoint Sources

10. The allowable load for discharges from MS4s and nonpoint sources can be derived from the basic equation:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

This equation can be expressed as:

$$Load_{TMDL} = Load_{RMCF} + Load_{TMSP} + Load_{Mining} + Load_{CSW} + Load_{MS4} + Load_{NPS} + MOS + FG$$

where:

$Load_{TMDL}$ = Allowable instream sediment load of the subwatershed [lbs/yr]

$Load_{RMCF}$ = Allocated load for all RMCFs in the subwatershed [lbs/yr] (see Step 4)

$Load_{TMSP}$ = Allocated load for all TMSPs in the subwatershed [lbs/yr] (see Step 5)

$Load_{Mining}$ = Allocated load for all mining sites in the subwatershed [lbs/yr] (see Step 6)

$Load_{CSW}$ = Allocated load for all construction sites in the subwatershed [lbs/yr]

FG = Future Growth [lbs/yr] (see Step 7)

MOS = Explicit Margin of Safety [lbs/yr] (see Step 9)

substituting:

$Load_{TMDL}$ = (Target) ($A_{Subwatershed}$)

$Load_{MS4}$ = (Unit Load)$_{MS4}$ (A_{MS4})

$Load_{NPS}$ = (Unit Load)$_{NPS}$ (A_{NPS})

and noting that:

$$(\text{Unit Load})_{MS4} = (\text{Unit Load})_{NPS} = (\text{Unit Load})_{CSW} \text{ (for post-construction stormwater)}$$

The equation can be solved for MS4s and nonpoint sources:

$$(\text{Load})_{NPS,MS4} = \text{Load}_{Target} - \text{Load}_{MOS} - \text{Load}_{FG} - \text{Load}_{RMCF} - \text{Load}_{TMSP} - \text{Load}_{Mining}$$

and the allowable unit load for MS4s and nonpoint sources:

$$(\text{Unit Load})_{NPS,MS4} = \frac{(\text{Target})\,(A_{Subwatershed}) - \text{Load}_{RMCF} - \text{Load}_{TMSP} - \text{Load}_{Mining} - \text{MOS} - \text{FG}}{A_{MS4} + A_{NPS}}$$

The MS4 and nonpoint source areas can be determined by:

$$(A_{MS4}) + (A_{NPS}) = (A_{Subwatershed}) - (A_{RMCF}) - (A_{TMSP}) - (A_{Mining})$$

where:

$A_{Subwatershed}$ = Area of the subwatershed [acres] (see Table E-1)

A_{MS4} = Area of MS4s in the subwatershed [acres]

A_{NPS} = Area of non-regulated NPS areas in the subwatershed [acres]

A_{RMCF} = Estimated total area of existing RMCFs in subwatershed [acres]

A_{TMSP} = Estimated total area of existing TMSPs in subwatershed [acres]

A_{Mining} = Estimated total area of existing mining sites in subwatershed [acres]

11. For each impaired subwatershed, WLAs for MS4s and LAs for nonpoint sources were considered to be the percent load reduction required to decrease the existing average annual instream sediment load to the allowable unit load for MS4s and nonpoint sources calculated in Step 10.

$$\text{WLA}_{MS4s} = \text{LA}_{NPS} = \frac{(\text{Existing Unit Load}) - (\text{Unit Load})_{NPS,MS4}}{(\text{Existing Load})} \times 100$$

Daily Expression of TMDL, WLAs, & LAs

Current EPA guidance states that daily load expressions should be included in TMDLs calculated using allocation time frames greater than daily (USEPA, 2007b). In accordance with this guidance, daily expressions of TMDLs, WLAs, and LAs were developed for all impaired subwatersheds.

<u>TMDLs</u>

An allowable daily load for each impaired subwatershed was determined by dividing the appropriate average annual instream target load (Step 1) by the average annual precipitation for the subwatershed. A composite average annual precipitation for each subwatershed (Table F-1) was determined using a GIS coverage downloaded from the Natural Resources Conservation Service Geospatial Data Gateway website (USDA, 2014):

http://datagateway.nrcs.usda.gov/

The TMDL for each impaired subwatershed consists of: a) the required overall percent reduction in instream sediment loading and b) the allowable daily instream sediment load per unit area per inch of precipitation (lbs/ac/in. precipitation). TMDLs are summarized in Table F-2.

WLAs for Ready Mixed Concrete Facilities

As stated in Appendix G, the "daily expression" of the overall WLA for existing RMCFs in impaired subwatersheds is based on the TSS limit for process wastewater and the TSS benchmark concentration for stormwater discharges in the *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2012a). The "daily expression" is expressed as an equation and is equal to:

$$WLA_{Overall\text{-}Daily} = [(50 \text{ mg/L}) (8.34 \text{ 1b-L/mg-Mgal}) (\Sigma Q_p)] + [(150 \text{ mg/L}) (8.34 \text{ 1b-L/mg-Mgal}) (\Sigma Q_{sw})]$$

where: ΣQ_p = Sum of all RMCF process wastewater discharges in the subwatershed [MGD]
ΣQ_{sw} = Sum of all RMCF stormwater discharges in the subwatershed [MGD]

Compliance with the WLA for RMCFs in an impaired subwatershed includes compliance with both the overall annual and daily components of the WLAs in Table G-1.

WLAs for NPDES Tennessee Stormwater Multi-Sector Permit for Industrial Activities

As stated in Appendix G, the "daily expression" of the overall WLA for existing TMSPs in impaired subwatersheds is based on the TSS benchmark concentration for stormwater discharges in the *Tennessee Storm Water Multi-Sector General Permit for Industrial Activities* (TDEC, 2015b). The "daily expression" is expressed as an equation and is equal to:

$$WLA_{Overall\text{-}Daily} = [(150 \text{ mg/L}) (8.34 \text{ 1b-L/mg-Mgal}) (\Sigma Q_{sw})]$$

where: ΣQ_{sw} = Sum of all TMSP stormwater discharges in the subwatershed [MGD]

Compliance with the WLA for existing TMSPs in an impaired subwatershed includes compliance with both the overall annual and daily components of the WLAs in Table G-2.

WLAs for Mining Sites

As stated in Appendix G, the daily expression of the overall WLA for mining activity in each impaired subwatershed is expressed as an equation and is equal to the product of the daily maximum permit limit for discharges from individual mining sites, an appropriate unit conversion factor, and the sum of all discharges from all mining sites in a single day in a particular subwatershed.

$$WLA_{Overall\text{-}Daily} = (70 \text{ mg/L}) (8.34 \text{ 1b-L/mg-Mgal}) (Q) \text{ for coal mining}$$

$$WLA_{Overall\text{-}Daily} = (40 \text{ mg/L}) (8.34 \text{ 1b-L/mg-Mgal}) (Q) \text{ for limestone quarries}$$

$$WLA_{Overall\text{-}Daily} = (10 \text{ mg/L}) (8.34 \text{ 1b-L/mg-Mgal}) (Q) \text{ for coal reclamation sites}$$

where: Q = Sum of all mining site discharges in the subwatershed [MGD]

Compliance with the WLA for mining activities in an impaired subwatershed includes compliance with both the overall annual and daily components of the WLAs in Table G-3.

WLAs for NPDES Regulated Construction Stormwater (CSW) Discharges

As stated in Appendix G, the WLAs provided to existing and future NPDES regulated construction activities will be implemented through appropriate erosion prevention and sediment controls and BMPs as specified in NPDES Permit No. TNR100000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b). Unless otherwise stated, full compliance with the requirements of the *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* is considered to be consistent with the WLAs described in Appendix G of this TMDL document.

WLAs for MS4s and LAs for Nonpoint Sources

A daily expression of the MS4 WLA and the LA for nonpoint sources was derived by dividing the allowable unit load by the average annual precipitation for the subwatershed. The MS4 WLA and LA for each impaired subwatershed consists of: a) the required percent reduction in instream sediment loading (Step 10) and b) the allowable daily instream load per unit area per inch of precipitation (lbs/ac/in. precipitation). Daily MS4 WLAs and LAs should be interpreted as per unit area of the MS4 or area addressed by the LA.

Example Calculation for subwatershed Cuckle Creek - TMDL, WLAs, & LAs

Step 1 Target for Ecoregion 67f = 164.6 lbs/ac/yr [ref.: Table 4]

Step 2 Erosion Unit Load = 488 lbs/ac/yr
Sediment Unit Load (Instream) = 358.5 lbs/ac/yr [ref.: Table C-4]
Subwatershed Area = 3,603 acres [ref.: Table E-1]

Step 3

$$\text{TMDL}_{\text{Cuckle}} = (\text{Required Reduction})_{\text{Overall}} = \frac{(358.5 \text{ lbs/ac/yr}) - (164.6 \text{ lbs/ac/yr})}{(358.5 \text{ lbs/ac/yr})} \times 100 = 54.1\%$$

$$\text{Load}_{\text{TMDL}} = (\text{Target})\,(A_{\text{Subwatershed}}) = (164.6 \text{ lbs/ac/yr})\,(3{,}603 \text{ acres})$$

$$\text{Load}_{\text{TMDL}} = 593{,}054 \text{ lbs/yr}$$

Step 4 WLA_{RMCP} = 1,871 lbs/yr [ref.: Table G-1]

Step 5 WLA_{TMSP} = 10,630 lbs/yr [ref.: Table G-2]

Step 6 $\text{WLA}_{\text{Mining}}$ = 14,603.8 lbs/yr [ref.: Table G-3]

Step 7 FG = (0.05) (164.6 lbs/ac/yr) (3,603 ac) = 29,653 lbs/yr

Step 8 WLA_{CSW} (see p. F-3)

Step 9 MOS = (0.1) (164.6 lbs/ac/yr) (3,603 ac) = 59,305 lbs/yr

Step 10

$(\text{Load})_{MS4,NPS}$ = 593,054 lbs/yr - 59,305 lbs/yr - 29,653 lbs/yr – 1,871 lbs/yr – 10,630 lbs/yr - 14,603.8 lbs/yr

$(\text{Load})_{MS4,NPS}$ = 476,991 lbs/yr

$(A_{MS4,NPS}) = (A_{MS4}) + (A_{NPS}) = (A_{Subwatershed}) – (A_{RMCF}) – (A_{TMSP}) – (A_{Mining})$

$(A_{MS4,NPS})$ = 3,603 – 2 – 6.58 – 60.0

$(A_{MS4,NPS})$ = 3534.4 ac

$$(\text{Unit Load})_{NPS,MS4} = \frac{(\text{Load})_{MS4,NPS}}{(A_{MS4,NPS})} = \frac{476{,}991 \text{ lbs/yr}}{3534.4 \text{ ac}}$$

$(\text{Unit Load})_{NPS,MS4}$ = 135.0 lbs/ac/yr

Step 11

$$WLA_{MS4,}LA_{NPS} = \frac{(358.5 \text{ lbs/ac/yr}) – (135.0 \text{ lbs/ac/yr})}{(358.5 \text{ lbs/ac/yr})} \times 100 = 62.3\%$$

Daily Expression of TMDL, WLAs, & LAs

Average annual precipitation = 52.8 in. precip./yr [ref.: Table F-1]

TMDL: Daily Maximum Load $= \frac{(164.6 \text{ lbs/ac/yr})}{(52.8 \text{ in. precip./yr})}$ = 3.12 lbs/ac/in. precip.

Ready Mixed Concrete Facilities (RMCFs):

Daily Maximum Load = $417(\Sigma Q_p) + 1{,}251(\Sigma Q_{sw})$

where: ΣQ_p = Sum of all RMCF process wastewater discharges in the subwatershed [MGD]
ΣQ_{sw} = Sum of all RMCF stormwater discharges in the subwatershed [MGD]

Tennessee Stormwater Multi-Sector Industrial Activities (TMSPs):

Daily Maximum Load = $1{,}251(\Sigma Q_{sw})$

where: ΣQ_{sw} = Sum of all TMSP stormwater discharges in the subwatershed [MGD]

Permitted Mining Sites:

Daily Maximum Load = $333.6(\Sigma Q_P) + 1251(\Sigma Q_{SW})$

where: ΣQ_P = Sum of all mining process wastewater discharges in the subwatershed [MGD]
ΣQ_{sw} = Sum of all mining stormwater discharges in the subwatershed [MGD]

MS4s & Nonpoint Sources:

$$\text{Daily Maximum Load} = \frac{(135.0 \text{ lbs/ac/yr})}{(52.8 \text{ in. precip./yr})} = 2.56 \text{ lbs/ac/in. precip.}$$

Table F-1. Average Annual Precipitation for Impaired Subwatersheds.

Subwatershed	Annual Average Precipitation (in.)
Cuckle Creek	52.8
Fall Creek	48.54

Table F-2. TMDLs for Impaired Subwatersheds.

Subwatershed	Level IV Ecoregion	Target Load	Existing Load	TMDL *	
				Required Load Reduction	Daily Maximum Load
		[lbs/ac/yr]	[lbs/ac/yr]	[%]	[lbs/ac/in. precip.]
Cuckle Creek	67f	164.6	358.5	54.1	3.12
Fall Creek	67f	196.4	214.5	8.4	4.05

* Applicable to instream sediment at pour point of subwatershed.

Table F-3. WLAs for RMCFs, TMSPs, and Mining Sites

Subwatershed	MOS [lbs/yr]	Future Growth [lbs/yr]	WLAs					
			RMCFs[a]		TMSPs[b]		Mining[c]	
			Annual Average Load	Daily Maximum Load [d]	Annual Average Load	Daily Maximum Load [e]	Annual Average Load	Daily Maximum Load [f]
			[lbs/yr]	[lbs/day]	[lbs/yr]	[lbs/day]	[lbs/yr]	[lbs/day]
Cuckle Creek	59,305	29,653	1871[g]	$417(\Sigma Q_p) + 1{,}251(\Sigma Q_{sw})$[d,g]	10,630[g]	$1{,}251(\Sigma Q_{SW})$[e,g]	14,603.8[g]	$333.6(\Sigma Q_P) + 1{,}251(\Sigma Q_{SW})$[f,g]
Fall Creek	51,928	25,964	(See Note g)	(See Note g)	(See Note g)	(See Note g)	(See Note g)	(See Note g)

Notes:
a. Values shown are overall WLAs for all permitted RMCFs in the subwatershed.
b. Values shown are overall WLAs for all permitted TMSPs in the subwatershed.
c. Values shown are overall WLAs for all permitted mining sites in the subwatershed.
d. ΣQ_P = Sum of all permitted RMCF process wastewater discharges in the subwatershed [MGD].
ΣQ_{SW} = Sum of all permitted RMCF stormwater discharges in the subwatershed [MGD].
e. ΣQ_{SW} = Sum of all permitted TMSP stormwater discharges in the subwatershed [MGD].
f. ΣQ_P = Sum of all permitted mining process wastewater discharges in the subwatershed [MGD].
ΣQ_{SW} = Sum of all permitted mining stormwater discharges in the subwatershed [MGD].
ΣQ_M = Sum of all permitted mining discharges in the subwatershed [MGD].
g. Allocations for future permitted discharges are provided in the future growth term.

Table F-4. WLAs for MS4s & LAs for Nonpoint Sources.

Subwatershed	WLAs *		LAs *	
	MS4			
	Required Reduction	Daily Maximum Load	Required Reduction	Daily Maximum Load
	[%]	[lbs/ac/in. precip.]	[%]	[lbs/ac/in. precip.]
Cuckle Creek	62.4	2.56	62.4	2.56
Fall Creek	22.2	3.44	22.2	3.44

* Applicable as instream sediment reduction at the pour point of the subwatershed.

APPENDIX G

Waste Load Allocations for NPDES Permitted Ready Mixed Concrete Facilities, Tennessee Stormwater Multi-Sector and Individual Industrial Activities, Mining Sites, and Construction Stormwater Sites

G.1 Determination of Overall Waste Load Allocation (WLA) for Ready Mixed Concrete Facilities

Discharges from any existing and future facilities will be expected to be in accordance with the limits and requirements of the *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2012a). This permit establishes a daily maximum TSS concentration limit of 50 mg/L on process wastewater effluent and specifies monitoring procedures and a benchmark concentration of 150 mg/L for TSS in stormwater discharges.

Compliance with the overall subwatershed WLA can be demonstrated by showing that the aggregate load from all permitted facilities within an impaired subwatershed is less than or equal to the WLA for that subwatershed. Loading from individual RMCFs can be estimated as the sum of process and stormwater loads:

$$AAL_{RMCF} = AAL_{P} + AAL_{SW}$$

The loading from process wastewater discharge for RMCFs is based on facility design flow and the daily maximum permit limit for TSS:

$$AAL_{PW} = (Q_{d}) \text{ x } (D_{Max}) \text{ (8.34 lb-l/Mgal-mg) (365 days/yr)}$$

where: AAL_P = Average annual load from process wastewater [lb/yr]
Q_d = Facility design flow [MGD]
D_{Max} = Daily Maximum concentration limit for TSS [mg/l]

The loading from stormwater runoff for RMCFs is based on an assumed runoff from the site drainage area and the daily maximum permit limit for TSS. Site runoff was estimated by assuming, conservatively, that 50% of the annual precipitation falling on the site drainage area results in runoff. Annual precipitation for subwatersheds in the Upper Clinch River watershed is shown in Table F-1.

$$AAL_{SW} = (A_{d}) \text{ (BM) (Precip) (0.2266 lb-l/ac-in-mg) (0.5)}$$

where: AAL_{SW} = Average annual load from stormwater discharges [lb/ac/yr]
A_d = Facility (site) drainage area [acres]
BM = Benchmark concentration for TSS [mg/l]
Precip = Average annual precipitation for watershed [in/yr]

Daily Expression of WLA

The "daily expression" of the overall WLA for RMCFs in impaired subwatersheds is based on the TSS limit for process wastewater and the TSS benchmark concentration for stormwater discharges in the *General NPDES Permit for Discharges of Stormwater Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2012a). The "daily expression" is expressed as an equation and is equal to:

$$WLA_{Overall\text{-}Daily} = \text{[(50 mg/l) (8.34 1b-l/mg-Mgal)} (\Sigma Q_{P})] + \text{[(150 mg/l) (8.34 1b-l/mg-Mgal)} (\Sigma Q_{SW})]$$

$$WLA_{Overall\text{-}Daily} = \text{(417 lb/Mgal)} (\Sigma Q_{P}) + \text{(1,251 lb/Mgal)} (\Sigma Q_{SW})$$

where: ΣQ_P = Sum of all RMCF process wastewater discharges in the subwatershed [MGD]

ΣQ_{SW} = Sum of all RMCF stormwater discharges in the subwatershed [MGD]

Compliance with the WLA for existing and future RMCFs in an impaired subwatershed includes compliance with both the overall annual and daily components of the WLAs in Table G-1.

Table G-1. WLAs for NPDES-Permitted Ready Mixed Concrete Facilities.

Subwatershed	Subwatershed Area (ac)	Target (lbs/ac/yr)	WLA[a]	
			Annual Average Load [lbs/yr]	Daily Maximum Load [lbs/day]
Cuckle Creek	3603	164.6	1871[c]	$417(\Sigma Q_P) + 1251(\Sigma Q_{SW})$[b,c]
Fall Creek	2644	196.4	(See Note c)	(See Note c)

Notes: a. WLA is overall allocation for subwatershed.
b. ΣQ_P = Sum of all permitted RMCF process wastewater discharges in the subwatershed [MGD]
ΣQ_{SW} = Sum of all permitted RMCF stormwater discharges in the subwatershed [MGD]
c. Allocations for future permitted discharges are provided in the future growth term.

G.2 Determination of Overall Waste Load Allocation (WLA) for Tennessee Stormwater Multi-Sector (TMSP) Industrial Activities and Individual Industrial Permits

Discharges from any existing and future facilities will be expected to be in accordance with the limits and requirements of the *Tennessee Storm Water Multi-Sector General Permit (TMSP) for Industrial Activities* (TDEC, 2015b) or any applicable individual NPDES permit. As of As of January 7, 2016, there are no individually permitted industrial point source facilities in the impaired subwatersheds of the Upper Clinch River watershed. The TMSP permit establishes a benchmark concentration of 150 mg/L for TSS in stormwater discharges.

Compliance with the overall subwatershed WLA can be demonstrated by showing that the aggregate load from all permitted facilities within an impaired subwatershed is less than or equal to the WLA for that subwatershed. The loading from stormwater runoff for TMSPs is based on an assumed runoff from the site drainage area and the benchmark concentration for TSS. Site runoff was estimated by assuming, conservatively, that 90% of the annual precipitation falling on the site drainage area results in runoff. This assumption was based on the estimated percent of impervious area for the developed, high intensity landuse classification, of which industrial areas are included. Annual precipitation for subwatersheds in the Upper Clinch River watershed is shown in Table F-1.

$$AAL_{TMSP} = (A_d)\ (BM)\ (Precip)\ (0.2266\ \text{lb-l/ac-in-mg})\ (0.9)$$

where: AAL_{SW} = Average annual load from stormwater discharges [lb/ac/yr]
A_d = Facility (site) drainage area [acres]
BM = Benchmark concentration for TSS [mg/l]
Precip = Average annual precipitation for watershed [in/yr]

Note: Future individual NPDES permitted industrial facilities may include TSS loading from process wastewater discharges. Average annual loading may be based on facility design flow and monthly average permit limits for TSS:

$$AAL_{PW} = (Q_d) \times (M_{Avg})\ (8.34\ \text{lb-l/Mgal-mg})\ (365\ \text{days/yr})$$

where: AAL_{PW} = Average annual load from process wastewater [lb/yr]
Q_d = Facility design flow [MGD]
M_{Avg} = Monthly average concentration limit for TSS [mg/l]

Daily Expression of WLA

The "daily expression" of the overall WLA for TMSPs in impaired subwatersheds is based on the TSS benchmark concentration for stormwater discharges in the *Tennessee Storm Water Multi-Sector General Permit (TMSP) for Industrial Activities* (TDEC, 2015b). The "daily expression" is expressed as an equation and is equal to:

$$WLA_{Overall\text{-}Daily} = [(150 \text{ mg/l})\ (8.34 \text{ 1b-l/mg-Mgal})\ (\Sigma Q_{SW})]$$

$$WLA_{Overall\text{-}Daily} = (1{,}251 \text{ lb/Mgal})\ (\Sigma Q_{SW})$$

where: ΣQ_{SW} = Sum of all TMSP discharges in the subwatershed [MGD]

Note: The "daily expression" for process wastewater for future NPDES-permitted industrial facilities may be expressed as:

$$WLA_{PW\text{-}Daily} = [(D_{Max})\ (8.34 \text{ 1b-l/mg-Mgal})\ (\Sigma Q_P)]$$

where: Q_P = Sum of process wastewater discharges in the subwatershed [MGD]
D_{Max} = Daily maximum concentration limit for TSS [mg/l]

Compliance with the WLA for existing and future TMSPs in an impaired subwatershed includes compliance with both the overall annual and daily components of the WLAs in Table G-2.

Table G-2. WLAs for NPDES-Permitted Tennessee Storm Water Multi-Sector Industrial Activities and Individual Industrial Permits.

Subwatershed	Subwatershed Area (ac)	Target (lbs/ac/yr)	WLA[a]	
			Annual Average Load [lbs/yr]	Daily Maximum Load [lbs/day]
Cuckle Creek	3603	164.6	10,630[c]	$1251(\Sigma Q_{SW})$[b,c]
Fall Creek	2644	196.4	(See Note c)	(See Note c)

Notes: a. WLA is overall allocation for subwatershed.
b. ΣQ_{SW} = Sum of all permitted TMSP stormwater discharges in the subwatershed [MGD].
c. Allocations for future permitted discharges are provided in the future growth term.

G.3 Determination of Overall Waste Load Allocation (WLA) for Mining Activities

Discharges from any existing and future mining activities will be expected to be in accordance with the limits and requirements of their Individual NPDES permits. Coal mining permits typically establish a daily maximum TSS concentration limit of 70 mg/L and a monthly average of 35 mg/L while mining permits for limestone quarry and processing facility permits establish a daily maximum TSS concentration limit of 40 mg/L on process wastewater effluent and a benchmark concentration of 150 mg/L for TSS in stormwater discharges.

The two existing active mining sites that discharge to the Cuckle Creek impaired subwatershed are limestone quarry and processing facilities and have individual NPDES permits. Discharges from these sites are subject to daily maximum TSS limits of 40 mg/L for process wastewater and a benchmark concentration of 150 mg/L for TSS in stormwater discharges.

For the purposes of existing load estimation, sites with pending permit applications were considered the same as active sites. Mining sites at certain stages of reclamation no longer have TSS limits. Loading from these sites were estimated to be 10 mg/l.

Compliance with the overall subwatershed WLA can be demonstrated by showing that the aggregate load from all permitted facilities within an impaired subwatershed is less than or equal to the WLA for that subwatershed. Loading from individual mining sites can be estimated as the sum of process and stormwater loads:

$$AAL_{Mining} = AAL_{P} + AAL_{SW}$$

The loading from process wastewater discharge is based on facility design flow and the monthly average permit limit for TSS:

$$AAL_{P} = (Q_{d}) \text{ x } (M_{Avg}) \text{ (8.34 lb-l/Mgal-mg) (365 days/yr)}$$

where: AAL_P = Average annual load from process wastewater [lb/yr]
Q_d = Facility design flow [MGD]
M_{Avg} = Monthly average concentration limit for TSS [mg/l]

Note: Limestone quarry and processing facilities do not have monthly average permit limits; use the daily maximum permit limit in the above equation. Coal mining facilities typically do not have process water discharges.

The loading from stormwater runoff for mining sites is based on an assumed runoff from the site drainage area and the daily maximum permit limit for TSS. For each impaired subwatershed, the permitted existing total suspended solids (TSS) load for each mining site was estimated using the following equation:

$$AAL_{SW} = (A_{d}) \text{ } (D_{Max} \text{ or BM}) \text{ (Precip.) (0.2266 lb-l/ac-in-mg) } (P_{Runoff})$$

where: AAL_{SW} = Annual average load from stormwater discharges [lbs/yr]
A_d = Total site contributing drainage area [acres]
D_{Max} = Daily maximum concentration limit for TSS [mg/l] (e.g., for coal mining sites)
BM = Benchmark concentration for TSS [mg/L] (e.g., for limestone quarries)
Precip. = Average annual precipitation for watershed (ref.: Table F-1) [in/yr]
P_{Runoff} = Percent of precipitation that results in runoff

The percent of annual precipitation that results in runoff was estimated to be 25% for all coal mining WLA calculations. This estimate was based, in part, on a discussion of climate in the “Hydrology of the Appalachian Bituminous Coal Basin” chapter of *Prediction of Water Quality at Surface Coal Mines* (Kleinman, 2000). The document states:

> ····Precipitation averages about 47 inches annually, much above the national average for regions of comparable size. ···

> In general, less than 15 inches (38 cm) of the average precipitation infiltrates the groundwater system, with evaporation and transpiration accounting for roughly 20 inches (51 cm) annually (Becher, 1978). The remaining precipitation directly runs off to surface waterways. These numbers are estimates; actual amounts vary depending on geology, soils, vegetation, and topography.

Therefore, for the average precipitation case, approximately 12 inches results in runoff, which is approximately 25.5%.

Existing loading from limestone quarry and processing facilities was estimated by assuming, conservatively, that 50% of the annual precipitation falling on the site drainage area results in runoff. Annual precipitation for subwatersheds in the Upper Clinch River watershed is shown in Table F-1.

Daily Expression of WLA

The "daily expression" of the overall WLA for each impaired subwatershed is expressed as an equation and is equal to the product of the Daily Maximum permit limit for discharges from coal related mining sites, an appropriate unit conversion factor, and the sum of all discharges from mining sites in a single day in a particular subwatershed.

$$WLA_{Overall\text{-}Daily} = (70\ mg/l)\ (8.34\ 1b\text{-}l/mg\text{-}Mgal)\ (\Sigma Q_M) \text{ for coal mining}$$

$$WLA_{Overall\text{-}Daily} = (40\ mg/l)\ (8.34\ 1b\text{-}l/mg\text{-}Mgal)\ (\Sigma Q_P) + (150\ mg/l)\ (8.34\ 1b\text{-}l/mg\text{-}Mgal)\ (\Sigma Q_{SW})$$

for limestone quarries

$$WLA_{Overall\text{-}Daily} = (10\ mg/l)\ (8.34\ 1b\text{-}l/mg\text{-}Mgal)\ (\Sigma Q_M) \text{ for coal reclamation sites}$$

where: ΣQ_M = Sum of all mining site discharges in the subwatershed [MGD]
ΣQ_P = Sum of all mining process wastewater discharges in the subwatershed [MGD]
ΣQ_{SW} = Sum of all mining stormwater discharges in the subwatershed [MGD]

Compliance with the WLA for mining activities in an impaired subwatershed includes compliance with both the overall annual and daily components of the WLAs in Table G-3.

G.4 Determination of Overall Waste Load Allocation (WLA) for Construction Activities

Discharges from NPDES-regulated construction activities are considered point sources of sediment loading to surface waters and occur in response to storm events. Currently, discharges from any existing and future construction activities disturbing an area of one acre or more are expected to be in accordance with the limits and requirements of NPDES Permit No. TNR10-0000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b).

Table G-3. WLAs for NPDES Permitted Mining Sites.

Subwatershed	Subwatershed Area [ac]	Target (lbs/ac/yr)	WLA[a]	
			Annual Average Load [lbs/yr]	Daily Maximum Load [lbs/ac/yr]
Cuckle Creek	3603	164.6	14,603.8[c]	$333.6(\Sigma Q_P) + 1251(\Sigma Q_{SW})$[b,c]
Fall Creek	2644	196.4	(See Note c)	(See Note c)

Notes: a. WLA is overall allocation for subwatershed.
b. ΣQ_P = Sum of all permitted mining process wastewater discharges in the subwatershed [MGD]
ΣQ_{SW} = Sum of all permitted mining stormwater discharges in the subwatershed [MGD]
ΣQ_M = Sum of all permitted mining discharges in the subwatershed [MGD].
c. Allocations for future permitted discharges are provided in the future growth term.

Since construction activities at a site are of a temporary, relatively short-term nature, the number of construction sites covered by the general permit at any point in time varies. The construction general permit establishes non-numeric limitations for point source discharges of stormwater associated with construction activities into waters of the State of Tennessee.

The WLAs provided to existing and future NPDES regulated construction activities will be implemented through appropriate erosion prevention and sediment controls and BMPs as specified in NPDES Permit No. TNR100000, *General NPDES Permit for Discharges of Stormwater Associated With Construction Activities* (TDEC, 2011b) (or an individual NPDES permit). This permit requires the development and implementation of a site-specific Stormwater Pollution Prevention Plan (SWPPP) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2012b) and must identify potential sources of pollution at a construction site that would affect the quality of stormwater discharges and describe practices to be used to reduce pollutants in those discharges. In addition, the permit specifies a number of special requirements for discharges entering Tennessee Exceptional Waters or waters identified as impaired due to siltation. The permit does not authorize discharges that would result in a violation of a State water quality standard.

Construction stormwater activities are considered to be in compliance with provisions of the TMDL (WLA) if they are covered under the current *General NPDES Permit for Discharges of Stormwater Associated with Construction Activities* or an individual NPDES permit and satisfy all conditions of the permit including the selection, installation and maintenance of all BMPs required, and any applicable additional BMPs required for discharges to impaired waters or meet local construction stormwater requirements if they are more restrictive than requirements of the General Permit.

In addition, due to MS4 permit provisions for post-construction stormwater, requiring control of runoff volume and pollutant loading, restored post-construction areas are essentially equivalent to WLAs for MS4s and/or LAs for non-MS4 nonpoint source (NPS) areas. Therefore, for the purpose of sediment loading analysis calculations, post-construction areas have the same requirements as, and the WLAs are equivalent to, WLA_{MS4} or LA_{NPS}.

APPENDIX H

Mitigation Measures

The following sections list many options available for BMPs aimed at urban and agricultural land use mitigation methods and stream restoration techniques. In addition, Table H-1 lists BMPs in a matrix format in which traditional and newly developed BMP types are rated according to their applicability to mitigate for impacts of siltation. Because many factors must be considered when choosing specific structural and non-structural BMPs (e.g., target pollutants, watershed size, soil type and infiltration, land use, runoff characteristics, cost, space considerations, etc.), the sections (and Table H-1) below only suggest categories of BMPs, not specific types for specific situations. Implementation of any BMPs will require site-specific assessments and coordination among local authorities and stakeholders, industry and businesses, and the public.

H.1 Mitigation Measures

The following sections present implementation measures and BMPs for controlling siltation stressors associated with urban sources (both point and non-point), agriculture, streambank erosion, and roadways for impaired waterbodies according to three categories (roadway BMPs are encompassed within the other categories). For each category, the lists are not intended to be exhaustive nor are they necessarily intended to be entirely applicable to the Upper Clinch River subwatersheds. In addition, many of the implementation measures and BMPs are applicable to more than one category (e.g., urban area practices to prevent stormwater runoff from reaching the stream directly result in reduction of peak discharge rates and volume during storms that results in reduction of streambank erosion).

H.2 Urban

Uncontrolled or treated runoff from the urban environment often includes pollutants, including solids. Pavement and compacted areas, roofs, and reduced tree canopy and open space increase runoff rates and volumes that rapidly flow into streams. In streams draining developed watersheds, biological communities are subjected to many stressors associated with stormwater runoff. Degradation of aquatic habitat is one of the most significant ecological impacts of the changes that accompany watershed urbanization. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of these activities on impaired waterbodies. Streams on the 303(d) List for siltation may require numerous measures to prevent increases in sediment loading to the stream.

The following is a list of general urban BMPs and brief descriptions of their benefits in alleviating stressors and improving stream health:

- Encouraging responsible development by promoting GI and/or LID guidelines and the use of pervious pavement techniques will minimize overall effects of urbanization.

- Reducing erosion from land use activities with mulches, grass covers, geotextiles or riprap will reduce the potential for sedimentation problems. In streambank stabilization projects, use of woody vegetation is preferred over riprap in most cases.

- Maintaining the riparian buffer where it is adequate, where possible, and is composed of native plants, including mature trees. Enhancing or replanting the riparian buffer where it is inadequate. An adequate buffer filters sediment and other pollutants in surface runoff from commercial and residential lots, improves shading (which helps to keep water temperature low), and provides habitat and corridors for species that have had habitat fragmented by various land uses.

- Avoid development and disturbance in areas that are particularly susceptible to erosion and sediment loss.

- Minimize the amount of impervious surfaces (roads, parking lots, roofs, etc.) by minimizing the creation, extension and widening of parking lots, roads and associated development.

- Reducing new impervious cover by promoting shared parking areas between homes or between facilities that require parking at different times will reduce impacts related to impervious surfaces. Lowering minimum parking requirements for businesses and critically assessing the need for new impervious surfaces will have the same effect.

- A sediment basin is a basin constructed with an engineered outlet, formed by excavation or use of an embankment, or a combination of the two. A sediment basin functions by detaining sediment or nutrient-laden water for sufficient time to attain a desired level of treatment. Sediment basins may be used in urban locales and are used to treat water from disturbed areas or construction sites, either on a temporary or a permanent basis.

- PAM application for sediment control: use of products containing water-soluble anionic polyacrylamide (PAM) as temporary soil binding agents to reduce off-site sedimentation into water bodies. The purpose of this practice is to remove sediment from turbid discharged water.

- Temporary and permanent vegetation: temporary seeding helps reduce runoff and erosion during construction. Permanent seeding stabilizes disturbed or exposed areas in a manner that adapts to site conditions and allows selection of the most appropriate plant materials for long-term erosion control.

- Implement policies to protect native soils, prevent topsoil stripping, and prevent compaction of soils.

- Investing in education and outreach efforts will raise public awareness for the connections between urbanization, impervious cover, stormwater runoff, and overall stream health.

H.3 Agriculture

Nonpoint source pollution is the leading cause of impairments in surface waters of the U.S (USEPA, 2003). One of the primary agricultural nonpoint source pollutants is sediment. Agricultural activities have the potential to directly impact the habitat of aquatic species through physical disturbances caused by land use changes and subsequent management practices, livestock or equipment. Livestock tend to congregate around the water source, trampling the stream banks and overgrazing the riparian vegetation, which further contributes to stream sedimentation issues. Improper pastureland management can lead to soil compaction and overgrazing, which encourage erosion and runoff. Cropland management practices may also contribute additional sediment by increasing the amount of runoff and soil loss during rain events. Agricultural BMPs are implemented on agricultural land and include practices which help to control erosion and improve water quality.

The following is a list of general agricultural BMPs and brief descriptions of their benefits in alleviating stressors and improving stream health:

- Maintaining the riparian buffer where it is adequate, where possible, and is composed of native plants, including mature trees. Enhancing or replanting the riparian buffer where it is inadequate. An adequate buffer filters sediment and other pollutants in surface runoff from agricultural pasture and croplands, improves shading (which helps to keep water temperature low), and provides habitat and corridors for species that have had habitat fragmented by various land uses.

- Contour buffer strips are strips of perennial vegetation alternated with wider strips of cropland strips which are farmed on the contour. They can reduce sheet erosion and reduce movement of sediment, nutrients, and pesticides.

- Filter strips are strips of grass or other vegetation used to intercept or trap sediment, organics, pesticides, and other pollutants before they reach a waterbody.

- Field borders are strips of perennial vegetation planted on the edge of a field. They can be used for turn areas or travel lanes for farm machinery.

- Vegetative filter strips are strips of herbaceous vegetation placed between pasture or cropland and environmentally sensitive areas such as streams and ponds. These strips of vegetation reduce the amount of sediment, nutrients and pesticides transported to streams and ponds from pastures during storm runoff.

- Heavy use area protection is a way to prevent negative production and environmental impacts often associated with heavy use areas on the farm. Heavy use area protection prevents soil erosion and nutrient loss in storm runoff.

- Stream fencing is the practice of excluding livestock from accessing a stream. Livestock can often degrade stream bank integrity, which leads to stream bank erosion and loss of pastureland. Stream fencing prevents nutrient and sediment loss from pastures.

- Pasture fencing is a cost-share BMP that can greatly enhance the efficiency of your farming operation. As more pasture is divided into smaller paddocks, the utilization of forages by grazing livestock can increase. As utilization of forages is increased and cattle are moved more frequently, the ungrazed paddocks will have fresh forage available for grazing and the previously grazed paddocks will have time to rest. Rest periods from grazing allow forage regrowth and prevent overgrazing, which can lead to increased storm water runoff and unnecessary sediment and nutrient loss.

- Alternative watering is a way of providing water for livestock that are fenced out of streams and ponds. Alternative watering is also designed to deliver water to livestock at multiple places on a farm, which enhances a rotational grazing system. The use of alternative watering enhances pastures' nutrient distribution by grazing animals and prevents stream bank erosion.

- Stream crossings provide a hard, stable area where livestock and equipment can cross a stream without damaging the stream bed or stream banks. Stream crossings prevent sediment loss, nutrient loss and stream bank erosion.

- Farm ponds can impound or collect storm runoff from a pasture before it leaves a field or enters a stream. Ponds also capture sediment and nutrients in runoff that would have entered a stream and can provide an alternate source of water for cattle. To increase their longevity, ponds should be fenced to exclude cattle.

- Livestock exclusion/access control is the temporary or permanent exclusion of livestock from a designated area—often to protect streambanks, wetlands, woods, cropland, wildlife habitat or conservation buffers.

- Conservation tillage is any tillage practice that leaves additional residue on the soil surface for purposes of erosion control on agricultural fields. Conservation tillage is one of the basic BMPs used on farms and can be implemented on almost every farm. Many different variations of this common practice are implemented, the specific variation selected is often based on climatic conditions and available equipment. Conservation tillage is one of the easiest ways to protect erodible land with the least interruption of cropping practices. Crop residue is the most important factor effecting erosion from different tillage systems. The more residue on the land following tillage, the less erosion from the field. No-till and strip till involve planting directly into crop residue that either hasn't been tilled at all (no-till) or has been tilled only in narrow strips (strip-till).

- Conservation Cover is establishing and maintaining permanent vegetative cover with the intention of reducing soil erosion.

- Cover crops as a BMP refers to the use of grasses, legumes or forbs planted to provide seasonal soil cover on cropland when the soil would otherwise be bare.

H.4 Streambank

Stream channels, streambanks, and associated riparian areas are dynamic and sensitive ecosystems that respond to changes in land use activity. Streambank and channel disturbance resulting from agricultural and urban development, loss of riparian and streambank vegetation, construction activities, and channelization can increase the stream's sediment load and cause channel erosion and/or sedimentation. These changes have adverse impacts on the biotic system. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of these activities on impaired waterbodies and enhance their recovery from riparian loss. Streams on the 303(d) List for siltation may require numerous measures to prevent increases in sediment loading to the stream.

The following is a list of general BMPs to control streambank erosion and sedimentation and brief descriptions of their benefits in alleviating stressors and improving stream health:

- Maintaining the riparian buffer where it is adequate, where possible, and is composed of native plants, including mature trees. Enhancing or replanting the riparian buffer where it is inadequate. An adequate buffer filters sediment and other pollutants in surface runoff from commercial and residential lots, improves shading (which helps to keep water temperature low), and provides habitat and corridors for species that have had habitat fragmented by various land uses. Riparian buffer also enhances bank stabilization, thereby reducing erosion and sedimentation.

- Reclamation of floodplains by returning these areas to a natural state will naturally moderate floods; reduce stress on the stream channel; provide habitat for fish, wildlife, and plant resources; promote groundwater recharge; and help maintain water quality. Protection of intact floodplains should be a high priority.

- Improving channel morphology (restoring sinuosity, pool availability and diversity, and flow diversity) will improve flow conditions and habitat for macroinvertebrates.

- Reducing erosion from land use activities with mulches, grass covers, geotextiles or riprap will reduce the potential for sedimentation problems. In streambank stabilization projects, use of woody vegetation is preferred over riprap in most cases.

- Prevent disturbances of natural waterbodies and natural drainage systems caused by development; including roads, highways, and bridges.

- Stream fencing is the practice of excluding livestock from accessing a stream. Livestock can often degrade stream bank integrity, which leads to stream bank erosion.

- Stream crossings provide a hard, stable area where livestock and equipment can cross a stream without damaging the stream bed or stream banks. Stream crossings prevent sediment loss, nutrient loss and stream bank erosion.

- Stream bank stabilization is a process that prevents an already eroding stream bank from further deterioration. Stream bank erosion can cause the loss of land area, damage to structures near the stream bank and sedimentation and nutrient loading of rivers and lakes.

- Stream restoration is the return of an ecosystem to a close approximation of its condition prior to disturbance. The objectives for stream restoration include, but are not limited to, reducing stream channel erosion, promoting physical channel stability, reducing the transport of pollutants downstream, and working towards a stable habitat with a self-sustaining, diverse aquatic community - the establishment of pre-disturbance aquatic functions and related physical, chemical and biological characteristics.

Table H-1. Best Management Practices Selection Matrix.

Management Practice	Type of Treatment		Applicability			
	Erosion Prevention	Sediment Control	Urban	Agricultural	Streambank & Channel	Roads and Highways
Recharge/Infiltration Practices						
Infiltration Trench		●	●			
Infiltration Basin		●	●			
Infiltration Swale		●	●			
Surface Sand Filter		●	●			
Low Impact Development Practices						
Minimize Disturbance Area	●		●	●		
Minimize Site Imperviousness	●		●			
Porous Pavement	●		●			●
Green Roof	●		●			
Bioretention	●		●			●
Rain Garden	●		●			
Preserve Infiltratable Soils	●		●	●		
Rain Barrels/Cisterns	●		●			
Flow Path Practices	●		●	●	●	●
Soil Amendment	●		●			
Vegetation Preservation	●		●	●	●	
Extended Detention Practices						
Extended Detention Pond		●	●			●
Wet Detention		●	●			●
Created Wetland/Biofilter Detention		●	●			●
Impervious Surface Reduction						
Natural area conservation	●		●	●	●	●
Disconnecting Impervious Areas	●		●			
Rain Barrels	●		●			
Green Roofs	●		●			●
Permeable Pavement	●		●			●
Parking Lot Impervious Surfaces	●		●			●
Decrease Pavement Length/Width	●		●			●
Sheet flow discharge to stream buffers	●	●			●	●
Reduce Connectivity of Impervious Surfaces	●		●			●
Grazing Management						
Prescribed Grazing (528A)	●			●		
Pasture & Hayland Management (510)	●			●		
Heavy Use Area Protection (561)	●			●		

Management Practice	Type of Treatment		Applicability			
	Erosion Prevention	Sediment Control	Urban	Agricultural	Streambank & Channel	Roads and Highways
Livestock Access Limitation						
Livestock Exclusion (472)	●			●	●	
Fencing (382)	●			●	●	
Stream Crossing	●			●	●	●
Alternative Water Supplies	●			●	●	
Access Control	●			●	●	
Trails and Walkways	●			●		
Rotation of Supplement & Feeding Areas	●			●		
Vegetative Stabilization						
Pasture & Hayland Planting (512)	●			●		
Riparian Buffers (391)	●	●	●	●	●	●
Field Border (386)	●		●	●		
Filter Strip (393)	●		●	●		
Critical Area Planting (342)	●			●		
Conservation Cover (327)	●			●		
Conservation Crop Rotation (328)	●			●		
Contour Farming (330)	●	●		●		
Cover Crop (340)	●			●		
Terrace (600)	●	●		●		
Tree/Shrub Establishment (612)	●		●	●		
Forest Stand Improvement (666)	●			●		
Hedgerow Planting (422)	●		●	●		
Channel Vegetation (322)	●	●	●	●	●	
Broadcast Seeding/Hydroseeding	●		●	●	●	●
Stream and Channel Protection						
Stream Restoration	●		●		●	
Grassed Waterway (412)	●	●	●	●	●	
Lined Waterway or Outlet (468)	●				●	
Streambank Setback	●				●	
Stream Bypass	●	●	●	●	●	
Bank and Bed Armoring	●				●	
Embedded Flow Obstructions	●				●	
Streambank Stabilization	●		●		●	
Channel Bed Stabilization	●				●	
Other Best Management Practices						
Sediment Basin		●	●			●
Sediment Trap		●	●	●	●	●

Management Practice	Type of Treatment		Applicability			
	Erosion Prevention	Sediment Control	Urban	Agricultural	Streambank & Channel	Roads and Highways
Other Best Management Practices (Cont.)						
Check Dam		●	●	●	●	
Point source controls	●	●	●		●	
Wildlife management	●			●		
Swale	●	●	●	●	●	●
Deep Sump Catch Basins	●	●	●			
Sand/Organic Filter	●	●	●			
Grade Stabilization Structure	●		●	●	●	●
Grade Control	●		●	●	●	●
Land Leveling and Land Smoothing	●		●	●		
Catch Basin Inserts		●	●	●		●
Hydrodynamic Structures		●	●		●	●
Water Quality Inlets		●	●			●
Baffle Boxes		●	●			●
Street Sweeping		●	●			●
Drainage Systems	●		●	●		●
Chemical/Biological Treatment		●	●	●		
Outsloping	●					●
Culverts	●		●		●	●
Energy Dissipater	●					●
Silt Fences	●	●	●			
Level Spreader	●		●			●
Blankets/Geotextile Fabric	●		●	●	●	●
Rock Breast Wall	●					●
Cribwall	●		●	●		●

Note: Numbers in parentheses are NRCS National Conservation Practice Standards.

APPENDIX I

HSPF Hydrologic Modeling Methodology

Hydrologic Modeling Approach

For watershed modeling analyses that entail long-term simulation of precipitation-runoff processes on ungaged waterbodies, development of reasonably accurate hydrologic representations may be accomplished by simulating time-series flows (e.g., hourly or daily) on a nearby gaged watershed with a suitably calibrated model and subsequently applying model parameters to separate models for each ungaged watershed.

For the Upper Clinch River watershed sediment TMDLs, the GWLF model was utilized for simulating long-term sediment loading to impaired and reference waterbodies. The monthly model time step used in the GWLF model is suitable for sediment modeling where annual averages are the appropriate resolution for evaluation of sediment loading.

However, for hydrologic processes, higher resolution and consequently a shorter model timestep is preferred. For this modeling application, the Hydrologic Simulation Program – Fortran (HSPF) model was calibrated for the gaged watershed (reference watershed for hydrology), Big Creek near Rogersville, TN (USGS 03491000), located in the same level IV ecoregion as the sediment impaired and reference watersheds. Then, the calibrated HSPF model parameters were applied to individual models representing the impaired and reference watersheds in order to conduct simulations representing “observed” conditions for each. GWLF models were then developed for each impaired and reference watershed and subsequently calibrated (for hydrology) by matching simulations to the HSPF models of “observed” conditions. After the GWLF models were calibrated to their respective HSPF models for hydrology, each was then utilized to simulate sediment processes in their respective subject watersheds.

The shorter model timestep and more comprehensive parameterization of the HSPF model for initial simulation and calibration of flow on the gaged watershed, Big Creek, was judged to have provided a higher resolution hydrologic calibration for impaired and reference watersheds than would have been achieved using GWLF to simulate time-series flows at the gaged station and applying model parameters to GWLF models for each. For this reason, the modeling methodology described was believed to provide the best possible results for representation of sediment loading in the Upper Clinch River impaired watersheds and the reference watersheds selected as their targets.

Model Selection

The Windows version of Hydrologic Simulation Program – Fortran (HSPF) was selected to simulate flow in the Big Creek subwatershed of the Holston River watershed (TN). HSPF is a watershed model capable of performing flow routing through stream reaches.

HSPF Model Setup

The Big Creek subwatershed was delineated in order to facilitate model hydrologic calibration. Boundaries were constructed so that subwatershed “pour points” coincided with the U.S. Geological Survey (USGS) gaging station. Watershed delineation was based on the NHD stream coverage and Digital Elevation Model (DEM) data. This discretization facilitates simulation of daily flows at selected modeling locations.

Several computer-based tools were utilized to generate input data for the HSPF model. EPA BASINS 4.1 and MapWindow GIS were used to display, analyze, and compile available information to support model simulations for the selected subwatershed. This information includes land use categories, topography, soil types and characteristics, stream characteristics, and weather data.

An important factor influencing model results is the precipitation data used for the simulation. Meteorological data for a selected 11-year period were used for all simulations at each location. The first year of this period was used for model stabilization with calibrated simulation data from the subsequent 10-year period used to support TMDL analyses. Adjacent meteorological stations with at least 11 years of data were reviewed for selection. Meteorological station #407884 at Rogersville, TN and station #444180 at Hurley, VA were selected for hydrologic calibrations for the Big Creek subwatershed.

HSPF Model Calibration

Hydrologic calibration of the watershed model involves comparison of simulated streamflow to historic streamflow data from USGS stream gaging stations for the same period of time. The USGS continuous record station located in the Big Creek subwatershed was selected as the basis of the hydrologic calibration. Station USGS 03491000 is located on Big Creek near Rogersville, TN. This station is located primarily within level IV ecoregion 67f and has a drainage area of 47.3 square miles.

Initial values for hydrologic variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed streamflow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession rate, losses to the deep groundwater system, and interflow discharge. The results of the hydrologic calibration for Big Creek are shown in Table I-1 and Figures I-1 and I-2.

Table I-1. Hydrologic Calibration Summary: Big Creek near Rogersville, TN (USGS 03491000).

Simulation Name:	(USGS 03491000)	**Simulation Period:**	
		Watershed Area (ac):	30828.62
Period for Flow Analysis			
Begin Date:	**10/01/98**	**Baseflow PERCENTILE:**	2.5
End Date:	**09/30/08**	*Usually 1%-5%*	
	(all results in inches)		(all results in inches)
Total Simulated In-stream Flow:	**128.12**	Total Observed In-stream Flow:	**125.70**
Total of highest 10% flows:	**66.47**	Total of Observed highest 10% flows:	**65.19**
Total of lowest 50% flows:	**10.78**	Total of Observed Lowest 50% flows:	**10.86**
Simulated Summer Flow Volume (months 7-9):	**13.46**	Observed Summer Flow Volume (months 7-9):	**9.72**
Simulated Fall Flow Volume (months 10-12):	**23.00**	Observed Fall Flow Volume (months 10-12):	**21.91**
Simulated Winter Flow Volume (months 1-3):	**51.23**	Observed Winter Flow Volume (months 1-3):	**51.85**
Simulated Spring Flow Volume (months 4-6):	**40.43**	Observed Spring Flow Volume (months 4-6):	**42.23**
Total Simulated Storm Volume:	**121.66**	Total Observed Storm Volume:	**118.97**
Simulated Summer Storm Volume (months 7-9):	**11.84**	Observed Summer Storm Volume (months 7-9):	**8.03**
Errors (Simulated-Observed)		*Recommended Criteria*	
Error in total volume:	**1.92**	10	
Error in 50% lowest flows:	**-0.76**	10	
Error in 10% highest flows:	**1.96**	15	
*** Seasonal volume error - Summer:	**38.56**	30	
Seasonal volume error - Fall:	**4.98**	30	
Seasonal volume error - Winter:	**-1.20**	30	
Seasonal volume error - Spring:	**-4.26**	30	
Error in storm volumes:	**2.26**	20	
Error in summer storm volumes:	**47.34**	50	

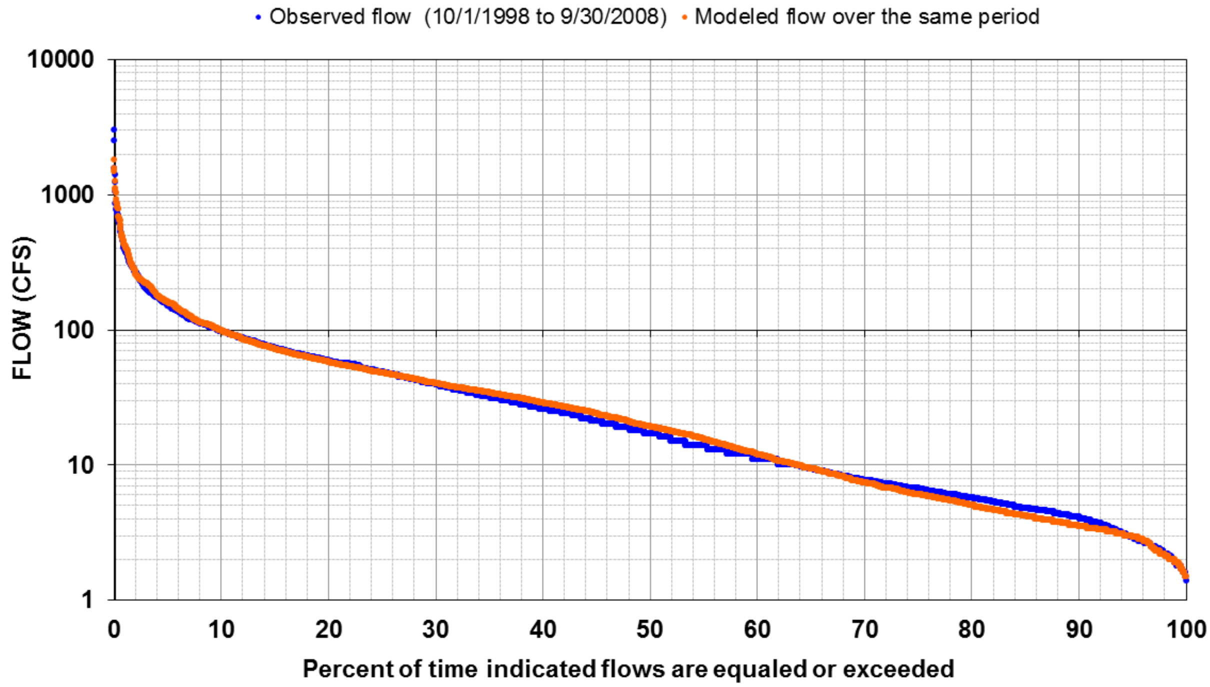

Figure I-1. Hydrologic Calibration: Big Creek, USGS 03491000 (WYs 1999 – 2008).

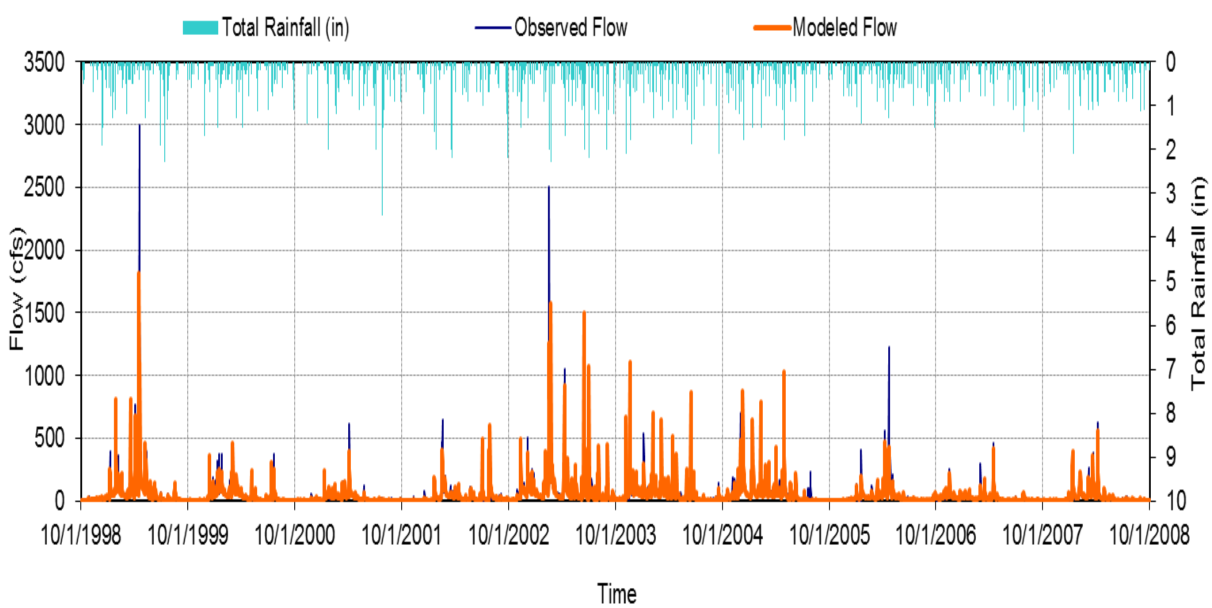

Figure I-2. 10-Year Hydrologic Comparison: Big Creek, USGS 03491000.

Appendix J

GWLF-E Hydrologic Modeling Methodology

Model Selection

The Generalized Watershed Loading Function Extension (GWLF-E) within EPA BASINS 4.1 was selected for flow simulations of ungauged sites in this report. This model is a GIS-based watershed modeling tool that is capable of simulating flow, runoff, and sediment loadings from a watershed given variable-size source areas.

GWLF-E Model Setup

The procedure for EPA BASINS 4.1 based watershed delineation and meteorological data selection for the GWLF model setup is similar to the methodology described in Appendix I, *HSPF Model Setup*. One difference in model setup for GLWF-E is the requirement to create input files. The input file contains weather, hydrology, and sediment transport data required for GWLF-E execution. Creating an input file requires a specific set of GIS layers, including: land use, topography, watershed boundary, stream network, soil type and characteristics, weather data, and unpaved roads. Detailed descriptions of each GIS layer can be found in Section C.6, *Sediment Modeling Methodology*. GWLF-E setup also requires the simulation period and growing season as model inputs.

For meteorological data, GWLF-E requires daily precipitation and temperature data to be available in the input file. Weather stations with 11 years of continuous precipitation data between October, 1997 and September, 2008 were selected for model simulations. The first year of this period was used for model stabilization with simulation data from the subsequent 10-year period used for TMDL analysis. Weather stations selected are as follows. Daily weather data from the NCDC Coop station at Norris, TN (station #406619) were used for the Cuckle, Fall, Clear, and White Creek subwatersheds.

GWLF-E Model Calibration

Although the GWLF model was originally developed for use in ungaged watersheds, calibration was performed to ensure that hydrology was being simulated accurately. This process was performed in order to minimize errors in sediment simulations due to potential gross errors in hydrology. A reference watershed approach was used for calibrations. The procedure is as follows:

1. The reference watershed was first calibrated with USGS flow data in HSPF (Appendix I), and the HSPF reference watershed is located in the same ecoregion as the ungaged ecoregion reference stream and impaired waterbodies. Each ungaged watershed and the associated HSPF reference watershed are shown in Table J-1.

2. The parameters from the HSPF calibration model were then applied to HSPF models for each ungaged subwatershed, both impaired and reference. Parameters from the Big Creek calibrated model were utilized for Cuckle, Fall, Clear, and White Creeks. Subsequently, simulation data from these HSPF models served as the “observed” flow for calibration of the GWLF-E hydrology for each of the impaired and selected reference subwatersheds.

3. A GWLF-E model was created for each ungaged watershed.

4. Each GWLF-E model was subsequently calibrated to its HSPF model for each unaged watershed.

5. The model’s parameters were assigned based on soil characteristics, land use, and topographic data. Parameters that were adjusted during calibration included the available water-holding

capacity, groundwater recession coefficient, groundwater seepage coefficient, erosivity coefficient, and the percentage of impervious area for urban land use.

Table J-1. GWLF-E Modeled Sites and Associated HSPF Hydrologic Calibration Sites.

Ecoregion	67f
HSPF Modeled Reference Watershed	Big Creek
GWLF-E Modeled Ecoregion Reference Steams	Clear Creek White Creek
GWLF-E Modeled Impaired Watersheds	Cuckle Creek Fall Creek

Clear Creek – Reference Stream

Streamflow data at the Clear Creek watershed were calibrated to an HSPF model parameterized according to the Big Creek HSPF model. The final GWLF-E calibration results for Clear Creek are displayed in Figures J-1 and J-2. The statistical analysis for the calibration period showing the model accuracy is given in Table J-2. Model calibration was considered good as the total runoff volume error is less than ten percent.

Table J-2. GWLF-E Flow Calibration Statistics for Clear Creek.

Watershed	Simulation Period	R^2 Correlation value	Total Volume Error (Sim - Obs)
Clear Creek	10/01/1998 - 9/30/2008	0.94	3.53%

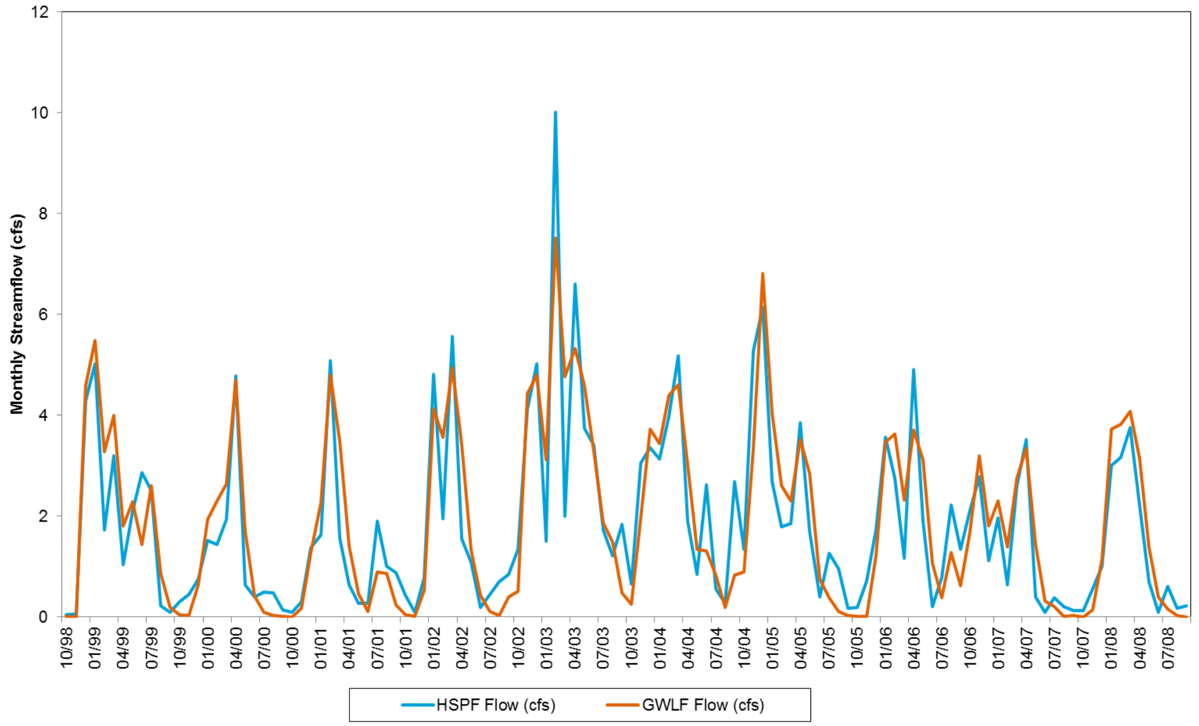

Figure J-1. Comparison of Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in Clear Creek.

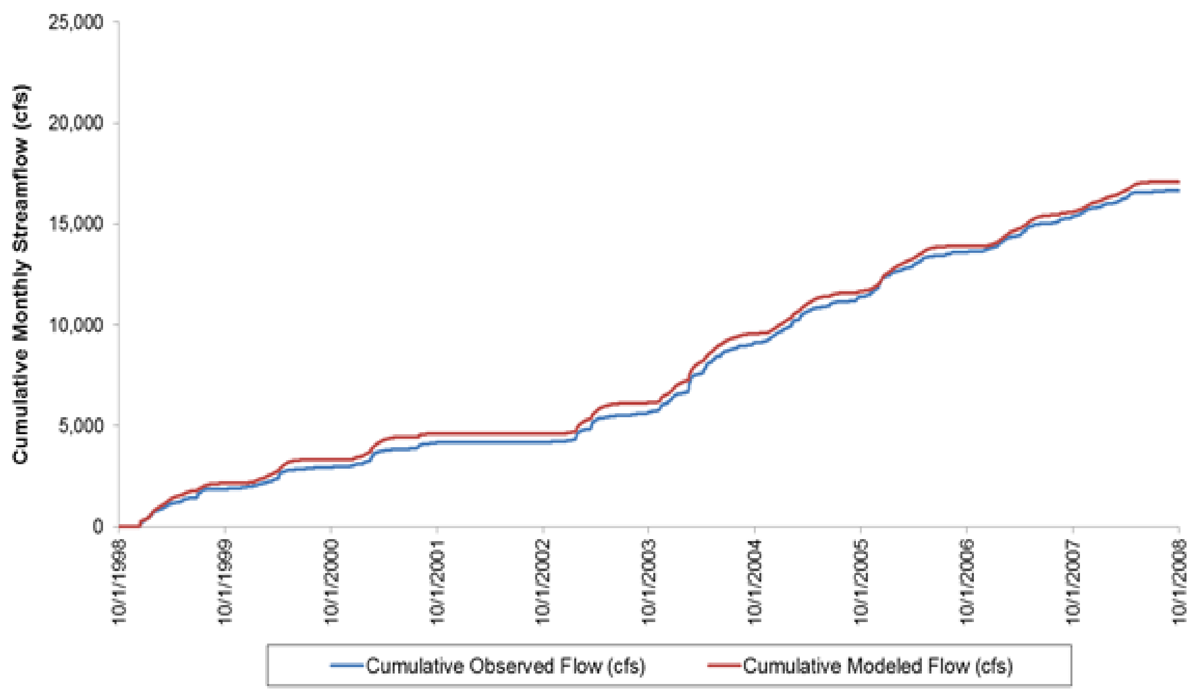

Figure J-2. Comparison of Cumulative Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in Clear Creek.

White Creek – Reference Stream

Streamflow data at the White Creek watershed were calibrated to an HSPF model parameterized according to the Big Creek HSPF model. The final GWLF-E calibration results for White Creek are displayed in Figures J-3 and J-4. The statistical analysis for the calibration period showing the model accuracy is given in Table J-3. Model calibration was considered good as the total runoff volume error is less than ten percent. Monthly fluctuations were variable but were still reasonable considering the general simplicity of GWLF-E, and the objective is the annual and average annual sediment loadings.

Table J-3. GWLF-E Flow Calibration Statistics for White Creek.

Watershed	Simulation Period	R^2 Correlation value	Total Volume Error (Sim - Obs)
White Creek	10/01/1998 - 9/30/2008	0.93	-9.22%

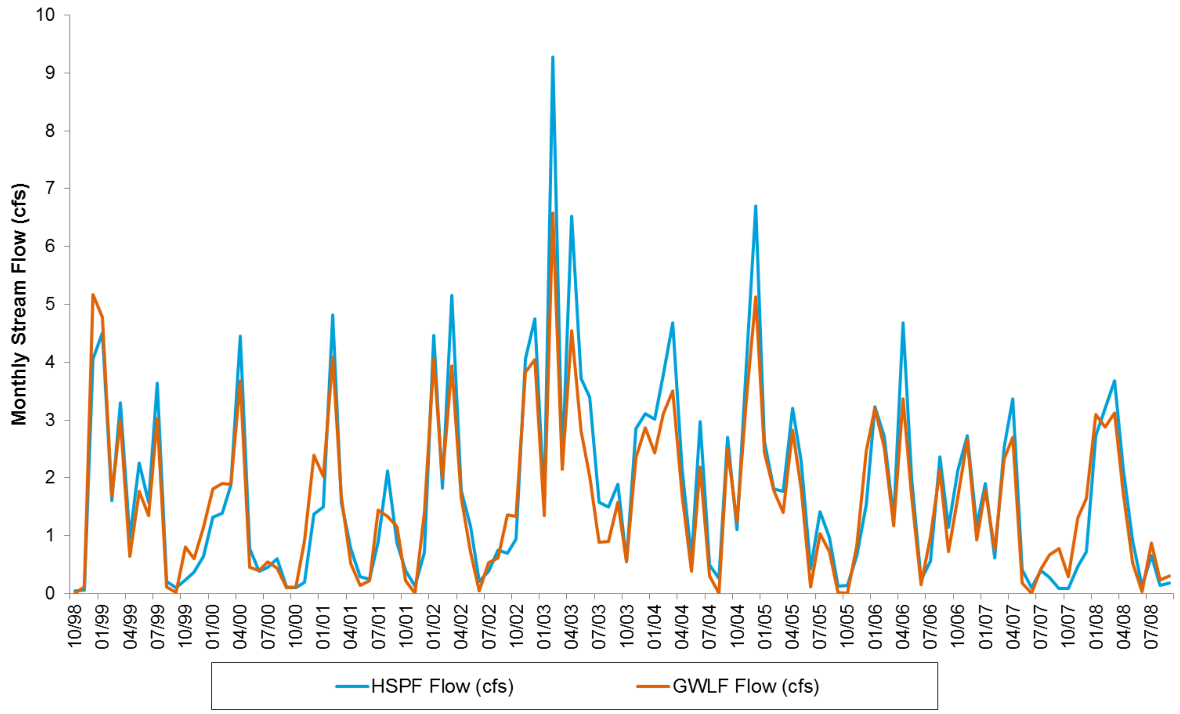

Figure J-3. Comparison of Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in White Creek.

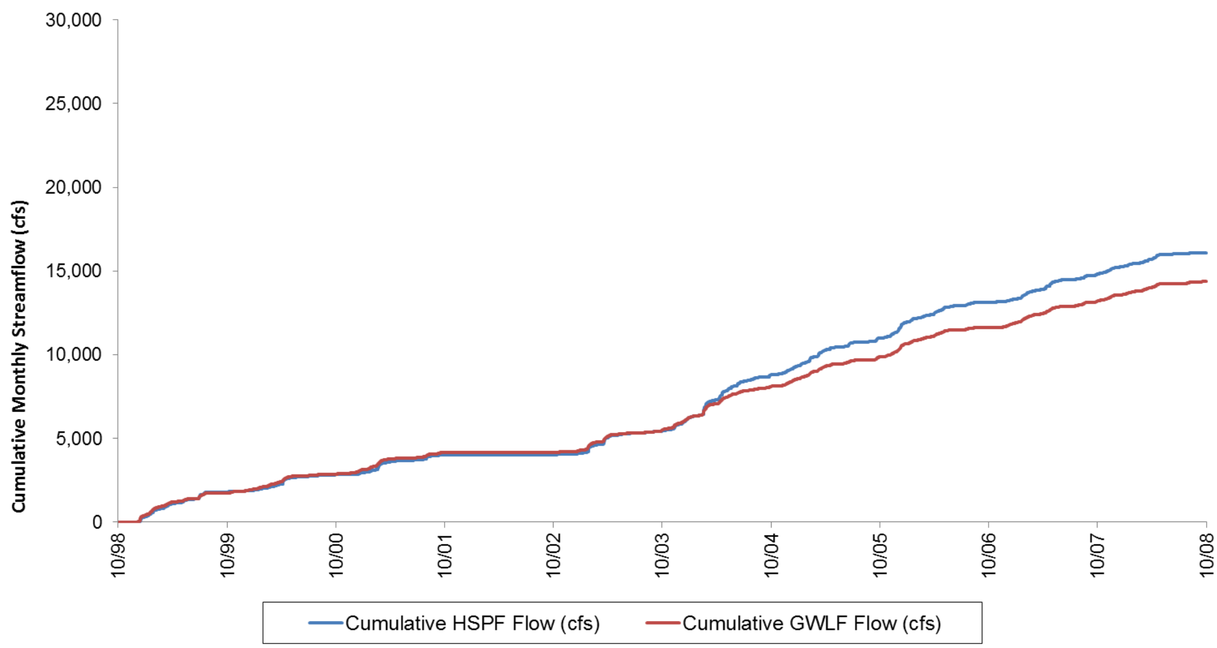

Figure J-4. Comparison of Cumulative Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in White Creek.

Cuckle Creek – Impaired Stream

Streamflow data at the Cuckle Creek watershed were calibrated to an HSPF model parameterized according to the Big Creek HSPF model. The final GWLF-E calibration results for Cuckle Creek are displayed in Figures J-5 and J-6. The statistical analysis for the calibration period showing the model accuracy is given in Table J-4. Model calibration was considered good as the total runoff volume error is less than ten percent. Monthly fluctuations were variable but were still reasonable considering the general simplicity of GWLF-E, and the objective is the annual and average annual sediment loadings.

Table J-4. GWLF-E Flow Calibration Statistics for Cuckle Creek.

Watershed	Simulation Period	R^2 Correlation value	Total Volume Error (Sim - Obs)
Cuckle Creek	10/01/1998 - 9/30/2008	0.94	5.65%

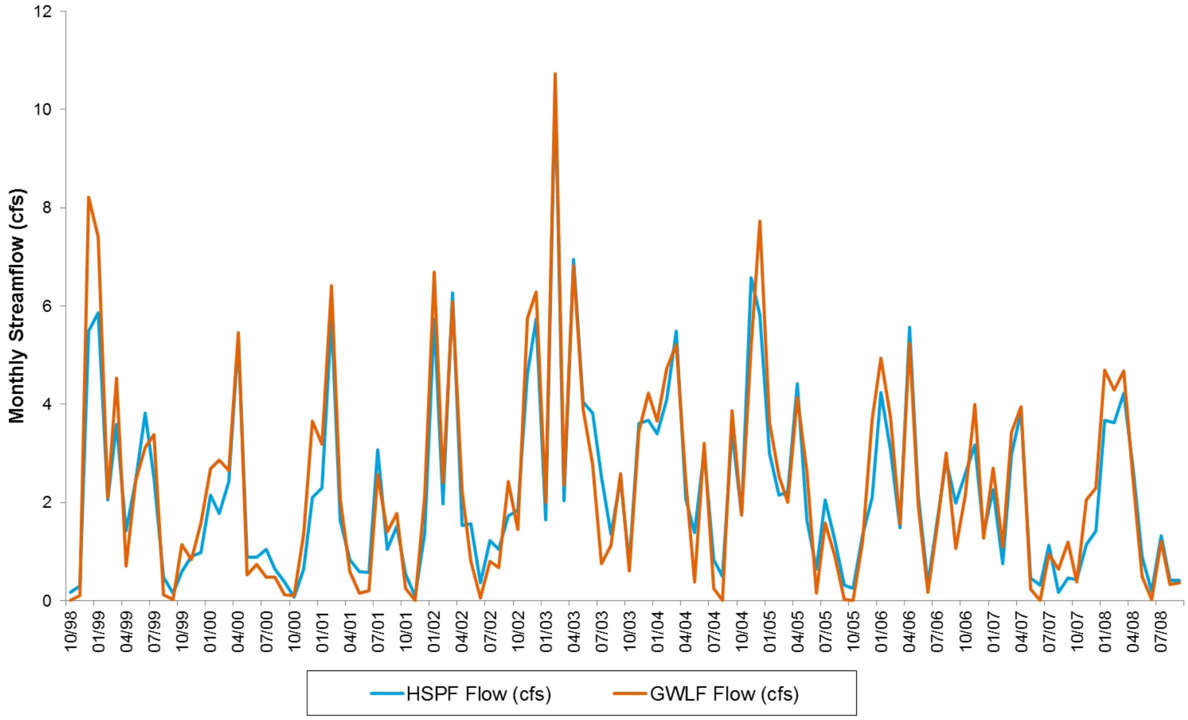

Figure J-5. Comparison of Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in Cuckle Creek.

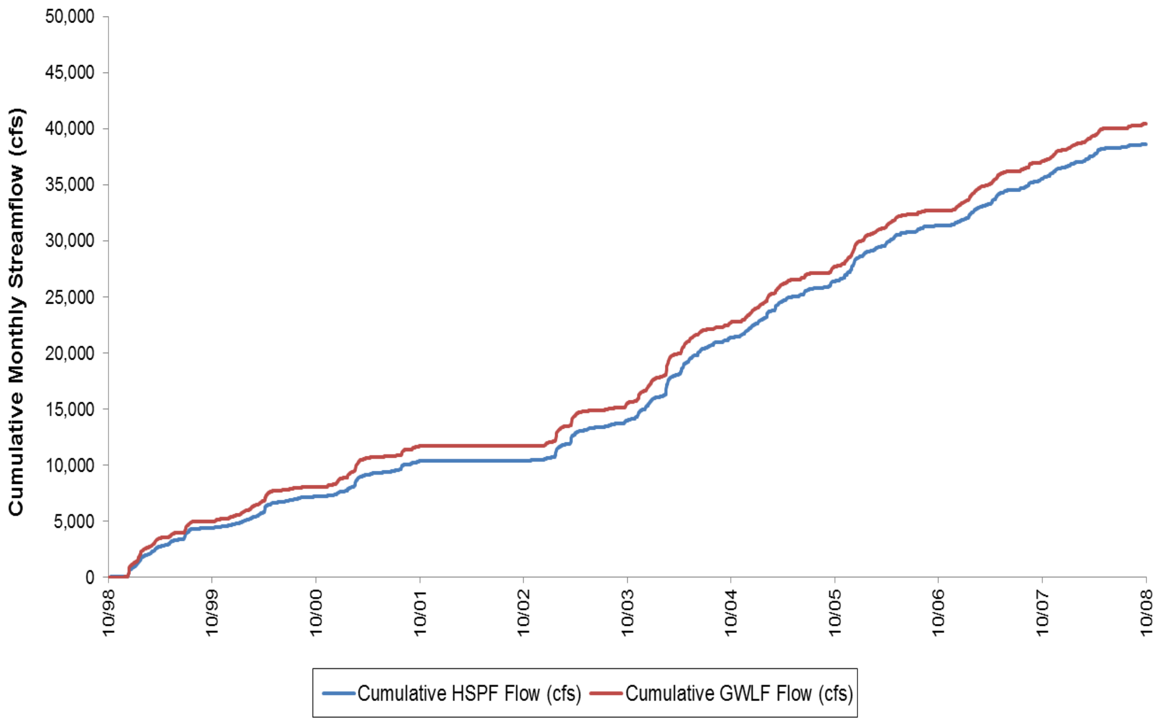

Figure J-6. Comparison of Cumulative Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in Cuckle Creek.

Fall Creek ─ Impaired Stream

Streamflow data at the Fall Creek watershed were calibrated to an HSPF model parameterized according to the Big Creek HSPF model. The final GWLF-E calibration results for Fall Creek are displayed in Figures J-7 and J-8. The statistical analysis for the calibration period showing the model accuracy is given in Table J-5. Model calibration was considered good as the total runoff volume error is less than ten percent.

Table J-5. GWLF-E Flow Calibration Statistics for Fall Creek.

Watershed	Simulation Period	R^2 Correlation value	Total Volume Error (Sim - Obs)
Fall Creek	10/01/1998 - 9/30/2008	0.98	4.20%

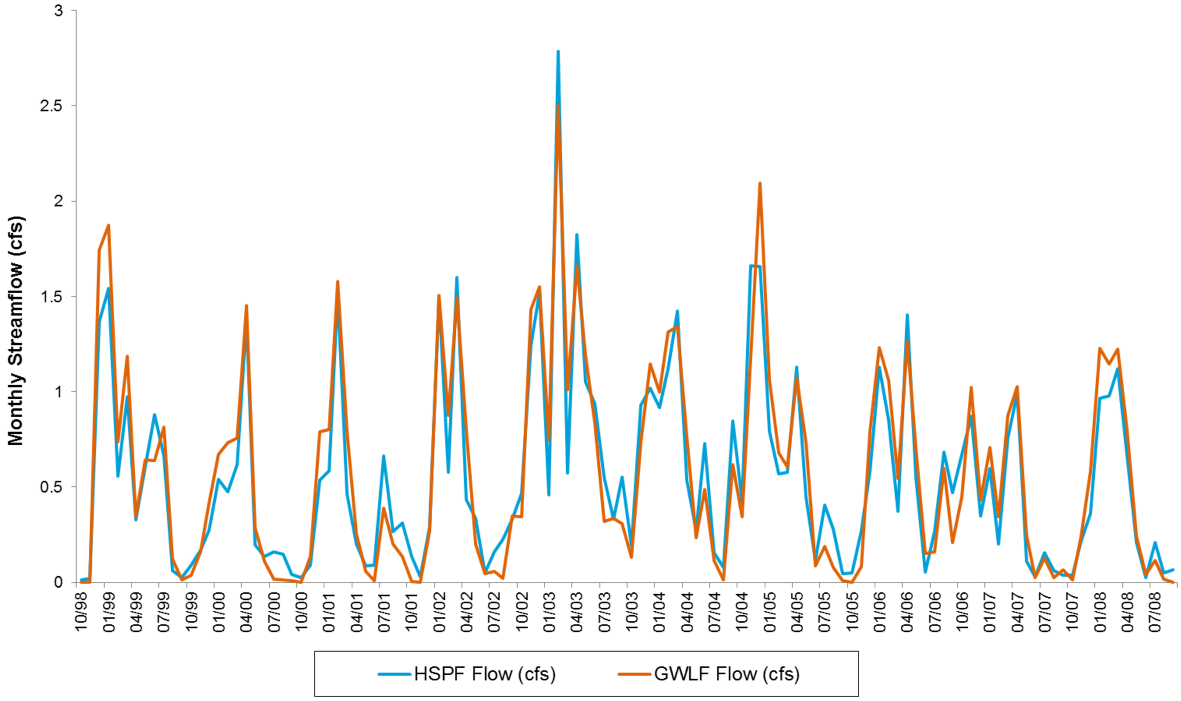

Figure J-7. Comparison of Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in Fall Creek.

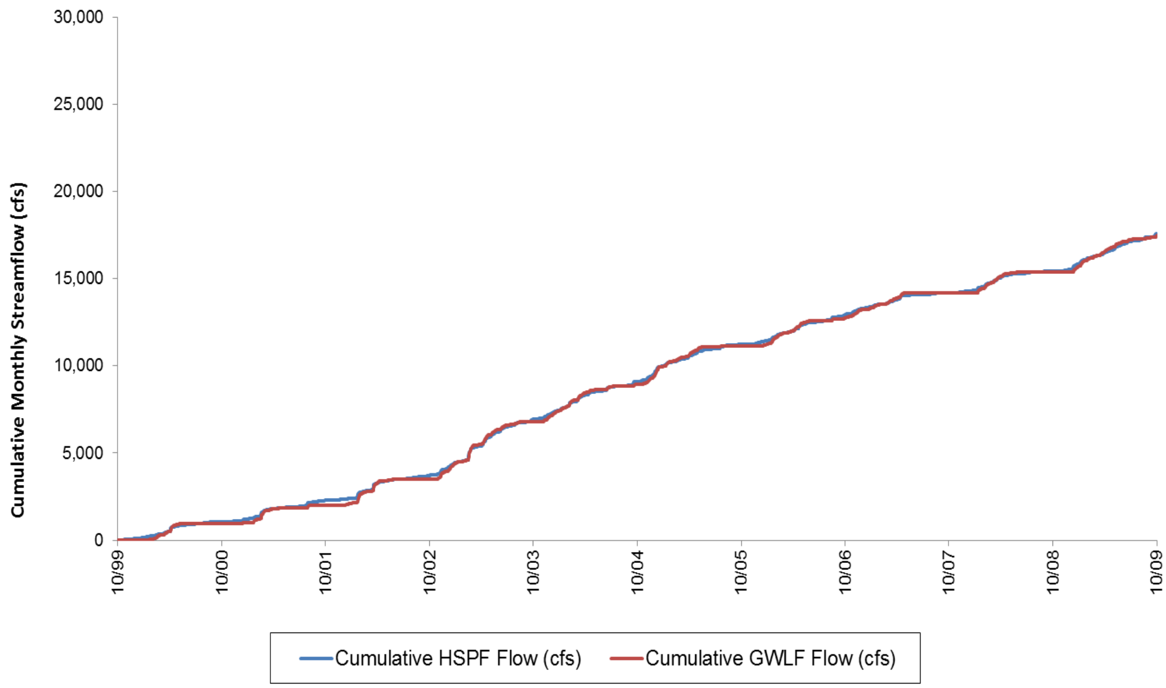

Figure J-8. Comparison of Cumulative Monthly GWLF-E Simulated and Monthly HSPF Modeled Streamflow in Fall Creek.

Appendix K

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER RESOURCES

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOADS (TMDLs) FOR SILTATION IN THE UPPER CLINCH RIVER WATERSHED (HUC 06010205), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Loads (TMDLs) for siltation in the Upper Clinch River watershed, located in northeast Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

A number of waterbodies in the Upper Clinch River watershed are listed on Tennessee's Proposed Final 2014 303(d) List as not supporting designated use classifications due, in part, to loss of biological integrity due to siltation associated with sand/gravel/rock quarry and pasture grazing. The TMDL utilizes Tennessee's general water quality criteria, ecoregion reference site data, land use data, digital elevation data, a sediment loading and delivery model, and an appropriate Margin of Safety (MOS) to establish reductions in sediment loading which will result in reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions in sediment loading of approximately 8% to 54% in the listed waterbodies.

The proposed siltation TMDLs may be downloaded from the Department of Environment and Conservation website:

http://www.tn.gov/environment/article/wr-ws-tennessees-total-maximum-daily-load-tmdl-program

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Resources staff:

Dennis Borders, P.E., Watershed Management Unit
E-mail: dennis.borders@tn.gov, Telephone: 615-532-0706

David M. Duhl, Ph.D., Manager, Watershed Management Unit
E-mail: david.duhl@tn.gov, Telephone: 615-532-0438

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than May 30, 2016 to:

Department of Environment and Conservation
Division of Water Resources
Watershed Management Unit
William R. Snodgrass TN Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Resources, William R. Snodgrass TN Tower, 312 Rosa L. Parks Avenue, 11th Floor, Nashville, Tennessee 37243. They may be inspected during normal office hours. Copies of the information on file are available on request.

Appendix L

Public Comments Received

TN DEPT. ENVIRONMENT AND CONSERVATION
MAY 3 1 2016
DIV OF WATER RESOURCES RECEIVED

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

ENVIRONMENTAL DIVISION
FACILITIES ENVIRONMENTAL COMPLIANCE OFFICE
SUITE 300, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-1402
(615) 741-4732

JOHN C. SCHROER
COMMISSIONER

BILL HASLAM
GOVERNOR

May 30, 2016

Mr. Dennis Borders
Tennessee Department of Environment and Conservation
Division of Water Resources
Watershed Management Unit
William R. Snodgrass Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, TN 37243

Re: TDOT Comments on Proposed Siltation Total Maximum Daily Load for the Upper Clinch River Watershed

Dear Mr. Borders,

The Tennessee Department of Environment and Conservation (TDEC) has recently issued a draft document for public comment presenting a proposed Total Maximum Daily Load (TMDL) for Siltation in the Upper Clinch River Watershed (HUC 06010205). In Section 8.1.6 of that document, the Tennessee Department of Transportation (TDOT) Municipal Separate Storm Sewer System (MS4), regulated under Permit TNS077585, is listed as a point source for the pollutant loading that is the subject of the TMDL.

Inclusion as a point source will trigger requirements in the TDOT MS4 Permit that could include stormwater effluent monitoring, in-stream monitoring, and the implementation of control measures at discharge points. The TDOT MS4 discharges to most streams within the state of Tennessee. TDOT's necessary approach in applying its finite resources that can be devoted to improving water quality is to focus on those locations where the efforts can truly be beneficial and cost effective. TDOT has proposed a prioritization process for all TMDLs to which the TDOT MS4 discharges that would most efficiently allocate TDOT resources to remediating the most significant water quality issues. TDOT does not believe that the inclusion of its MS4 as a point source for the pollutant loading which is the subject of this TMDL is consistent with this approach and requests that the subject document be modified to remove the TDOT MS4 as an identified point source.

The rationale for this request includes the following three points:

1. **The drainage area of the TDOT MS4 which contributes to the subject watershed is a negligible portion of the overall watershed area.** The subject TMDL affects a total of

two impaired stream segments in the Upper Clinch River Watershed. Those two stream segments include designated portions of:

- Cuckle Creek (TN06010205001T-0200)
- Fall Creek (TN06010205001T-1400)

Data from TDOT's outfall mapping program has determined that the TDOT MS4 has point source discharges to the Cuckle Creek stream segment at nine (9) locations and point source discharges to the Fall Creek stream segment at 21 stormwater outfall locations. The total area within the TDOT MS4 that drains to the Cuckle Creek subwatershed is calculated to be 20.4 acres, while the total area within the TDOT MS4 that drains to the Fall Creek subwatershed is calculated to be 27.1 acres. However, the total drainage area of the Cuckle Creek impaired stream segment subwatershed is 3785 acres, and the total drainage area of the Fall Creek impaired stream segment subwatershed is 2790 acres. The TDOT MS4 drainage area contributing to the watersheds of the Cuckle Creek and Fall Creek stream segments is 0.54% and 0.97%, respectively, of the overall impaired watershed drainage areas. Assuming that the drainage area would be roughly proportional to the volume of stormwater discharge to the stream segments, the TDOT MS4 is clearly a negligible contributor to these hydrologic systems. Even If the TDOT MS4 could somehow completely eliminate its stormwater discharges to the subject stream segments, the ultimate effect would be imperceptible.

Additionally, numerous sources in the literature have found that impervious areas within a watershed do not significantly impact water quality until the impervious area exceeds 10% of the watershed area. See for example the following online articles:

- EPA: Caddis Volume 2: Thresholds of Imperviousness
  https://www3.epa.gov/caddis/ssr_urb_is4.html

- Center of Watershed Protection: The Importance of Imperviousness
  http://scc.wa.gov/wp-content/uploads/2015/06/The-Importance-of-Imperviousness_Schueler_2000.pdf

- EPA: Screening to Identify and Prevent Urban Stormwater Problems: Estimating Impervious Area Accurately and Inexpensively
  https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=63937&CFID=5841148&CFTOKEN=61881503&jsessionid=3830106d366c41758a8969772a4b123943b3.

The TDOT MS4 drainage area used to calculate the relative drainage area values of 0.54% and 0.97% of the total subwatersheds includes the total drainage area of the TDOT Right-of-Way, including both the impervious roadway and any adjacent pervious shoulders, ditches, swales, and vegetated areas. Thus, the actual effective impervious area of the TDOT MS4 would be expected to be significantly lower than 0.54% and 0.97% values. The TDOT MS4 should only be accountable for contamination that originates within its boundaries.

2. **Post-construction highway run-off from the TDOT MS4 is not a significant source of solids contamination in stormwater.** The TDOT MS4 Program has been acquiring and analyzing actual samples of stormwater runoff from state highways in Tennessee over the past four years. These samples have been acquired from a variety of highway scenarios

across the State, ranging from high traffic volume interstate highways in urban commercial areas to low traffic volume highways in rural agricultural areas. The sampling sites were selected (and approved by TDEC) to ensure that the runoff was exclusive to the TDOT ROW with minimal impact from non-roadway runoff. To date, a total of 277 stormwater samples from the TDOT MS4 have been evaluated for Total Suspended Solids (TSS). The average state wide TSS result from the analysis of these samples is 43.7 mg/L. For sampling locations within the Ridge and Valley Level III Ecoregion (i.e. East Tennessee) the average TSS result is reduced to 19.5 mg/l (157 samples). These values are less than one-third the benchmark value of 150 mg/L in the Tennessee Storm Water Multi-Sector General Permit for Industrial Activities. Contrary to the common paradigm, in Tennessee **post-construction** highway run-off is not a significant source of solids contamination in stormwater.

3. **The TDOT MS4 would not be able to quantitatively demonstrate compliance with the specified Waste Load Allocations (WLAs) or Percent Load Reduction Goals (PLRGs).** The WLAs prescribed in the subject TMDL document for MS4s are:

    - 2.56 lbs/acre/in. precip (Cuckle Creek subwatershed)
    - 3.44 lbs/acre/in. precip (Fall Creek subwatershed)

    Because of the unique nature of the discharges from the TDOT MS4, TDOT does not believe it is possible for it to quantitatively demonstrate compliance to these numeric criteria, for the following reasons:

    - The TDOT MS4 discharges to the Cuckle Creek and Fall Creek stream segments at 30 discrete (i.e. point source) outfall locations. However, outfall mapping and sampling research has demonstrated that most of these outfalls not only discharge stormwater from the TDOT MS4 but also stormwater which originated from adjacent MS4 and non-MS4 properties that ran-on to the TDOT MS4. Again, the TDOT MS4 should only be accountable for contamination that originates within its boundaries. There would be no reasonable way to differentiate between the quantity of contaminants which originated on the TDOT MS4 with those that originated off-site to define the "lbs" term in the WLA.

    - The discharge from the 30 TDOT outfalls is produced only in direct response to rainfall events. The TDOT MS4 Program has been acquiring and analyzing actual samples of stormwater runoff from state highways in response to rainfall events throughout Tennessee over the past four years. These rainfall events can vary significantly in the amount of rainfall, the intensity of the rainfall, and the duration of the storm event. All of these factors have been shown to affect the quantity of discharge and concentration of contaminants in the run-off. Other factors that are unique to each rainfall event, such as antecedent precipitation, can also impact the quantity and nature of the discharge. Delineating the quantity of contamination (i.e. the "lbs" term in the WLA) that would be produced by the discharges from these 30 outfall locations to any single rainfall event without direct sampling of each outfall would be impossible.

    - Although TDOT has defined the total area of the MS4 within the subject watershed, this area is much greater than the actual area which drains to the discrete outfall points. Most of the area within the TDOT MS4 (within the subject watersheds) drains in a sheet-flow manner to the pervious shoulders, ditches and vegetated swales which usually border the impervious roadway. This stormwater is infiltrated into the soil or runs-off the MS4 as a non-point source discharge. Additionally, the effective drainage area for each outfall is a function of the conditions during the rainfall event, such as rainfall intensity, antecedent precipitation, and wind velocity, among others. Thus, it is virtually impossible to quantify the effective drainage area of the TDOT MS4 for any given rainfall event and the "per acre" term in the WLA cannot be defined.

- Multiple federal court cases have defined that the "per day" term in a TMDL must be evaluated on a daily basis. For example, the U.S. Court of Appeals for the D.C. Circuit in *Friends of the Earth, Inc. v. EPA, et al.*, (No. 05-5015, April 25, 2006) found that nothing in the language of 33 U.S.C. § 1313 suggested that the EPA was authorized to approve total maximum loads that could be evaluated other than on a daily basis. The court's decision included the comment: "Daily connotes every day," said Judge Tatel. "Daily means daily, nothing else." This principle was reaffirmed in the Federal court case *Virginia Department of Transportation, et al, v. EPA, et al.*, No. 12-775 (E.D. Va. 2013). The TDOT MS4 does not discharge to the impaired stream segments on a daily basis, but likely only 40 to 60 times per year (and the discharge generally only lasts a few hours), and thus demonstrating a "daily" loading would seem impractical for TDOT. For example, would TDOT be able to distribute the observed sediment levels in its stormwater discharge from a rainfall event over the preceding antecedent dry days? Thus, the "per day" term in the WLA could not be reasonably and accurately evaluated for the discharges from the TDOT MS4 and applying this TMDL to the TDOT MS4 is not valid.

- The TMDL document also prescribes a "Percent Load Reduction Goal (PLRG)" as alternate criteria to the WLAs to demonstrate compliance. This criterion is a percentage reduction in the current loading. However, the document does not give any indication as to the source or nature of the baseline levels to which the percentage reduction would be applied. For TDOT to establish a current baseline of sediment levels in its discharges, stormwater sampling at its 30 outfalls would have to be performed for at least a year. This could require over 1800 sample acquisitions and analyses, with a cost to TDOT that could exceed $6 million. This would not be a prudent expenditure of State of Tennessee resources.

The stormwater runoff from the TDOT MS4 has been shown to be an unlikely source of sediment contamination and a negligible contributor to the hydrologic regime of the subject watersheds based upon a comprehensive consideration of multiple factors discussed above, including:

- the evaluation of multiple stormwater runoff studies regarding the very limited potential contribution of highway runoff to sediment contamination of surface water;

- the analysis of the relative area of the TDOT MS4 to the subject watersheds which demonstrate that the TDOT MS4 drainage area contributing to the watersheds of these stream segments is less than 0.54% and 0.97% of the overall impaired watershed drainage areas and that the TDOT MS4 is clearly a negligible contributor to this hydrologic system; and

- Tennessee specific stormwater sampling results which demonstrate the low levels of sediment contamination which originate from post-construction TDOT highways.

Additionally, due to the unique nature of the discharges from the TDOT MS4 to the subject watershed, quantitatively demonstrating compliance to the specified numeric WLA criteria would not be possible. Expending State of Tennessee resources to attempt to characterize the unlikely contaminant contribution of the TDOT MS4 to this watershed does not appear to be prudent Based on this information, TDOT respectfully requests that this draft TMDL document be revised to remove the TDOT MS4 as a possible source for the subject contamination.

Thank you for the opportunity for TDOT to provide comments on this draft TMDL document. If you have any questions, or require additional information or documentation, please call me at 615-741-4732 or email me at Barry.Brown@tn.gov.

Sincerely,

Barry C. Brown
Program Manager, Environmental Compliance Office
TDOT Environmental Division

Cc:
Jim Ozment, TDOT
Sharon Shutz, TDOT
Project Files

Appendix M

Response to Public Comments Received

Response to comments from TDOT (numbers correspond to bulleted comments by TDOT):

Introduction

The TMDL document identifies TDOT as a point source with the potential to contribute siltation to the subject waterbodies.

TDEC supports prioritization of TDOT MS4 discharge locations to most efficiently allocate resources in order to remediate the most significant water quality issues.

The following are responses to numbered comments (additional information follows):

1. The drainage areas of the TDOT MS4 in each watershed are larger than other point source facilities that have been assigned Waste Load Allocations (WLAs). Like other stormwater permittees (e.g., TMSP), regardless of size, the TDOT MS4 is considered a potential source and is assigned a WLA.

2. TDEC is familiar with the TDOT stormwater sampling study on Tennessee highways. The data confirm that TDOT outfalls have the potential to be contributors of siltation and that these contributions can be quantified. (See calculations below).

3. TDEC maintains that TDOT has already quantitatively demonstrated the capability to calculate loading from TDOT sites on an annual unit area basis, consistent with TMDL WLAs. (See calculations below). Although loading can be calculated, compliance with the WLA is demonstrated by TDOT permit compliance.

The daily expression of MS4 WLAs is in units of pounds per acre per inch of precipitation (lb/ac/in). The daily allocation is based on the amount of precipitation on any given day. Therefore, loading from MS4s is only allowable on days with precipitation. On days with no precipitation, the allocation is zero. The daily expression of the TMDL MS4 WLA = 2.56 lb/ac/in for Cuckle Creek. The daily expression of the TMDL MS4 WLA = 3.44 lb/ac/in for Fall Creek.

The term “Percent Load Reduction Goal” is not used in the TMDL; however, the TMDL and WLAs/LAs are also expressed as percent reductions. Baseline levels are derived from ecoregion reference watersheds and the percent reductions are those required to bring impaired watersheds to reference loading levels.

Additional information:

The following information was presented to TDEC by TDOT in a presentation titled “Stormwater Runoff from Tennessee Highways” on September 8, 2015:

The example shown is from TDOT location SR-61 in Clinton, TN (site C01), located in the Lower Clinch River watershed.

Calculation of sediment contribution from site C01 (note: ***bolded/italicized*** numbers are from TDOT; others are calculated):

Drainage Area (DA) = ***12.7 ac*** = 553,212 ft^2

Average Discharge per event = ***187,347 gal.*** = 25,048 ft^3

Average Runoff per event = (25,048 ft^3/553,212 ft^2)*12 in/ft = 0.54 inches

TDOT estimated Runoff Coefficient (C)[1] for area draining to C01 outfall = ***0.78***

Average precipitation per event = 0.54 in/0.78 = 0.70 inches

Average sediment loading per sampling event = ***3.94 lb/ac***

<u>Therefore, average sediment loading per unit area per sampling event</u>

(3.94 lb/ac)/0.70 inches = <u>5.66 lb/ac/inch of precipitation</u>

The daily expression of the TMDL MS4 WLA = 2.56 lb/ac/inch of precip for Cuckle Creek.

The daily expression of the TMDL MS4 WLA = 3.44 lb/ac/inch of precip for Fall Creek.

Four additional sites were similarly examined by TDOT. Three of the four sites had higher average sediment loading (lb/ac) than the example site C01. This and the above calculations demonstrate <u>potential</u> for TDOT MS4 outfalls to contribute to sediment loading and even exceed the TMDL WLA in the Upper Clinch River watershed and that it is possible for TDOT to quantify loading from a single outfall.

[1] The runoff coefficient (C) is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received.