

## **Obed River Watershed Based Plan**

**Name of Project: Obed Watershed Headwaters IV**

**Lead Organization: Obed Watershed Community Association**

### **Watershed Identification:**

The Obed River Watershed is located primarily in Cumberland County, TN with a small portion located in Fentress County. It drains into the Emory River. There are ten HUC-12 numbers that describe subwatersheds that are entirely or mostly within Cumberland County. All ten of these subwatersheds will eventually be included in the Watershed Management Plan, but only four of them are being included in this current plan because there has been sufficient assessment work to describe the problems and identify problem areas that can be mitigated. The ten HUCs with their names are: Obed River, 060102080101, Obed River, 060102080102, Obed River, 060102080103, Obed River, 060202080104, Daddys Creek, 060102080201, Daddys Creek, 060102080202, Daddys Creek, 060102080203, Clear Creek 060102080301, Clear Creek 060102080302 and Crab Orchard Creek 060102080406. The five sections that will be addressed in this plan are Obed River 060102080101, Obed River, 060102080102, Obed River, 060202080103, Daddys Creek, 060102080201, and Daddys Creek, 060102080202. Within these five subwatersheds are eleven stream segments listed as 303(d) streams. Three are within the 060102080101 Obed section, two in the 060102080102 Obed section, and there is one in the 060102080201 section of Daddys Creek and five in the 060102080202 section of Daddys Creek.

As of the 2014 303(d) list, the following are the fourteen 303(d) streams or stream sections listed in Cumberland County. Maps showing their location and their watersheds follow.

One Mile Creek is located in Cumberland County, TN with most of its watershed within the city limits of Crossville. The Waterbody ID is TN06010208015-0930. There is a siltation TMDL for this stream.

Byrds Creek is a tributary of Daddys Creek and receives the waters of One Mile Creek, Three Mile Creek and a number of smaller tributaries. It is listed for 32.01 miles from its headwaters to its confluence with Daddys Creek. The Waterbody ID is TN 06010208015-0900. A TMDL has not yet been issued for this stream because all sources of impairment have not been determined or listed.

There are three impaired sections of the Obed River in Cumberland County. The first is located within the city limits of Crossville, below Holiday Lake. The Waterbody ID is

TN06010208013-2000. Part of its headwaters begins outside the city limit but most of the watershed is within the city south and west of downtown. It has a major tributary in Spiers Branch and a number of secondary tributaries, one of which is named Town Branch. There is a habitat alteration TMDL for this stream, but significant sedimentation is also present.

The next downstream section of the Obed River is also listed. It begins downstream of the Crossville Water Treatment Plant and flows north and east out into the county and ends when the river crosses Genesis Road. Its Waterbody ID is TN06010208013-1000. It is listed for nutrients.

The final segment of the Obed River begins at Genesis Road and runs to the junction with Daddys Creek. Its Waterbody ID is TN 06010208007-2000. It is also listed for nutrients.

The Little Obed River has a number of branches that form the stream. Roughly half of them begin within the City limits, but they come together within the City and flow west to meet the Obed. Its Waterbody ID is TN06010208013-0200. A TMDL exists to deal with some of its pollutants.

Drowning Creek has a TMDL and is a direct tributary to the Obed River in the TN06010208013-1000 section. The part of its watershed with the greatest impairment from animal feeding lies outside the city limit and is being addressed by NRCS and is not included in this plan. This plan will address problem areas within this watershed that are covered by its most important tributaries – Meadow Creek and Copeland Creek. The Drowning Creek Waterbody ID is TN06010208013-0400.

Copeland Creek was added to the 2014 303(d) list for siltation and has an approved TMDL. Its Waterbody ID is TN06010208013-0420.

The following three stream segments are 303(d) listed because of flow alterations due to impoundments, but assessment work by OWCA uncovered other issues, including siltation that offer opportunities for remediation: All three are in the Daddys Creek watershed.

Bagwell Creek has been impounded by three of the lakes at Fairfield Glade. No TMDL will be developed. Its Waterbody ID is TN06010208015-1111

North Creek has been impounded by Turner Lake. No TMDL will be developed. Its Waterbody ID is TN06010208015-1150.

Black Gum Branch has been impounded by one of the lakes at Fairfield Glade. No TMDL will be developed. Its Waterbody ID is TN06010208015-1410.

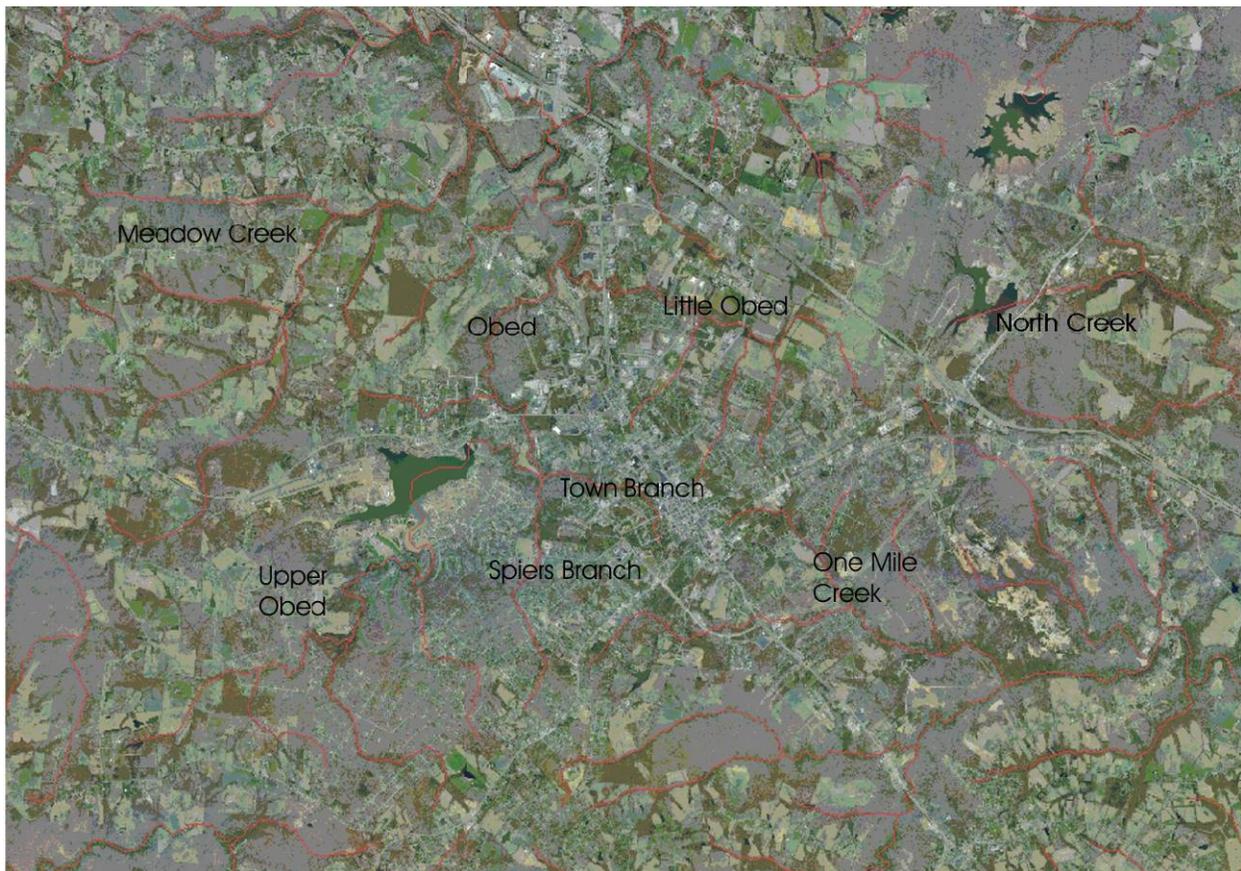
The following are the 303(d) listed streams that will not be addressed by this plan.

Scantling Branch drains an impoundment and then feeds Fox branch, which is a trib to the Obed River in the 060102080104 section. A TMDL does not yet exist for this stream. Its Waterbody ID is TN06010208007-0210.

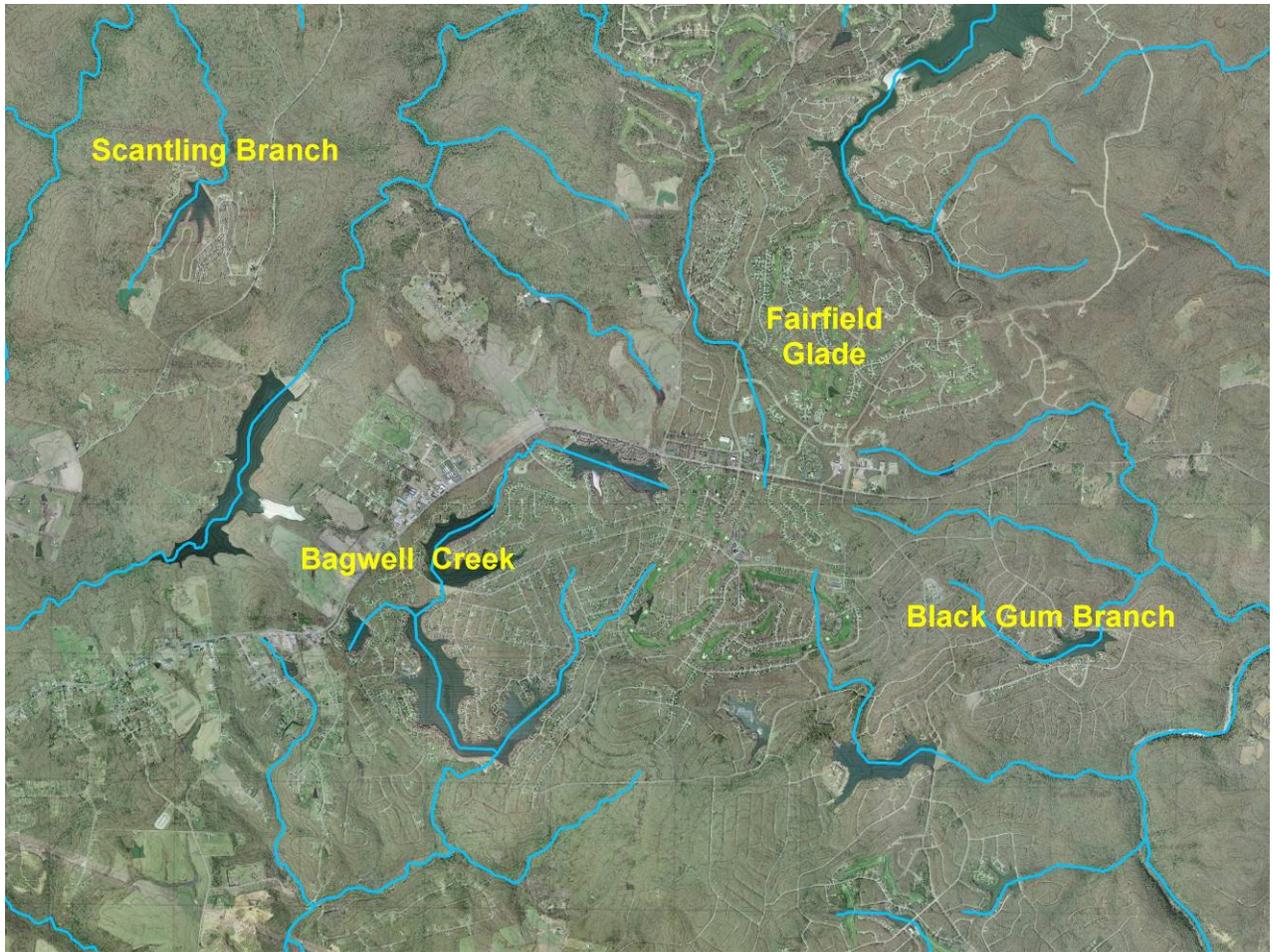
Lick Creek is south of Crossville and is a tributary to Daddys Creek. OWCA has not assessed this stream but its impairment is incorrectly listed as upstream impoundment. Its Waterbody ID is TN06010208015-0600.

Long Branch is also south of Crossville in Cumberland County, TN and is a tributary to Lick Creek. It is in the Daddys Creek watershed. The Waterbody ID is TN06010208015-0610. There is a siltation TMDL for this stream.

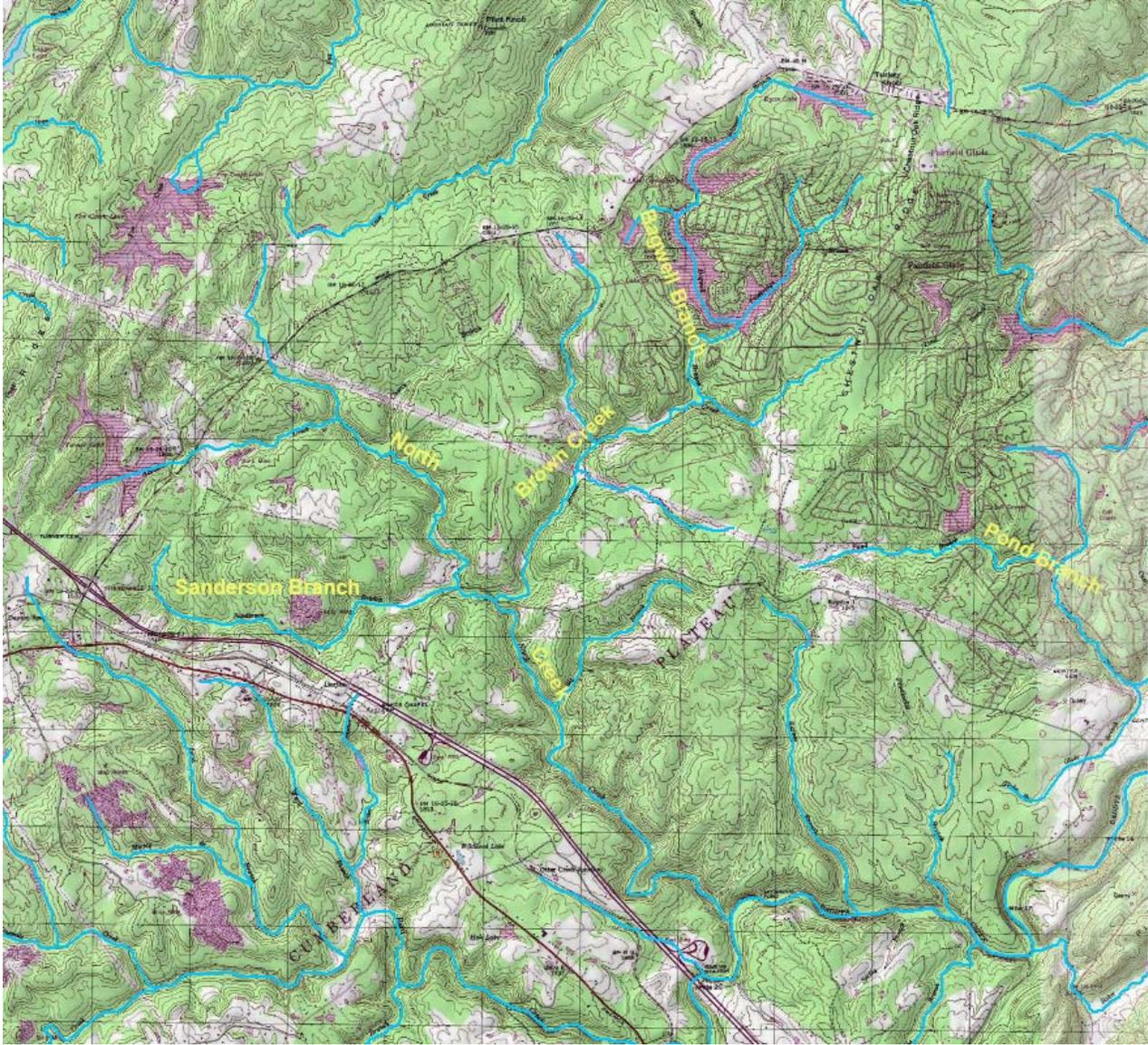
A goal of the Obed Watershed Community Association is to assess all streams in the ten HUC 12 subwatersheds over the next seven years and to include them in the overall Watershed Plan once the assessments are completed.



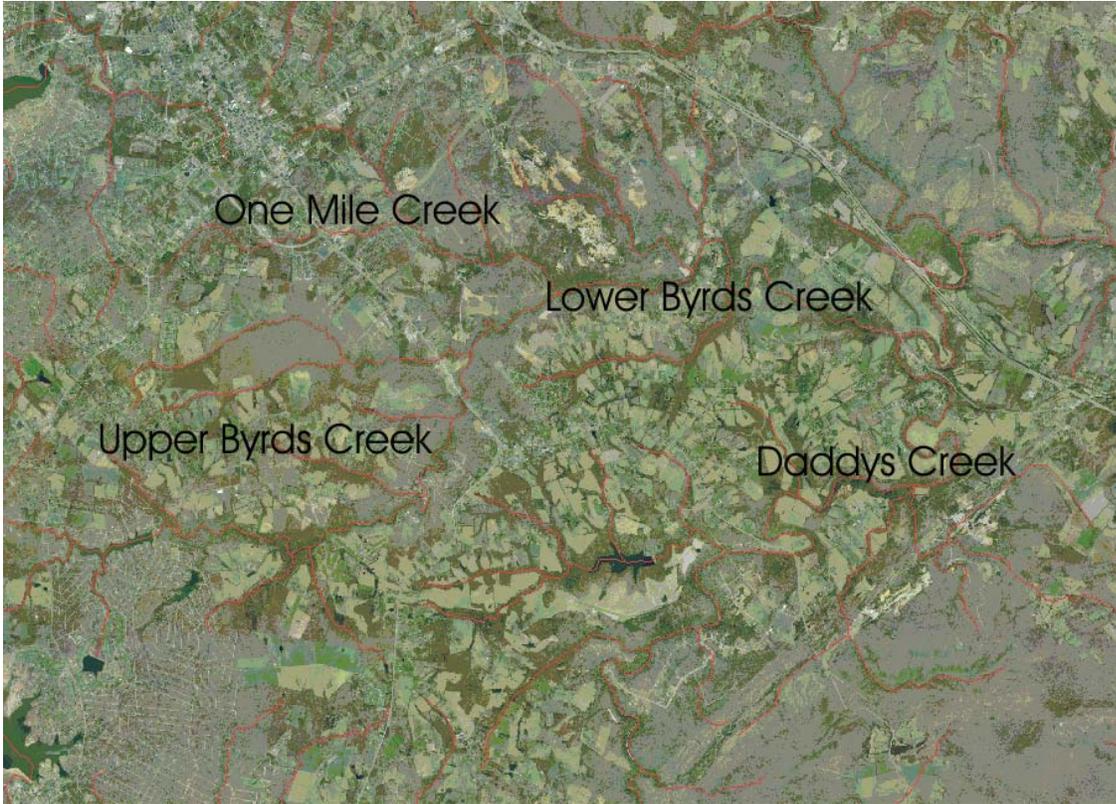
Map 1



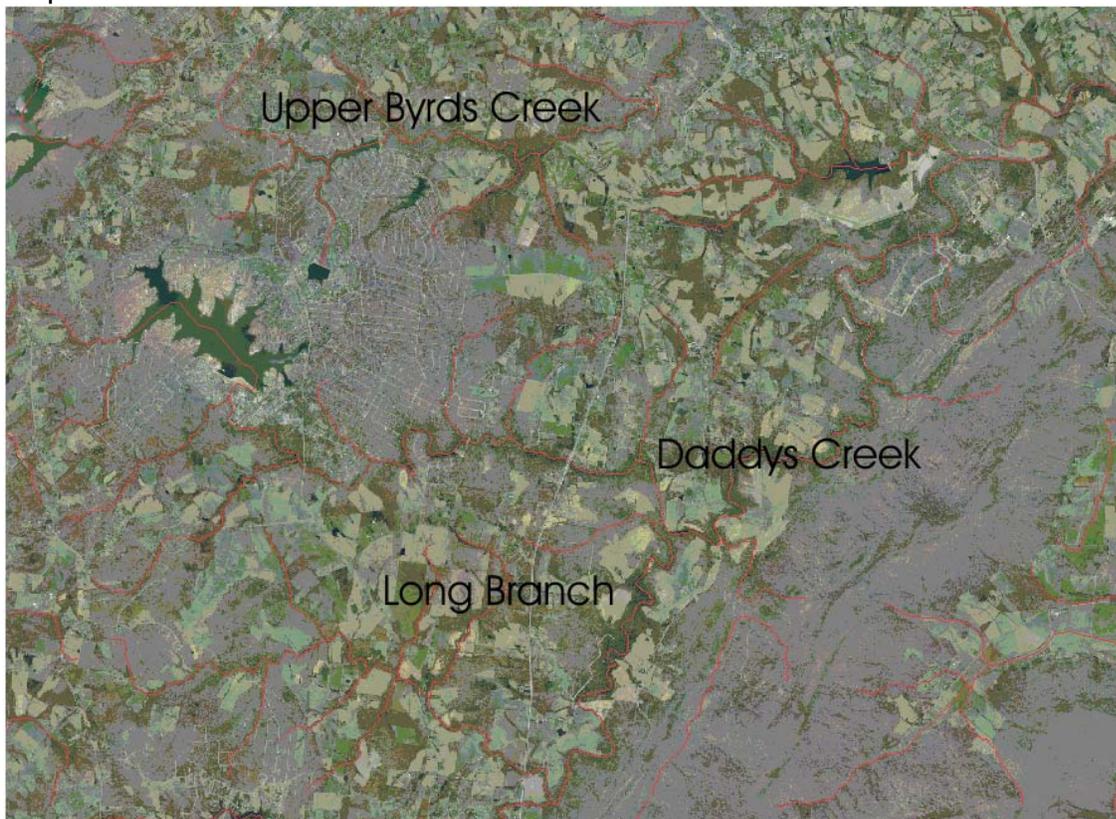
Map 2



Map 3



Map 4



Map 5

## **Causes and Sources of Nonpoint Source Pollution in the Watershed**

There are fourteen stream segments listed in the 2014 303(d) list for Cumberland County within the Obed River watershed. Seven of the segments are listed as Category 5, of which five have no TMDL, with the listing related to upstream impoundments or discharges from point sources in the Crossville MS4 area, including the wastewater plant. (Of course, correcting the wastewater leakages is not a component of the 319 program). The remaining Category 5 stream segment lists both leakages from the wastewater collection system as well as siltation that is covered by the existing TMDL for siltation. Of the seven listed stream segments listed as Category 4, three are listed as 4c, citing the impacts of upstream impoundments and no TMDLs have been written. One is listed as 4a with a habitat alteration TMDL, as well as 4c for a flow alteration due to an impoundment. The remaining three have siltation TMDLs. In total, then, five listed streams have sediment as a source of impairment with the sixth habitat alteration cause incorporating both alterations in flow regimes and sedimentation.

Unfortunately, the brief descriptions in the 303(d) list and the limited assessment that TDEC conducts to determine impairment significantly understates the impact of development on the hydrology of the watershed and the effect of the “urban stream syndrome” on bank erosion and siltation of streams. The Obed Watershed Community Association (OWCA) has done visual stream assessments of roughly three hundred fifty miles of streams, all within these impaired watersheds and has uncovered significant impairments along many segments. Of the fourteen segments listed, OWCA has not assessed only the Clear Creek and Lick Creek watersheds. It assessed all of the Drowning Creek watershed with the exception of the main stem of Black Drowning Creek. The Byrds Creek watershed (including Three Mile Creek, Lead and Muddy Branches, and Long Branch), Bagwell Branch watershed, North Creek watershed, and Black Gum Branch watershed, all have significant sedimentation and bank erosion issues related to development which goes far beyond the issue of flow alteration due to impoundments listed in the 303(d) document. Adding these four 303(d) listed streams to the sedimentation list brings the total of sediment- impacted streams to ten out of the fourteen streams, and even that understates the problem as tributary and upstream segments of some of the 303(d) listed segments also have bank erosion and sedimentation problems.

While there continues to be some conversion of forest land to pasture, for the most part pasture management practices increasingly leave a vegetated buffer along the edge of streams though this is not universally so. A larger source of agriculture-related siltation comes from row cropping of commercial vegetables, especially green beans with stream buffers not wide enough to capture the soil erosion after heavy rains. The far larger impact on streams, however comes from impervious conversion of land to residential and commercial use, including roads and parking lots. Often such properties compound the problem of such conversion by directing runoff into hardened channels that empty directly into nearby streams. Both residential and commercial properties

often clear right up to stream banks. Even when this occurs only along existing road corridors, the “urban stream syndrome” effect is present.

A more detailed narrative description

The primary water quality problem for One Mile Creek, identified by TDEC and listed as the TMDL for One Mile Creek is “loss of biological integrity due to siltation.” TDEC has ranked its TMDL Priority as high. The pollutant source is listed as Land Development and it is listed as a Category 5 stream. A visual assessment conducted of the watershed during 2007 revealed a more complex set of factors than simply “land development.” The stream itself has four major branches and each of these has more than one tributary. There are significant differences in both the amount of water and the quality of water that each branch delivers. Stormwater run-off is the key source of siltation, but there are different dynamics at different sites that contribute to the erosion that brings the silt onto the water. One segment is impacted heavily by a large auto salvage operation that contributes heavy silt loads during storm events. This same segment is most heavily impacted by the recent new TDOT relocation and widening of Lantana Road. Further down that branch is a TDEC permit holder who operates a rock yard. Also on that branch is significant 4-wheeler riding in and across the stream, contributing to the erosion and run-off of soil. On two other branches, the key factor is simply volume of run-off which is causing bank erosion and stream bed scouring, due to concentrated areas of impervious surfaces feeding directly into the stream. On the final branch, it is impacted by an eroding gravel (mainly dirt) road that is spilling mud into both of the tribs of that branch, as well as a separate large pond that is developing a new spillway from both the bottom of the dam (seepage), and drainage around that side of the dam from a 4-wheeler road. This new channel for the water is cutting a new channel and adding the soil it is displacing to the silt load.

Local governmental regulation of land development is quite different within the City of Crossville and outside it. The lower portion of One Mile Creek and the branch farthest to the east are outside of city limits. Within the City, there are currently permits required for both land preparation and building, and Crossville, as a MS4 jurisdiction, began implementing new Stormwater Ordinances in January, 2009. Included in these new regulations is a requirement that post construction retains a significant amount of rainwater on site during a storm event. If successfully implemented as designed, these ordinances will help keep the stormwater volumes in One Mile Creek from getting significantly worse. The ordinances will also incorporate all the proven BMPs necessary to prevent siltation from construction sites. The County has dragged its feet on adopting building codes since 2007, but in 2012 decided to adopt such codes and contract with the City to do the permitting and inspections. This created for the first time, a regulatory framework out in the county to monitor stormwater by ensuring that buildings in the county comply with the provisions of TDEC’s Construction General Permit, as applicable. While there are no county level stormwater regulations, it is a reasonable expectation that construction that requires TDEC permits will not be allowed to proceed without those permits. This is a level of oversight that has not previously existed. Development has been occurring within the One Mile Creek watershed, outside the city

limits that has been in violation of the buffer requirements for 303(d) streams. The new permitting arrangement should reduce this occurrence. The same is true for the utilization of silt trapping practices.

In late summer of 2009, the Lantana Road project was begun by TDOT and construction was completed in 2012. This involved both widening the existing road, as well as creating a new route between the existing Lantana Rd and one of the branches of One Mile Creek. Significant negotiations occurred with TDOT to minimize and mitigate the impact of this project on One Mile Creek. Since the road uses a curb and gutter system with storm drains, stormwater volumes have been monitored to see if the potential impacts have been mitigated.

In addition to the problem areas identified that are contributing to silt in the stream, a number of positive areas were identified as wetland areas that function to capture sediment from upstream. One of the unexpected benefits to come from the Lantana Road project was the purchase of an in-stream wetland from a private landowner which TDOT has restored. Most of the other wetland sites that OWCA has identified have not been officially designated as wetlands by the U.S. Fish and Wildlife service, so there is a lack of clarity as to what management controls, if any, the landowner is required to follow. It will be a priority to work with landowners to preserve and protect these areas.

For Long Branch, the primary water quality problem identified by TDEC and listed as the TMDL is also "loss of biological integrity due to siltation." TDEC has ranked its TMDL Priority as low. The pollutant source is listed as abandoned mine lands and it is listed as a Category 5 stream. A visual assessment conducted of the watershed during 2007 provided a more detailed picture of the stream and its impairments. While the stream is relatively simple, fed by drainageways but no tributaries, it has a quite different character in different sections. The upper section does not have perennial flow and has a meandering channel with a sandy bottom. The second section develops a rocky bottom which ends at an active rock-harvesting mine. The third section, downstream from the mine contains a large in-stream wetland caused by the build-up of silt causing ponding and perennial wet conditions. The fourth section, just below this is the area impacted by the non-active mines, which continue to add silt through stormwater run-off. There are a number of areas where sediment has caused sufficient blockage that temporary ponding occurs and larger sediment is deposited. This gives way to the final section that is primarily forested with undisturbed forest land and has almost all the characteristics of an undisturbed stream. There is perennial flow here.

In addition to the mine, the potential for residential development in this area may have an impact. While current development is in larger tracts that are being built some distance from the stream, the potential is there for a higher density development with roads, creating much greater stormwater run-off volumes. While the county has a Planning Commission, there is no zoning, so there is little to prevent such development from occurring. There are also a number of gravel road crossings and evidence of 4-wheeler activity. As this is also unrestricted, these road crossings could become a greater source of sedimentation in the future

The key positive area in this watershed is the large in-stream wetland. It serves to collect and remove the sediment load from upstream where the majority of external sedimentation is coming from. It also serves to detain and retain water, reducing the impact of stormwater events on the stream downstream. It will be a priority to work with landowners to preserve and protect these areas.

The third subwatershed to be included in this plan, is the HUC-14 subwatershed, Little Obed River (inaccurately named as it is the Obed River itself, as opposed to one of its tributaries, the Little Obed), 06010208010010. The part of the watershed that feeds the impaired section of the Obed was assessed by OWCA in 2007. The primary water quality problems for this section of the Obed, identified by TDEC and listed as the TMDL are “habitat loss due to stream flow alterations” and “physical substrate habitat alterations.” TDEC has ranked its TMDL Priority as low. The causes of these problems are stormwater discharges, and the upstream impoundment of Holiday Lake (the city’s water supply). However, in addition to the impoundment in the Obed River itself, there are three significant tributaries to the Obed in this section that carry perennial flow, two named - Spiers Branch and Town Branch and one unnamed. Assessment of these tribs in addition to the Obed section itself, confirmed the impact of stormwater run-off as a source of in-stream erosion and habitat loss, but also provided insights as to how mitigation techniques, both in the stream and along the banks could both reduce peak flows during storm events and potentially increase flows between storm events. Both of these outcomes would be beneficial to the biological integrity of the stream.

Town Branch is the most problematic tributary as it acts as a de facto storm sewer for the southeastern half of downtown Crossville. It is extremely responsive to storm events, rising two feet with as little as ¼ inch of rain. It is the only stream that contains gravel bars where the gravel is not native but has washed in from road crossings and parking lots and been transported down the stream bed. It is subject to flooding at three road crossings and has significant erosional scouring at three sites where it is culverted or where outfalls add significant volumes to the stream. The primary strategy here is to reduce stormwater volumes through detention and infiltration retrofits and to stabilize stream banks where erosion is active. The City has installed a water harvesting system on City Hall and may install a similar system on the Police and Fire Building. The city has also reworked some of the outfalls from storm sewers to absorb the energy at the point of discharge, and has included plans in the redevelopment plans for downtown to capture, detain and infiltrate more stormwater.

Spiers Branch is the largest tributary to the Obed in this section with eighteen separate branches that join together before it joins the Obed. The highest branches start out in the county in low density developments which contain a number of impoundments. Lower branches are much more heavily impacted by commercial development, including three schools with large campuses. As the area has transitioned from forest to subdivisions to town densities, impervious surfaces increase, stormwater volumes increase, and erosional impacts also increase. Bank stability becomes dependent on maintaining adequate vegetative cover and a healthy riparian zone. There are a

number of stretches where this has broken down and the banks are actively eroding. While bank stabilization has helped correct these erosion areas, more careful management of the riparian zone, including protecting the buffers is essential to reversing the trends. Work at two of the schools has begun to address their erosion issues and to increase infiltration.

The unnamed major tributary begins west of the city on agricultural land then flows through a series of subdivisions where both the stream itself and its tributary drainageways are heavily armored. While this reduces erosion within the subdivisions themselves, it creates a tremendous scouring in the stream immediately below the subdivision. A new subdivision being built below the three existing ones contains an impoundment that slows the water and allows heavier sediment to settle. Immediately below the dam, there is tremendous turbulence in the channel which shortly empties into the Obed River itself. While it is unlikely that property owners in the subdivisions will remove the armoring to allow more infiltration, it is hoped that future building under the Crossville Stormwater regulations will prevent people from adding to this problem.

The lower portion of the Obed River impaired section below and including Holiday Lake is within the city of Crossville and should be positively affected by the new Stormwater regulations. There are a number of active erosional areas along this stretch, many of which have been treated under the existing 319 grant in 2010 and 2011. It may also be impacted in a positive way by the development of a greenway along a large part of the section on the Obed itself. Part of the Obed section is already within a county park, and a secured right of way would provide long-term protection for the riparian zone.

The big positive for this watershed is that a large portion of the streams have forested riparian buffers and a significant portion of the watershed flows through forested areas. These sections are in the best condition, and with the new Stormwater Ordinances, there is a good chance that a minimum of a 60 foot buffer will be maintained.

The watershed of the Little Obed was assessed in 2008. It joins the Obed at the midpoint of the middle impaired section of the Obed. Macroinvertebrate sampling upstream from highway 127 showed a reasonably healthy stream, but upstream from a large wetland where four tributaries converge is a different story. Were the wetland to be removed or to become overwhelmed, the quality downstream would quickly deteriorate. The Tennessee Department of Environment and Conservation added the Little Obed to the 303d list in 2010.

There has been a tremendous amount of new residential and some commercial development in this watershed in the past seven years. Over 25% of this watershed is now impervious. The upper part of the watershed feeds three branches that join together in a large wetland that both captures sediment and filters the water. Two of the three branches are heavily impacted by new residential subdivisions and a new elementary school. The third branch, which primarily flows through agricultural land and forests is affected both by bank erosion caused by cattle and the major impact of the interstate on stormwater, causing the most massive amount of bank erosion seen thus

far in Cumberland County with vertical banks five and six feet high. This branch and its erosional problems was addressed by a 319 funded stabilization project in 2014. While the wetland is performing its duty in capturing some of the sediment and absorbing excess nutrients from the cattle operations, it is unclear whether it can continue to perform this function or whether it is being overwhelmed by the increased sediment loads that have reduced aquatic life above the wetland. An important development in 2013 was the creation of a permanent Conservation Easement protecting almost all of the wetland.

Below the wetland, a branch that drains the northeast side of downtown Crossville joins in. There has been a lot of development in this sector as well, both immediately downtown where the previously forested riparian zone has been cleared for commercial purposes, and further out where there have been a number of high-density apartment complexes and a nursing home built. Two undeveloped areas, one close to downtown and the other a large farm above the main Little Obed stream serve to break up the impact, but are both showing erosional stresses from the increased flows.

The final branch begins on commercial and industrial property, draining both a large amount of roofs and parking lots as well as road surfaces. The increased stormwater volumes have caused extensive erosional damage north of Highway 127, and sediment deposition is apparent. Two major projects in 2011 addressed both the erosion problem on private land and erosional drainageways in Centennial Park.

There were two other stream assessments completed in 2009. The first was the section of the Obed River above Holiday Lake. Its main branch begins in the county and flows first through agricultural and forest land (including the 4-H camp), before passing through increasingly dense residential development before reaching Holiday Lake. In the upper sections, particularly below impoundments, there are erosional impacts as well as deep, vertical banks. Some areas where livestock is present either lack buffers entirely or allow the cattle to have full access to the stream. Other segments arise in residential areas with multiple road crossings and stormwater impacts. These increased flows also cause erosion and send sediment downstream. While it might be expected that Holiday Lake as an impoundment would provide a place to capture such sediment, the nature of the particle sizes means that during storm flows, particularly during the winter and spring when the lake is full, much of the fine sediment transits the lake and continues downstream. There are many sites upstream where mitigation opportunities exist for streambank stabilization, dam outfall stabilization, and buffer establishment. A project that combined stormwater control measures and stream bank stabilization was completed in 2011 at the 4-H camp.

The other stream sections assessed in 2009 were in the Byrd's Creek watershed (except One Mile Creek, which was previously done). This watershed can conveniently be divided in two, with the Upper Byrds Creek feeding water into the Cumberland Mountain State Park, and the Lower Byrds Creek covering the stream from the State Park to the confluence with Daddys Creek. This whole watershed is 303d listed but no TMDL has yet been written and only one impairment cause has been listed (low DO

from an impoundment). The headwaters of Upper Byrds Creek are primarily located within a large residential development, Lake Tansi, that has a number of impoundments on these headwaters. After leaving Lake Tansi, the streams flow through agricultural and low-density residential development before forming the two main tributaries that join together within the Cumberland Mountain State Park. A large portion of the watershed is still in agriculture and forest, much of the part of Tansi that feeds the streams and lakes is undeveloped forest, but there is significant development in the headwaters of the feeder streams and along the large lakes in Tansi. The construction of the new sewer system at Lake Tansi may spur the development of many lots that have been unable to sustain septic systems. That, in turn, would change the permeability of much of this headwaters land.

There were two major tornados that hit this area in the past ten years. Five of the stream sections are impacted by blowdowns caused by the tornados. Exposed roots along the stream bank are obvious sources of erosion, but the turned up trees anywhere near the streams is a source of loose soil that gets carried to the streams. Blowdowns in residential areas, on the other hand, have mainly been addressed. Large trees partially blocking the streams divert flows and cause bank erosion. A stream-clearing effort in these affected areas would speed stabilization.

Within the State Park, the streams have been impacted by increased stormwater flows due to upstream development. Streambank stabilization work in some sections would be helpful. The golf course that is part of the State Park could improve its stream buffers in some areas without changing the playability of the course. Simply allowing or planting shrub species and a ten foot buffer would provide stability to the streams. In many cases, such buffers exist. It needs to be universal. Also, the campground area in the State Park needs to take measures to manage the stormwater. A major restoration and stabilization project was conducted in the State Park in 2013 working on both Byrds Creek and a major tributary, Three Mile Creek.

Cattle farming is widespread in the Upper Byrds Creek watershed. In some areas, cattle are not restricted from streams and are impacting the banks and stimulating erosion. Buffers are not complete in many pasture or hay fields. Buffers are not present in many residential areas as well. Property owners need to be encouraged to cease mowing and using herbicides along stream banks. There are many undeveloped residential lots in this watershed, far more than have been developed. Complete development without taking stormwater management measures will raise the impervious cover ratio to the level where permanent degradation of Byrds Creek will be unavoidable. Unfortunately, this area is outside of the Crossville city limits and is not covered by the MS4 regulations and procedures. Stream restoration sites exist and will be incorporated with landowner interest and cooperation.

The Lower Byrds Creek section is similar to the Upper Byrds Creek section in that the headwaters are primarily in residential areas as roads follow the watershed ridges and housing has been built along these ridges. One of the feeder branches drains a commercial/industrial area with a cement block facility and hotels with parking lots.

There are, however, significant forested and agricultural areas as well, primarily pasture for beef. A piece of the watershed, Three Mile Creek, also flows through the State Park for a while, but was damaged by the tornado that passed through. There are significant log and debris dams causing erosion in this section. Three Mile received a lot of stabilization work in the State Park during 2013. The most significant overall characteristic of this watershed, however, aside from the One Mile Creek drainage that is heavily urban is the presence of large tracts of dimension stone mines. While in most cases, these mines are permitted by TDEC and have erosion-control measures in place, the bare ground, often with exposed bedrock, means a lack of perviousness, leading to increased stormwater flows. This has impacted both the tribs that drain these properties as well as Byrds Creek that receives these waters. Two illegal dumps were also observed in this watershed. On the positive side, much of the streams and tribs have buffers which are assisting the stream both in maintaining its temperature and habitat values, but stabilizing the streams themselves.

In 2013, OWCA was able to conduct stream assessment work in a number of watersheds previously not assessed. The portion of Daddys Creek from the junction of Byrds Creek to the Antioch bridge was assessed, along with all the tributaries and feeder streams. As this section of Daddys Creek receives about 2/3 of the drainage from Fairfield Glade, the impact of this urbanizing development was apparent, which included impacts beyond those expected simply from the impoundments of Bagwell Branch and Black Gum Branch. Much of the terrain of Fairfield Glade is hilly, so as lots are cleared for houses, roads and drainage ditches installed, golf courses built, along with commercial development, including churches and other community facilities, the hydrology of these streams has been affected with more “flashiness” and bank erosion. Homeowner and developer attempts to harden channels and use existing streams as the stormwater system has also taken its toll. North Branch, which receives much of the waters from Fairfield Glade, though it does not flow through the development, begins at another lake, Turner Lake, and has significant erosional issues at a number of sites including and downstream of the listed segment. A number of stream sections are in need of stabilization.

Also in 2013, about 2/3 of the Drowning Creek watershed was assessed, primarily the area drained by Drowning Creek’s main tributaries – Meadow Creek and Copeland Creek. This area is a mixture of farmland and forest, but there are sections that show a lot of erosional impact. There are also significant in-stream and riparian wetlands in these watersheds that need protection. While Meadow Creek is not yet listed, some of the worst sedimentation seen in Cumberland County was encountered on this stream and it will be included as a site for potential mitigation under this program..

## **Estimate of Load Reductions**

Before offering estimates of load reductions based on BMPs that could be implemented over time, it is necessary to provide some context and caveats.

The TMDL for the Emory Watershed for siltation approved in 2006 looked at the stream segments that were listed as impaired at that time. There has been no update of this document since then to include the newer added impaired segments, nor is there a methodology included to incorporate stormwater impacts due to increased development. The population of Cumberland County has doubled over the past twenty years and after a pause from 2008-2014, growth is beginning again. One can calculate the load reduction due to BMPs installed on existing impairments, but without accounting for the development impacts on streams, it is difficult to speak of overall load reductions. New MS4 rules within the City of Crossville should reduce the additional impacts of development, but no such rules exist outside the city borders where the majority of development is occurring. Correction of impairments on one stream segment may be overwhelmed by degradation on another segment.

Given the lack of guidance on predicting future impacts, load reductions can be estimated based on existing impairments and TMDLs. In 2006, the TMDL's called for sediment reductions ranging from 21.5% in the upper Drowning Creek watershed to 82.4% along One Mile Creek and 74.0% for the Obed River. For lower Drowning Creek which includes the sediment from Copeland Creek and Meadow Creek, the TMDL calls for a 62.1% reduction.

Sedimentation loads are expressed as lbs/ac/yr where the acre refers to the drainage area of the stream segment. It is important to note, however, that erosion and sedimentation are not evenly distributed throughout a watershed. For the purpose of this plan, we can accept the TMDL goal of 135.5 lbs/ac/yr as the target throughout the watershed while at the same time recognizing that it is specific areas of sedimentation due to run-off or in-stream bank erosion that need to be attacked.

When attempting to predict expected load reductions for sedimentation, there are difficulties due to the size and scale of the watershed and both the multiple sources of sedimentation as well as the existing sediment storage within the watershed. To achieve reference stream values will take far longer in a sediment saturated stream versus a stream where sedimentation is a relatively new occurrence.

Given the above qualifications, load reduction calculations can be made based on the load reduction tables supplied by the TN 319 program in its RFP using the BMP implementation goals described in the following sections.

The calculations are as follows:

PRACTICE	AMOUNT		N Reduction Factor	= lbs N/yr
Riparian Buffer	363,000 ft	x	0.28	101,640
Streambank Stabilization	45,000 ft	x	1.75	78,850
Infiltration and Detention Structures	4,000 average basins	x	199.41	765,640
			Total expected N reduction	946,130
PRACTICE	AMOUNT		P Reduction Factor	= lbs P/yr
Riparian Buffer	363,000 ft	x	.02	7,260
Streambank Stabilization	45,000 ft	x	.17	7,650
Infiltration and Detention Structures	4,000 average basins	X	33.92	135,680
			Total expected P reduction	150,590
PRACTICE	AMOUNT		Sediment Reduction Factor	= tons/ Sediment/yr
Riparian Buffer	363,000 ft	X	.002	726
Streambank Stabilization	45,000 ft	X	.047	2,115
Infiltration and Detention Structures	4,000 average basins	x	6.109	24,436
			Total expected sediment reduction	27,277

## **BMP List, Educational Activities and Budget**

There are two primary ways to attack the problems that are occurring in the streams included in this project – reduce the volume and speed of stormwater run-off and stabilize stream sections that are eroding. Both will require the cooperation and assistance of property owners. To address the stormwater run-off problem, it will be necessary to convince landowners along drainageways to detain stormwater and provide opportunities for increased absorption, rather than speeding stormwater off their property and onto the stream sections downstream. For business owners and government buildings, this will mean adding rain gardens, detention ponds, infiltration ditches, pervious paving, disconnecting roof drains from the stormwater system, and increasing the use of woody landscaping downslope from impervious surfaces. It may

also mean, in conjunction with the government, the enhancement of in-stream wetlands to slow the flow and trap sediment. For residential property owners, it will mean planting drainageways with woody plants and/or restructuring drainageways to enhance infiltration using a gravel/geotextile layer under the soil and vegetation layer.

Protecting streams from further erosion will involve four strategies. First is to make sure there is an appropriate riparian buffer and establishing one if it does not exist. Second, is to identify sections that are currently eroding and stabilize these banks with bioengineered solutions where possible and/or native stone rip rap where needed. Third, is to install grade control structures where head-cutting and downcutting is occurring and/or install other rock structures such as vanes, barbs, and hooks to deflect stream flow pressure from eroding banks. And fourth is to monitor the stream for blockages in the channels that are causing the channel to divert into a bank or to cut a new channel. Where channel blocking is caused by downed trees or other temporary dams, the solution is to remove the blockage.

Because all of the activities needed must be voluntarily accepted by landowners, education of landowners and those who disturb the land is of critical importance. This is of particular importance because these are headwater watersheds and consist of many drainageways that are seasonal and may not be viewed by the property owners as being connected to the waterways themselves. The goal of getting water to run off the site may have been achieved and the property owner is unaware of the impact of that water on the stream it flows into. Specific workshops will be held targeting specific audiences, but the most time-consuming aspect of this work will be the outreach to landowners in areas that have been identified as either causing problems or having erosion problems. In this case, outreach to specific landowners must occur and their cooperation and “buy-in” must be earned. They need to be shown how their property is contributing to the problem and how things can improve with their participation. This will involve personal contact beyond educational mailings and public meetings.

<b>BMP Name</b>	<b>Quantity</b>	<b>Cost/Unit</b>	<b>Budget Estimate</b>
Reestablish Riparian Buffer	500 Ac	\$1200/ac	\$600,000
Streambank Stabilization	45000 ft	\$40/ft	\$1,800,000
Infiltration Structures	1,000,000 sq ft	\$7/sq ft	\$7,000,000
Detention Structures	100 Ac	\$25,000/Ac	\$2,500,000
Channel Maintenance		\$10,000/yr	\$50,000
<b>Educational Event</b>	<b>Quantity</b>	<b>Cost/Unit</b>	<b>Budget Estimate</b>
Training for homebuilders	1/yr/5 yrs	\$1000 ea	\$5,000
Training for farmers	1/yr/5 yrs	\$1000 ea	\$5,000
Training for homeowners and outreach	5 yrs	\$25,000/yr	\$125,000

Training for loggers and land clearers	1yr/5 yrs	\$1000	\$5,000
Targeted outreach	40/yr/5yrs	\$500/cap	\$100,000

<b>Total Budget for Project:</b>	<b>\$12,190,000</b>
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## **Timeline, Tasks, and Assessment of Progress**

A timeline for restoring the complete Obed River Watershed, as described here, depends most heavily on adequate funding and landowner interest and cooperation. While the 303(d) listed streams and stream segments are primarily in or near the City of Crossville, that does not mean that there are no impacts in other parts of the watershed as development proceeds in those areas. Good regulations and enforcement can reduce the impact of future development but does not necessarily affect areas that were previously damaged or are being damaged by the increasing volumes of stormwater run-off. The \$12 million budget estimate given above is not precise but does give an idea of the scale of the need. With 319 funding, and our limited capacity to raise matching funds, we are limited to about \$100,000 worth of work a year, though we have had some exceptional years that exceeded that. At that rate, it will take many years to complete all the restoration and mitigation work needed.

The process that makes the most sense is to start with the 303(d) listed streams, select no more than three or four to concentrate on at any one time, identify the most pressing needs in those streams and to address these needs with willing landowners. It is expected that within three years, the most pressing areas of remediation can be attacked for any given stream segment. Each year, OWCA will assess or reassess stream miles and identify potential projects, and each year, OWCA will develop and implement restoration and mitigation projects on damaged streams. Assessment work occurs primarily in the fall, winter, and spring when there is most likely to be water in the streams. Planting activities for riparian zones or to repair stream banks occurs in the late winter and early spring, and bank stabilization work can occur at any time of the year, though winter is often a less desirable time to be working in the cold water.

Educational activities are on-going, but are weighted most heavily to the first few years of activity in a 303(d) stream section, where the number of uninformed builders, developers, and landowners will be highest. As more and more information is put out to these targeted groups, the level and type of educational activities will change, with more emphasis on self-assessment and self-help. As larger developments such as Fairfield Glade adopt their own rules to encourage stormwater controls, OWCA can participate in annual workshops for new residents.

Progress is measured with both annual assessments as well as relative progress. Streams that are 303(d) listed due to impoundments, for example, may never be de-

listed, but if levels of turbidity and sedimentation are significantly reduced, biological life is occurring. The primary goal is to improve or maintain high water quality and high biological health in these streams. Annual assessments of biological measures are part of the timeline, conducted in the spring. Water quality monitoring, particularly for sedimentation, is on-going. Stream segments that have received BMP's are monitored several times the first two years and at least annually thereafter to ensure that the BMP's installed are functioning as designed. A stream that does not show overall improvement or which degrades over time, is cause for concern and special attention. At that point, a modification of work plans to direct additional resources to those streams will occur. Streams which have been assessed but where no BMPs have been installed will not receive much monitoring until corrective BMPs are implemented.

## **Criteria to Assess Achievement of Load Reduction Goals**

As noted above in the discussion of impairments, the main source of impairments listed is sedimentation due to increased stormwater volumes, both bringing sediment into the stream channels and causing in-stream bank erosion. The criteria for assessing progress in this area are 1) reduction in number, frequency, and severity of imbeddedness sites noted on visual assessments, and 2) levels of turbidity readings during and immediately after storm events. Streams with high levels of imbeddedness and sediment covered bottoms will take longer to clear than streams less heavily loaded, but the reduction of active erosion will more quickly be detected in lower turbidity readings which tend to pick up the smaller particles that can go into suspension. Clearing embeddness will also restore more rocky habitat and should be reflected in higher macroinvertebrate scores over time as well.

A few stream segments were also listed for e.coli due to leakages and overflows from the sanitary sewer system. While OWCA is not involved in maintenance of this system, it works closely with Veolia, the City of Crossville's wastewater contractor, to identify potential or actual leakages and encourage prioritization of line replacement where infiltration and outflows cannot be readily controlled. Through this partnership, a number of such sources have already been addressed and others are in process. This ensures that all sources of impairment are being addressed. Because of the human source of the e coli, the wastewater system conducts its own monitoring and that information is shared with TDEC and OWCA.

## **Monitoring and Documenting Success**

TDEC's regional office in Cookeville, TN participates with the Obed Watershed Community Association by serving on it Technical Advisory Committee (TAC). The TAC meets quarterly to discuss the watershed improvement activities that are currently underway and to plan for future activities. All Watershed Management Plans that OWCA prepares are reviewed by the TAC before adoption. As such TDEC will not only

be informed but will have an opportunity to help shape the type and nature of specific activities that OWCA undertakes.

As siltation is the primary impairment listed in the TMDLs, monitoring will focus on measuring silt loads at monitoring sites located on each of the branches at key points throughout the watersheds. Monitoring is being done by volunteers using turbidity tubes, and samples are then measured with a turbidity meter to develop correlation standards for the watershed. Particular attention is paid to run off from problem areas. As remediation and restoration projects are completed, the silt loads should decline in the particular branches and ultimately for the streams overall. A stormwater surge model is also being developed to try to correlate rainfall with increase flow in the different stream segments. As monitors collect samples for turbidity, they also record approximate volumes as well. While differences in storm flows can be difficult to separate from changes in land-use and highly local variations in rainfall, as detention structures are added to the system, volumes of peak storm surges should decline. During 2011, three of OWCA's partners installing semi-permanent monitoring stations. The City of Crossville, in partnership with the National Park Service, and as part of its MS4 monitoring requirements, installed continuous sampling equipment, focusing on pH, turbidity, DO, and temperature. Veolia NA, who manages the wastewater plant for the City of Crossville installed conductivity monitoring stations, not only at the outfall from their plants but at a number of other points within the watershed. Finally, the Cookeville Regional Office installed flow meters to help develop a more precise hydrologic model of the watershed(s) in order to more precisely focus mitigation efforts.

A second type of monitoring is Visual Assessment. A detailed Visual Assessment of the One Mile Creek, Long Branch and the impaired section of the Obed and its tributaries Spiers Branch and Town Branch was completed in 2007. The Little Obed was completed in 2008, and the assessment of the Upper Byrd's Creek (above the State Park lake) and the Upper Obed (above Holiday Lake) were completed in mid- 2009. The Lower Byrds Creek was completed by the end of 2009. A significant section of the Daddys Creek watershed and the Drowning Creek watershed were assessed in 2013. In early 2014, the Rocky Branch and Proctor Creek subwatersheds were surveyed, completing the assessment of all streams that flow at least partially within the Crossville City limits. Annually, in the fall, winter, or spring, when there are significant water flows, these streams are walked to assess changes, both positive and negative, since the detailed surveys were completed. City of Crossville personnel cover stream miles within the city limits. These visual assessments identify new sources of siltation that could over-ride the improvements being made on other stretches.

Improvements in the silt load should be continuous as BMPs are installed. The only possibility that would trigger a significant revision of the watershed-based plan would be significant development outside the city limits which could directly impacts these streams or unforeseen impacts from major highway projects.