Chapter 4 -
Water Quality Issues Related to the Entire Little Tennessee River Basin

4.1 Overview

The 1997 Little Tennessee River Basinwide Water Quality Management Plan included several recommendations to address water quality issues in the basin. Most of these recommendations were for specific stream segments and are discussed separately in the individual subbasin chapters in Section B. This chapter discusses water quality issues that relate to the entire Little Tennessee River basin. Habitat degradation, including sedimentation (resulting primarily from land clearing activities and rural roads), loss of riparian vegetation, loss of instream microhabitats, and urban runoff, are the main water quality issues in the basin. Water quality and aquatic life impacts from dams and golf courses have also been identified.

4.2 Habitat Degradation

Instream habitat degradation is identified in the use support summary (Appendix III) where there is a notable reduction in habitat diversity or a negative change in habitat. This term includes sedimentation, bank erosion, channelization, lack of riparian vegetation, loss of pools or riffles, loss of woody habitat, and streambed scour. Good instream habitat is necessary for aquatic life to survive and reproduce. Streams that typically show signs of habitat degradation are in watersheds that have a large amount of land-disturbing activities (construction, mining, timber harvest and agricultural activities) or a large percentage of impervious surfaces. A watershed in which most of the riparian vegetation has been removed from streams or channelization has occurred also exhibits instream habitat degradation. Streams that receive a discharge quantity that is much greater than the natural flow in the stream often have degraded habitat as well.

Determining the cause and quantifying amounts of habitat degradation is very difficult in most cases. To assess instream habitat degradation in most streams would require extensive technical and monetary resources and perhaps even more resources to restore the stream. DWQ is working to develop a reliable habitat assessment methodology.

Although DWQ and other agencies are starting to address this issue, local efforts are needed to prevent further instream habitat degradation and to restore streams that have been impaired by activities that cause habitat degradation. As point sources become less of a source of water quality impairment, nonpoint sources that pollute water and cause habitat degradation need to be addressed to further improve water quality in North Carolina’s streams and rivers.

4.2.1 Sedimentation

Introduction

Soil erosion, transport and redeposition are among the most essential natural processes occurring in watersheds. However, land-disturbing activities such as the construction of roads and buildings, crop production, livestock grazing and timber harvesting can accelerate erosion rates by causing more soil than usual to be detached and moved by water. If best management practices (BMPs) are not used effectively, accelerated erosion can strip the land of its topsoil, decreasing soil productivity and causing sedimentation in streams and rivers (NCDENR-DLR, 1998).

Sedimentation is the process by which eroded soil is deposited into waters. Sediment that accumulates on the bottom of streams and rivers smothers aquatic insects that fish feed upon and buries fish habitat that is vital to reproduction. Sediment filling rivers and streams decreases their storage volume and increases the frequency of floods (NCDENR-DLR, 1998).

Major Causes of Sedimentation in the Little Tennessee River Basin

- Land clearing activities (construction and preparing land for planting and crops)
- Streambank erosion
- Runoff from unpaved rural roads and eroding road grades

Suspended sediment can decrease primary productivity (photosynthesis) by shading sunlight from aquatic plants, affecting the overall productivity of a stream system. Suspended sediment also has several effects on various fish species including avoidance and redistribution, reduced feeding efficiency, and therefore, reduced growth by some species, respiratory impairment, reduced tolerance to diseases and toxicants, and increased physiological stress (Roell, June 1999). Suspended sediment also increases the cost of treating municipal drinking water.

During 1999 basinwide monitoring, DWQ aquatic biologists reported streambank erosion and sedimentation throughout the Little Tennessee River basin that was moderate to severe. Lower bioclassification ratings were assigned because of sedimentation; bottom substrate was embedded by silt and/or pools were partially filled with sediment. Unstable and/or undercut (eroding) streambanks were also noted in explanation of lower ratings (NCDENR-DWQ, April 2000).

Land Clearing Activities

Erosion and sedimentation can be controlled during most land-disturbing activities by using appropriate BMPs. In fact, substantial amounts of erosion can be prevented by planning to minimize the (1) amount and (2) time the land is exposed. Land clearing activities that contribute to sedimentation in the Roanoke River basin include: construction of homes and subdivisions as well as commercial and public buildings; plowing of soil to plant crops; site preparation and harvest on timberlands; and road projects.

DWQ's role in sediment control is to work cooperatively with those agencies that administer sediment control programs in order to maximize the effectiveness of the programs and to protect water quality. Where programs are not effective, as evidenced by a violation of instream water quality standards, and where DWQ can identify a source, then appropriate enforcement action can be taken. Generally, this entails requiring the landowner or responsible party to install acceptable BMPs.

As a result of new stormwater rules enacted by EPA in 1999, construction or land development activities that disturb one acre or more are required to obtain a NPDES stormwater permit (refer to page 30). An erosion and sediment control plan must also be developed and approved for these sites under the state's Sedimentation Pollution Control Act (SPCA) administered by the NC Division of Land Resources. Site disturbances of less than one acre are required to use BMPs, but a plan is not required.

Forestry activities in North Carolina are subject to regulation under the SPCA. However, a forestry operation in the Little Tennessee River basin may be exempt from the permitting requirements if compliance with performance standards outlined in *Forest Practice Guidelines Related to Water Quality* (15NCAC 1I .201-.209) and General Statutes regarding stream obstruction (77-13 and 77-14) are maintained. Extensive information regarding these performance standards and rules as they apply to forestry operations can be found on the NC Division of Forest Resources website at http://www.dfr.state.nc.us/managing/water_qual.htm.

For agricultural activities which are not subject to the SPCA, sediment controls are carried out on a voluntary basis through programs administered by several different agencies (see Appendix VI for further information).

Some Best Management Practices

Agriculture

- Using no till or conservation tillage practices
- Fencing livestock out of streams and rivers
- Leaving natural buffer areas around small streams and rivers

Construction

- Using phased grading/seeding plans
- Limiting time of exposure
- Planting temporary ground cover
- Using sediment basins and traps

Forestry

- Controlling runoff from logging roads
- Replanting vegetation on disturbed areas
- Leaving natural buffer areas around small streams and rivers

Unpaved Roads and Eroding Road Grades

As is typical of settlement in mountainous areas, many roads in the Little Tennessee River basin follow streams. The roads are often constructed on the streambank with very little (if any) vegetated buffer to filter sediment and other pollutants from surface runoff. Many of the steep road grades are actively eroding because of a lack of stabilization. Road grades of 12 percent or less are desirable. Unpaved roads with grades in excess of 12 percent erode easily and are difficult to maintain (WNCT, 1999). Additionally, when road maintenance activities are conducted, there is often inadequate space for structural BMPs to be installed to control erosion from the land-disturbing activity.

Roads built to accommodate vehicles and equipment used for forestry activities in the Little Tennessee River basin also contribute to sediment runoff. These roads are generally unpaved and accelerate erosion unless they are maintained with stable drainage structures and foundations. In the mountainous areas of North Carolina, ordinary forest roads are known to lose as much as 200 tons of soil per acre of roadway during the first year following disturbance (NRCD-DFR, September 1989).

Stronger Rules For Sediment Control

The Division of Land Resources (DLR) has the primary responsibility for assuring that erosion is minimized and sedimentation is reduced. In February 1999, the NC Sedimentation Control Commission adopted significant changes for strengthening the Erosion and Sedimentation Control Program. The following rule changes were filed as temporary rules, subject to approval by the Rules Review Commission and the NC General Assembly:

- Allows state and local erosion and sediment control programs to require a pre-construction conference when one is deemed necessary.
- Reduces the number of days allowed for establishment of ground cover from 30 working days to 15 working days and from 120 calendar days to 90 calendar days. (Stabilization must now be complete in 15 working days or 90 calendar days, whichever period is shorter.)
- Provides that no person may initiate a land-disturbing activity until notifying the agency that issued the plan approval of the date the activity will begin.
- Allows assessment penalties for significant violations upon initial issuance of a Notice of Violation (NOV).

Additionally, during its 1999 session, the NC General Assembly passed House Bill 1098 to strengthen the Sediment Pollution Control Act of 1973 (SPCA). The bill made the following changes to the Act:

- Increases the maximum civil penalty for violating the SPCA from $500 to $5000 per day.
- Provides that a person may be assessed a civil penalty from the date a violation is detected if the deadline stated in the Notice of Violation is not met.
- Provides that approval of an erosion control plan is conditioned on compliance with federal and state water quality laws, regulations and rules.
- Provides that any erosion control plan that involves using ditches for the purpose of de-watering or lowering the water table must be forwarded to the Director of DWQ.
- Amends the General Statutes governing licensing of general contractors to provide that the State Licensing Board for General Contractors shall test applicants' knowledge of requirements of the SPCA and rules adopted pursuant to the Act.
- Removes a cap on the percentage of administrative costs that may be recovered through plan review fees.

For information on North Carolina's Erosion and Sedimentation Control Program or to report erosion and sedimentation problems, visit the new website at http://www.dlr.enr.state.nc.us/ or you may call the NC Division of Land Resources, Land Quality Section at (919) 733-4574.

Recent Review of Sediment Control Research

The two most popular sediment control devices are silt fences and sediment basins. In 2001, DWQ staff conducted a review of peer-reviewed research publications and consulted with experts at NC State University (NCSU) to investigate the effectiveness of current sediment and erosion control practices. In addition, engineering calculations have been conducted to obtain theoretical effectiveness of sediment basins and silt fences. Research conducted in North Carolina showed that construction sites in North Carolina produce 10-188 tons per acre per year of sediment. Such wide variation might be attributed to the significant spatial and temporal differences in rainfall intensity and duration, soil characteristics, slope, and the type of soil cover. DLR currently uses the assumption that (on average) construction sites produce 84 tons/acre-year. For comparison, erosion in undisturbed natural systems is only 0.1-0.2 tons/acre-year.

Currently, sediment basins are designed to have 1,800 cubic feet of storage space for each acre of disturbed land. Based on the reference review and consultation, DWQ has concluded that these basins have numerous deficiencies, including:

1. Insufficient volume. [Pennsylvania requires 5,000 cubic feet; Maryland and Virginia require 3,600 cubic feet.]
2. Inadequate cleaning frequency. [Basins are cleared only once a year, which significantly reduces their effectiveness.]
3. Short-circuiting. [In many cases, inlet and outlet in basins are constructed in very close proximity, which results in a shorter than predicted retention time.]
4. Water is not being removed from the surface where concentration of the sediment is the lowest.
5. Basins are designed with consideration of only cleared land. [In many cases, basins are treating runoff from the entire drainage area, which is significantly larger than that of cleared land.]

A sedimentation basin that is ideally designed and constructed is only able to capture 55 percent of all sediment in runoff. As a result, each acre of cleared land will deliver 38 tons of sediment to the waterways each year. After six months of operation, the effectiveness of the sediment basin will be reduced to 33 percent and the loss of sediment will approach 56 tons/acre-year.

Silt fences are even less effective. A typical silt fence can capture only 22 percent of all particles in runoff. Very often, they are improperly installed and receive inadequate maintenance that results in further reduction in their effectiveness.

New research indicates that use of new technologies such as installation of baffles in the sediment basins, application of flocculants, and use of skimmers can significantly increase efficiency of sedimentation basins. Experiments conducted at NCSU demonstrated that the current turbidity standard of 50 NTU (for waters not classified Tr) can be achieved in runoff if these devices are used. However, the fact that is most important factor in reducing sedimentation is timely cover of cleared land with mulches or use of the flocculent solutions to prevent erosion. It has been conclusively proven that use of ground cover (temporary or permanent) dramatically reduces erosion rates.

4.2.2 Loss of Riparian Vegetation

During 1999 basinwide sampling, DWQ biologists reported degradation of aquatic communities at numerous sites throughout the Little Tennessee River basin in association with narrow or nonexistent zones of native riparian vegetation. Riparian vegetation loss was common in rural and residential areas as well as in urban areas (NCDENR-DWQ, April 2000).

Removing trees, shrubs and other vegetation to plant grass or place rock (also known as riprap) along the bank of a river or stream degrades water quality. Removing riparian vegetation eliminates habitat for aquatic macroinvertebrates that are food for trout and other fish. Rocks lining a bank absorb the sun's heat and warm the water. Some fish require cooler water temperatures as well as the higher levels of dissolved oxygen cooler water provides. Trees, shrubs and other native vegetation cool the water by shading it. Straightening a stream, clearing streambank vegetation, and lining the banks with grass or rock severely impact the habitat that aquatic insects and fish need to survive (WNCT, 1999).

Livestock grazing with unlimited access to the stream channel and banks can cause severe streambank erosion resulting in degraded water quality. Although they often make up a small percentage of grazing areas by surface area, riparian zones (vegetated stream corridors) are particularly attractive to cattle that prefer the cooler environment and lush vegetation found beside rivers and streams. This concentration of livestock can result in increased sedimentation of streams due to "hoof shear", trampling of bank vegetation, and down-cutting by the destabilized stream. Despite livestock's preference for frequent water access, farm veterinarians have reported that cows are healthier when stream access is limited (EPA, 1999).

Preserving the natural streamside vegetation (riparian buffer) is one of the most economical and efficient BMPs. Forested buffers in particular provide a variety of benefits including filtering runoff and taking up nutrients, moderating water temperature, preventing erosion and loss of land, providing flood control and helping to moderate streamflow, and providing food and habitat for both aquatic and terrestrial wildlife (NCDENR-DWQ, October 2001). To obtain a free copy of DWQ's *Buffers for Clean Water* brochure, call (919) 733-5083, ext. 558.

4.2.3 Loss of Instream Organic Microhabitats

Organic microhabitat (leafpacks, sticks and large wood) and edge habitat (root banks and undercut banks) play very important roles in a stream ecosystem. Organic matter in the form of leaves, sticks and other materials serve as the base of the food web for small streams. Additionally, these microhabitats serve as special niches for different species of benthic macroinvertebrates, providing food and/or habitat. For example, many stoneflies are found almost exclusively in leafpacks and on small sticks. Some beetle species prefer edge habitat, such as undercut banks. If these microhabitat types are not present, there is no place for these specialized macroinvertebrates to live and feed. The absence of these microhabitats in some streams in the Little Tennessee River basin is directly related to the absence of riparian vegetation (refer to Part 4.2.2 above). Organic microhabitats are critical to headwater streams, the health of which is linked to the health of the entire downstream watershed, as discussed in Part 4.6.

4.2.4 Channelization

Channelization refers to the physical alteration of naturally occurring stream and riverbeds. Typical modifications are described in the text box. Although increased flooding, bank erosion and channel instability often occur in downstream areas after channelization has occurred, flood control, reduced erosion, increased usable land area, greater navigability and more efficient drainage are frequently cited as the objectives of channelization projects (McGarvey, 1996).

Direct or immediate biological effects of channelization include injury and mortality of benthic macroinvertebrates, fish, shellfish/mussels and other wildlife populations, as well as habitat loss. Indirect biological effects include changes in benthic macroinvertebrate, fish and wildlife community structures, favoring species that are more tolerant of or better adapted to the altered habitat (McGarvey, 1996).

> ***Typical Channel Modifications***
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> - Removal of any obstructions, natural or artificial, that inhibit a stream's capacity to convey water (clearing and snagging).
> - Widening, deepening or straightening of the channel to maximize conveyance of water.
> - Lining the bed or banks with rock or other resistant materials.

Restoration or recovery of channelized streams may occur through processes, both naturally and artificially induced. In general, streams that have not been excessively stressed by the channelization process can be expected to return to their original forms. However, streams that have been extensively altered may establish a new, artificial equilibrium (especially when the channelized streambed has been hardened). In such cases, the stream may enter a vicious cycle of erosion and continuous down cutting. Once the benefits of a channelization project become outweighed by the costs, both in money and environmental integrity, channel restoration efforts are likely to be taken (McGarvey, 1996).

Channelization of streams within the continental United States is extensive and promises to become even more so as urban development continues. Overall estimates of lost or altered riparian habitats within US streams are as high as 70 percent. Unfortunately, the dynamic nature of stream ecosystems makes it difficult (if not impossible) to quantitatively predict the effects of channelization (McGarvey, 1996). Channelization has occurred historically throughout the Little Tennessee River basin and continues to occur in some watersheds, especially in small headwater streams.

4.2.5 Recommendations for Reducing Habitat Degradation

<u>Sedimentation</u>

In March 2002, Environmental Management Commission (EMC) sent a letter to the Sedimentation Control Commission (SCC) expressing seven recommendations for improving erosion and sedimentation control, based on a comprehensive performance review of the turbidity standard conducted in 2001 by DWQ staff (refer to page 62 for a summary). Specifically the recommendations are that the EMC and SCC:

1. Evaluate, in consultation with the Attorney General's Office, whether statutory authority is adequate to mandate temporary ground cover over a percentage of the uncovered area at a construction site within a specific time after the initial disturbance of the area. If it is found that statutory authority does not exist, then the EMC and SCC should prepare resolutions for the General Assembly supporting new legislation to this effect.

2. Prepare resolutions supporting new legislation to increase the maximum penalty allowed in the Sedimentation Pollution Control Act from $5,000 to $25,000 for the initial response to a non-compliant site.
3. Jointly support a review of the existing Erosion and Sediment Control Planning and Design Manual by DLR. This review should include, but not be limited to, a redesign of the minimum specifications for sedimentation basins.
4. Evaluate, in consultation with the Attorney General's Office, whether the statutory authority is adequate for effective use of the "Stop Work Order" tool, and, if found not to be adequate, to prepare resolutions for the General Assembly supporting new legislation that will enable staff to more effectively use the "Stop Work Order" tool.
5. Support increased research into and experimentation with the use of polyacrylamides (PAMs) and other innovative soil stabilization and turbidity reduction techniques.
6. Jointly support and encourage the awarding of significant monetary penalties for all activities found to be in violation of their Stormwater Construction General Permit, their Erosion and Sediment Control Plan, or the turbidity standard.
7. Hold those individuals who cause serious degradation of the environment through excessive turbidity and sedimentation ultimately responsible for restoration of the area.

The EMC and the SCC have agreed to hold a joint meeting of the two Commissions for the purpose of exploring the recommendations made by DWQ staff.

In addition, DWQ will continue to work cooperatively with DLR and local programs that administer sediment control in order to maximize the effectiveness of the programs and to take appropriate enforcement action when necessary to protect or restore water quality. However, more voluntary implementation of BMPs is needed for activities that are not subject to these rules in order to substantially reduce the amount of widespread sedimentation present in the Little Tennessee River basin.

Funding is available for cost sharing with local governments that set up new erosion and sedimentation control programs or conduct their own training workshops. The Sediment Control Commission will provide 40 percent of the cost of starting a new local erosion and sedimentation control program for up to 18 months. Two municipalities or a municipality and county can develop a program together and split the match. Jackson County, Swain County, Macon County and the Town of Highlands currently have locally-delegated erosion and sediment control programs (refer to page 124 for further details) in the Little Tennessee River basin. It is recommended that other local governments draft and implement local erosion and sedimentation control programs.

The Department of Transportation should take special care when constructing and maintaining (including mowing) roads along streams in the Little Tennessee River basin. The lack of riparian vegetation and streambank erosion is well documented and will lead to increased instream habitat degradation if these problems remain unchecked. Vegetation along streams should remain as undisturbed as possible when conducting these construction and maintenance activities, keeping in mind that most of these streams are trout waters. Additionally, more public education is needed basinwide to educate landowners about the value of riparian vegetation along small tributaries and the impacts of sedimentation to aquatic life.

Funding is available through numerous federal and state programs for landowners to restore and/or protect riparian buffer zones along fields or pastures, develop alternative watering sources for livestock, and fence animals out of streams (refer to Section C). EPA's *Catalog of Federal Funding Sources for Watershed Protection* (Document 841-B-99-003) outlines some of these and other programs aimed at protecting water quality. A copy may be obtained by calling the National Center for Environmental Publications and Information at (800) 490-9198 or by visiting the website at http://www.epa.gov/OWOW/watershed/wacademy/fund.html. Local contacts for various state and local agencies are listed in Appendix VI.

4.3 Urban Runoff

Runoff from built-upon (developed) areas carries a wide variety of contaminants to streams including sediment, oil and grease from roads and parking lots, street litter, and pollutants from the atmosphere. The volume and speed of runoff are greatly increased in these areas as well, causing erosion of streambanks, temperature and salinity alterations, and scouring of the streambed. Generally, there are also a larger number of point source discharges in these areas. Cumulative impacts from habitat and floodplain alterations, as well as point and nonpoint source pollution can cause severe impairment to streams.

Proactive planning efforts at the local level are needed across the entire western portion of the basin in order to assure that development is done in a manner that minimizes impacts to water quality. A lack of good environmental planning was identified by participants at the public workshops as a threat to water quality in the Little Tennessee River basin. Additionally, there are many things that individuals can do to reduce the quantity and improve the quality of stormwater runoff.

4.3.1 Rural Development

More than three-quarters of the land in western North Carolina has a slope in excess of 30 percent. Building site preparation and access are complicated by shallow bedrock, high erosion rates, soils that are subject to sliding, and lack of adequate sites for septic systems. Additionally, road grades of 12 percent or less are desirable. Unpaved roads with grades in excess of 12 percent erode easily and are difficult to maintain (WNCT, 1999). This terrain presents a challenge for environmentally sensitive development. Development could occur in the relatively flat stream and river valleys, placing pressure on floodplains and riparian zones and displacing agricultural land uses. Alternatively, it could occur on the steep slopes accelerating erosion during construction. In addition, chronic problems with failing septic systems and eroding road grades are more likely.

4.3.2 Urbanization

Urbanization often has greater hydrologic effects than any other land use, as native watershed vegetation is replaced with impervious surfaces in the form of paved roads, buildings, parking lots, and residential homes and yards. Urbanization results in increased surface runoff and correspondingly earlier and higher peak flows after storms. Flooding frequency is also increased. These effects are compounded when small streams are channelized (straightened) or piped and storm sewer systems are installed to increase transport of drainage waters downstream. Bank scour from these frequent high flow events tends to enlarge streams and increase suspended sediment. Scouring also destroys the variety of habitat in streams leading to degradation of benthic macroinvertebrate populations and loss of fisheries (EPA, 1999).

In and around developed areas in the Little Tennessee River basin, 1999 DWQ biological assessments revealed that streams are being impacted by urban stormwater runoff. Most of the impacts are in terms of habitat degradation (refer to page 59), but runoff from developed and developing areas can also carry toxic pollutants to a stream (NCDENR-DWQ, May 2000).

The presence of intact riparian buffers and/or wetlands in urban areas can lessen these impacts and restoration of these watershed features should be considered where feasible; however, the amount of impervious cover should be limited as much as possible. Wide streets, huge cul-de-sacs, long driveways and sidewalks lining both sides of the street are all features of urban development that create excess impervious cover and consume natural areas.

4.3.3 Stormwater Regulations

DWQ administers several programs aimed at controlling stormwater runoff in the Little Tennessee River basin. They are: 1) programs for the control of development activities within designated water supply (WS) watersheds; 2) NPDES stormwater permit requirements for construction or land development activities on one acre of land or more; and 3) NPDES stormwater requirements for certain industrial activities. For more detailed information on current and proposed stormwater rules, refer to page 30.

4.3.4 Recommendations

Proactive planning efforts at the local level are needed to assure that development is done in a manner that minimizes impacts to water quality. These planning efforts must find a balance among water quality protection, natural resource management and economic growth. Growth management requires planning for the needs of future population increases as well as developing and enforcing environmental protection measures. These actions are critical to water quality management and the quality of life for the residents of the basin.

Action should be taken at the local level to plan for new development in urban and rural areas. For more detailed information regarding recommendations for new development found in the text box, refer to EPA's website at www.epa.gov/owow/watershed/wacademy/acad2000/protection.

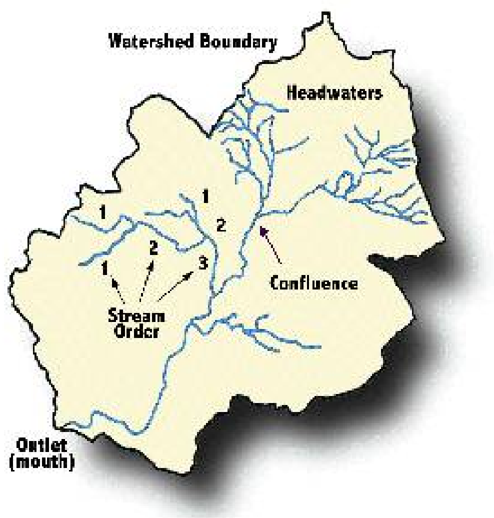
Planning Recommendations for Little Tennessee Development

- Minimize number and width of residential streets.
- Minimize size of parking areas (angled parking and narrower slots).
- Place sidewalks on only one side of residential streets.
- Vegetate road right-of-ways, parking lot islands and highway dividers to increase infiltration.
- Plant and protect natural buffer zones along streams and tributaries.
- Minimize floodplain development.
- Protect and restore wetland / bog areas.

Additional public education is also needed in the Little Tennessee River basin in order for citizens to understand the value of urban planning and stormwater management. DWQ recently developed a booklet that discusses actions individuals can take to reduce stormwater runoff and improve stormwater quality entitled *Improving Water Quality In Your Own Backyard*. To obtain a free copy, call (919) 733-5083, ext. 558.

4.4 Protecting Headwaters

Many streams in a given river basin are only small trickles of water that emerge from the ground. A larger stream is formed at the confluence of these trickles. This constant merging eventually forms a large stream or river. Most monitoring of fresh surface waters evaluates these larger streams. The many miles of small trickles, collectively known as headwaters, are not directly monitored and in many instances are not even indicated on maps. However, degradation of headwater streams can (and does) impact the larger stream or river.



In smaller headwater streams, fish communities are not well developed and benthic macroinvertebrates dominate aquatic life. Benthic macroinvertebrates are often thought of as "fish food" and, in mid-sized streams and rivers, they are critical to a healthy fish community. However, these insects, both in larval and adult stages, are also food for small mammals, such as river otter and raccoons, birds and amphibians (Erman, 1996). Benthic macroinvertebrates in headwater streams also perform the important function of breaking down coarse organic matter, such as leaves and twigs, and releasing fine organic matter. In larger rivers, where coarse organic matter is not as abundant, this fine organic matter is a primary food source for benthic macroinvertebrates and other organisms in the system (CALFED, 1999). When the benthic macroinvertebrate community is changed or extinguished in an area, even temporarily, it can have repercussions in many parts of both the terrestrial and aquatic food web.

Headwaters also provide a source of insects for repopulating downstream waters where benthic macroinvertebrate communities have been eliminated due to human alterations and pollution. Adult insects have short life spans and generally live in the riparian areas surrounding the streams from which they emerge (Erman, 1996). Because there is little upstream or stream-to-stream migration of benthic macroinvertebrates, once headwater populations are eliminated, there is little hope for restoring a functioning aquatic community.

Recommendations

Because of the small size of headwater streams, they are often overlooked during land use activities that impact water quality. All landowners can participate in the protection of headwaters by keeping small tributaries in mind when making land use management decisions on the areas they control. This includes activities such as retaining vegetated stream buffers, minimizing stream channel alterations, and excluding cattle from streams. Local rural and urban planning initiatives should also consider impacts to headwater streams when land is being developed.

For a more detailed description of watershed hydrology, refer to EPA's Watershed Academy website at http://www.epa.gov/OWOW/watershed/wacademy/acad2000/watershedmgt/principle1.html.

4.5 Impact of Dams

By altering the flow of water in a river or stream, dams have the ability to change the chemical, physical and biological processes of the river downstream. Dams block free-flowing rivers and reduce the flow of nutrients and sediments, including heavy gravel and cobble, and organic matter that are important to the health of the stream and its biological communities. The river downstream of the dam becomes deprived of its sediment load, and, depending on the type of river, can begin to generate its own sediment by eroding its banks and channel undermining bridges and other riverbank structures. This bank erosion and channel entrenchment can extend for up to fifty miles below the dam. The reduction of gravel, cobble and organic matter inputs also reduces the habitat and food source of many fish and macroinvertebrates (IRN, 2000).

The operation of the dam itself can also lead to accelerated erosion in downstream segments as it alters the timing of flows. Instead of providing a constant flow, some dams cause a withholding and then releasing of water which causes the downstream stretches to alternate between no water and powerful surges. This drastic fluctuation in flow can erode soil and vegetation, flood lands and change the natural seasonal flow variations that trigger natural growth and reproduction cycles in many plant, fish and benthic macroinvertebrates (IRN, 2000).

Dams are also barriers to downstream drift. When benthic macroinvertebrates in a particular section of stream are severely impacted by storm events or toxic conditions, the primary method by which the community is reestablished (re-colonization) is by natural drift of benthic macroinvertebrates from upstream areas. In pond or lake environments, flow is greatly reduced and many benthic macroinvertebrates sink to the bottom where habitat conditions are not suitable for survival. Additionally, water is warmer in these larger bodies of water and predators (primarily fish) have the advantage. Dams can also represent a barrier to fish movement in a stream or river (DWQ, February 2002).

Water temperature and dissolved oxygen (DO) levels are significantly different when rivers are impounded. By slowing water flow, most dams increase the temperature of the water flowing over the dam. Others decrease water temperature by releasing cooled water from the bottom of the reservoir. Fish and other species, especially native trout populations, are extremely sensitive to these temperature irregularities which can change the structure of the communities from native and rare species to less desirable species more tolerant of fluctuating water temperatures. Dissolved oxygen is also decreased in the waters held by the dam and when released can have severe impacts, including death, on the fish, benthic macroinvertebrates and vegetation downstream (IRN, 2000).

Recommendations

Situations exist in which it is economically and environmentally feasible to remove dams, restoring free movement of water, sediment, nutrients and aquatic life throughout the river system. However, this recommendation is usually costly, difficult and impractical. Another effective solution involves relocating streams to flow around dams. This solution is particularly valid when populations of aquatic life are thriving upstream of the impoundment, and there are concerns about releasing excess sediment and other pollutants within the existing reservoir (from behind the dam).

Requirement of minimum flow releases and management of dam operations to provide more consistent flow is a solution for streams and rivers that are primarily affected by flow-related problems. Flow management does not usually solve problems with recolonization of benthic macroinvertebrates, but can substantially improve conditions for existing populations below dams. Additionally, there are a variety of engineering solutions to improve temperature and dissolved oxygen both within the reservoir and below the dam.

Due to the impacts of dams on aquatic communities, the construction of most instream ponds and reservoirs, particular in headwater streams, should be prohibited. The Department of Environment and Natural Resources should reexamine its policy related to dams that are less than 15 feet in height or impounding less than ten-acre feet of water. DWQ should continue to actively participate in the FERC relicensing process.

4.6 Golf Course Impacts

There were 17,108 golf courses in the United States in 2000; and in that year, 524 new courses were built; 707 were under construction; and 1,049 were being planned (NGF, 2001). In North Carolina, 150,000 acres of new turf areas, including athletic fields, recreational areas, home lawns and golf courses, are developed each year, and the rate of development continues to grow (NCCES, 1995). Without proper site design, construction practices and maintenance, all turf areas can serve as source of sediment, nutrients and other contaminants that can impact water quality. Golf courses, because of their size, location and historical design practices, can cause significant impacts to small streams. In order to insure water quality protection, BMPs should be implemented throughout the life of a golf course from design to construction to daily maintenance.

Proper site design works with the landscape. The design should designate environmentally sensitive areas throughout the course and strive to protect them with minimal disturbance. The design can prevent or minimize erosion and stormwater runoff by maintaining natural vegetated riparian areas near streams, wetlands and lake shorelines as much as possible. Good design also minimizes the development of gullies, avoids channelization (straightening) of streams, and prohibits the unnecessary disruption of stream banks and lake shorelines (NCCES, 1995).

During golf course construction, the exposed soils and steep slopes are highly susceptible to erosion and sedimentation. In order to reduce erosion and sedimentation from the site, strategies to effectively control sediment, minimize the loss of topsoil, and protect water resources need to be implemented throughout the construction of the course (CRM, 1996). One most effective BMPs to use during construction activities on large sites is to minimize the duration of exposed soils and to establish ground cover as soon as possible after soil disturbance.

Maintenance of the golf course also has the potential to impact water quality through improper fertilization, mowing and irrigation. Fertilizer applications should be based on a soil test to determine the appropriate timing, level and type of fertilizer necessary for the type of grass on particular areas of the course. Fertilizers should also not be applied on the steep slopes near surface waters or directly to lakes, streams and drainage areas. It is a good practice to maintain a buffer of low-maintenance grasses or natural vegetation between areas of the highly maintained portions of the golf course and surface waters (NCCES, 1995).

The appropriate level of irrigation for a golf course is vital to the health of the grasses and the preservation of water quality. Under-watering may harm the grasses while over-watering increases the potential for leaching fertilizers and nutrients from the soil and increasing runoff. A properly designed irrigation system will apply a uniform level of water at the desired rate and time. The amount and frequency of watering should be based on the type of grass and soil and weather conditions.

Golfers can also play a role in protecting water quality on the golf course. Players should respect designated environmentally sensitive areas within the course and recognize that golf courses are managed areas that complement the natural environment. Golfers should also support and encourage maintenance practices that protect and enhance the environment and encourage the development of environmental conservation plans for the course. In addition, golfers can choose to patronize courses that are designed, constructed and maintained with protection of natural resources in mind.

4.7 Trout Production Facilities

North Carolina ranks second only to Idaho in commercial production of rainbow trout in the United States, producing four to six million pounds per year. In 2000, there were 61 trout production facilities licensed by the NC Department of Agriculture (NCDA) and about 80 percent of the trout produced (5,703,000 pounds) were sold to local processors. The estimated value of the industry in 2000 was $7,137,240 (NCDA, 2000).

A Notice of Intent is required by DWQ prior to construction of a trout farm for those facilities designed to produce more than 20,000 pounds or using more than 5,000 pounds of feed in any month. Most trout production facilities are covered under a general permit and are considered “operations with limited impacts”. However, DWQ may (and has in the Little Tennessee River basin for those operations noted below) require an individual permit if there are already documented impacts to the receiving waters from excess nutrients or pathogens or if there is potential for water quality impacts to specific site conditions (i.e. lake or pond downstream). The US Army Corps of Engineers may also require a Section 404 Permit for construction of an intake and/or a structure to divert water from a stream to the trout farm. In addition, trout farm site analysis is required to determine if wetlands will be impacted (NCCES, 1999).

There are 40 permitted trout production facilities in North Carolina, which represents 65 percent of the total number licensed. In the Little Tennessee River basin, six facilities are covered under a general permit and five hold individual permits. Facilities with an individual permit are listed in Appendix I and are inspected annually as are other NPDES-permitted facilities (WWTPs). All five facilities with individual permits are located within subbasin 04-04-04 and discharge to streams that flow into Santeetlah Lake. Water quality impacts to Santeetlah Lake are discussed in more detail in Section B, Chapter 4 (beginning on page 102).

Currently, there is no written protocol for an NPDES permit inspection of trout farms because most facilities have limited "treatment" operations. The extent of water quality impact from a particular trout farm is directly linked to management practices at the facility, therefore the focus of a DWQ inspection includes a review of: feeding practices, how waste is stored and moved out of the active production facilities (the raceway areas), and generally how the farm is operated. For facilities that discharge into a stream with good flow and few existing impacts from excess nutrients or pathogens, water quality problems are immediately downstream from the facility and are typically minor in nature. Downstream problems can also be minimized by implementing waste management BMPs such as maintaining a rigorous raceway cleaning schedule, appropriate disposal of waste from raceways and utilizing settling ponds before discharge. Hand feeding, rather than using an automated system, is also a good BMP for reducing nutrient inputs to the receiving waters and recently, trout growers in Graham County have shown that low-phosphorus feed may result in a significant reduction of phosphorus from facility discharges.

In locations where there are limitations to the ability of a receiving water to assimilate the residual trout waste (i.e. flow is reduced downstream as in a lake situation or the receiving stream is already affected by excess nutrients or pathogens), facilities can easily cause water quality impacts leading to impairment of designated uses, even when BMPs are implemented. After water quality problems develop, a facility can generally can only address them by reducing trout production. Technologies available to "treat" the large volumes of water flowing through trout farms (typically 1,000 gallons per minute) are not operationally effective or economically viable.

Recommendations

Any proposed (new) trout production facility should work closely with the NC Cooperative Extension Service, NCDA, and DWQ to make sure a stream site is appropriate for the planned production operation.

DWQ should continue to:

- scrutinize any request for a new trout production facility to ensure that site conditions and mass production are such that receiving waters can assimilate the proposed discharge;
- conduct special studies when problems with trout farms are suspected and work with facilities to implement nutrient reduction measures if problems are documented as part of those studies;

- respond to water quality complaints related to trout farming operations; and
- coordinate with the NC Cooperative Extension Service, Aquaculture Specialist in the Haywood County Extension Center who works with facilities to reduce water quality impacts from trout production facilities in western North Carolina.

4.8 Priority Issues for the Next Five Years

Clean water is crucial to the health, economic and ecological well-being of the state. Tourism, water supplies, recreation and a high quality of life for residents are dependent on the water resources within any given river basin. Water quality problems are varied and complex. Inevitably, water quality impairment is due to human activities within the watershed. Solving these problems and protecting the surface water quality of the basin in the face of continued growth and development will be a major challenge. Looking to the future, water quality in this basin will depend on the manner in which growth and development occur.

The long-range mission of basinwide management is to provide a means of addressing the complex problem of planning for increased development and economic growth while protecting and/or restoring the quality and intended uses of the Little Tennessee River basin's surface waters. In striving towards its mission, DWQ's highest priority near-term goals are to:

- identify and restore impaired waters in the basin;
- identify and protect high value resource waters and biological communities of special importance; and
- protect unimpaired waters while allowing for reasonable economic growth.

4.8.1 Strategies for Restoring and Protecting Impaired Waters

Impaired waters are those waters identified in Section A, Chapter 3 as partially supporting (PS) or not supporting (NS) their designated uses based on DWQ monitoring data. These waters are summarized by subbasin in Table A-29 (page 57) and indicated on Figure A-16. The impaired waters are also discussed individually in the subbasin chapters in Section B.

These waters are impaired, at least in part, due to nonpoint sources (NPS) of pollution. The tasks of identifying nonpoint sources of pollution and developing management strategies for these impaired waters is very resource intensive. Accomplishing these tasks is overwhelming, given the current limited resources of DWQ, other agencies (e.g., Division of Land Resources, Division of Soil and Water Conservation, Cooperative Extension Service, etc.) and local governments. Therefore, only limited progress towards restoring NPS impaired waters can be expected during this five-year cycle unless substantial resources are put toward solving NPS problems. Due to these restraints, this plan has no NPS management strategies for two of the streams with NPS problems.

DWQ plans to further evaluate the impaired waters in the Little Tennessee River basin in conjunction with other NPS agencies and develop management strategies for a portion of these impaired waters for the next Little Tennessee River Basinwide Water Quality Plan, in accordance with the requirements of Section 303(d) (see Part 4.8.2 below).

4.8.2 Addressing Waters on the State's 303(d) List

For the next several years, addressing water quality impairment in waters that are on the state's 303(d) list will be a priority. The waters in the Little Tennessee River basin that are on this list are presented in the individual subbasin descriptions in Section B. For information on listing requirements and approaches, refer to Appendix IV.

Section 303(d) of the federal Clean Water Act requires states to develop a 303(d) list of waters not meeting water quality standards or which have impaired uses. States are also required to develop Total Maximum Daily Loads (TMDLs) or management strategies for 303(d) listed waters to address impairment. In the last few years, the TMDL program has received a great deal of attention as the result of a number of lawsuits filed across the country against EPA. These lawsuits argue that TMDLs have not adequately been developed for specific impaired waters. As a result of these lawsuits, EPA issued a guidance memorandum in August 1997 that called for states to develop schedules for developing TMDLs for all waters on the 303(d) list. The schedules for TMDL development, according to this EPA memo, are to span 8-13 years.

There are approximately 2,387 impaired stream miles on the 2000 303(d) list in NC. The rigorous and demanding task of developing TMDLs for each of these waters during an 8 to 13-year time frame will require the focus of much of the water quality program's resources. Therefore, it will be a priority for North Carolina's water quality programs over the next several years to develop TMDLs for 303(d) listed waters.

4.8.3 Strategies for Addressing Notable Water Quality Concerns in Unimpaired Waters

Often during DWQ's use support assessment, water quality concerns are documented for waters that are fully supporting designated uses. While these waters are not considered impaired, attention and resources should be focused on these waters over the next basinwide planning cycle to prevent additional degradation or facilitate water quality improvement. Waters with notable water quality concerns are discussed individually in the subbasin chapter in Section B.

Water quality problems in the Little Tennessee River basin are varied and complex. Inevitably, many of the water quality impacts noted are associated with human activities within the watershed. Solving these problems and protecting the surface water quality of the basin in the face of continued growth and development will be a major challenge. Voluntary implementation of BMPs is encouraged and continued monitoring is recommended. DWQ will notify local agencies and others of water quality concerns for these waters and work with them to conduct further monitoring and to locate sources of water quality protection funding.