

Impacts of Human Activities

5.0

Question 4:

What are the current and potential effects on Aquatic Resources from various activities?

In this chapter, the effects of various land management or human activities on Southern Appalachian aquatic resources will be assessed. Effects refer to the quality or condition of the water, the stream or river channel, the lake bed or its margins, aquatic organisms, and the riparian area that is adjacent to the water. Effects can be either positive or negative changes in quality or condition.

These activities can increase or decrease erosion into the aquatic system and deposit sediment in streams, rivers, and lakes; alter the physical shape of stream channels; change the chemistry of waters; and change aquatic organisms.

Activities include the development of human habitation and service facilities at urban, suburban, and rural sites; agricultural facilities and operations; construction, maintenance, and use of roads and highways; mining and petroleum extraction and processing sites; industrial facilities; water resources development; and forestry operations including silviculture, recreation, and wilderness or preservation actions.

As the assessment progressed, the aquatics team recognized that portions of chapters 2, 3, and 5 raise similar and overlapping concerns. Thus, the reporting of the assessments of aquatic species at risk is included with chapter 2, while the assessment of aquatic habitat condition is included in chapter 3.

Question 4 was answered by searching various databases from the U.S. Environmental Protection Agency (EPA), National Resource Conservation Service (NRCS), and U.S. Geological Survey (USGS), for information on human activities and their effects on water resources in the Southern Appalachian

Assessment (SAA) area. Using Geographical Information System (GIS) technology, these data were combined with maps of the waterbodies and watersheds (section 2.1) or counties of the area to determine the extent of the impact of these activities. Where regionwide databases were not available, results from surveys of literature and research reports were relied upon to define principles that are likely to apply throughout the SAA region.

5.1 HYDROLOGIC, NONPOINT, AND POINT SOURCE EFFECTS

Key Findings

- Two-thirds of the reported water quality impacts are due to nonpoint sources, such as agricultural runoff, stormwater discharges, and landfill and mining leachate.
- Soil disturbance, due to agriculture and its potential for generating soil erosion that might reach the aquatic system, declined from 1982 to 1992. Potential soil erosion was reduced by more than 50 percent in 23 counties during that 10 years, while 8 counties showed an increase of more than 50 percent.
- The impacts on hydrology are greatest for land uses and activities near streams. Away from the riparian zone, hydrologic impacts increase with the proportion of watershed that is disturbed.
- In the majority of counties in the SAA area, less than 30 percent of the land base is devoted to agriculture. Those counties with more land in agriculture do not necessarily have greater estimated erosion potential, but often do have greater estimated nitrogen loading from fertilizer and animal manure.
- In counties with high pesticide sales, 25 percent or more of the land base is more likely to be devoted to agricultural uses.
- Population in the SAA area increased 19

percent from 1970 to 1980. The growth rate totaled 7 percent over the next 10 years. Development of housing, service facilities, and roads to serve the growing population has provided increasing impacts on water quality.

- In nearly 40 percent of the watersheds in the SAA area, at least 6 percent of their stream length is near to and potentially impacted by graveled or paved lower class roads. In a few counties, as much as 20 percent of their stream length is near roads.
- A total of 890 potential pollution-source sites are listed under the Comprehensive Environmental Resource Compensation Liability Act (CERCLA) within the SAA. Of these, 22 superfund sites are on the National Priorities List (NPL), and 84 are either abandoned or closed landfills.
- At the time of this assessment, 170 sanitary landfills were active in the SAA area that were not on the CERCLA list.
- In the 305(b) Water Quality Reports to Congress, SAA states indicate that the mining impacts on water quality occur predominantly in the Tennessee River basin and southwestern Virginia. Mining and urban or suburban developments have made the largest alterations in hydrology of the SAA region, principally by changing the timing of flows and increasing stormflows.
- Forest comprises the primary land cover of the region. Unlike agriculture, forestry activities that disturb soil are dispersed in both space and time. Thus, forestry has a low potential for impacting aquatic resources.
- Both agriculture and forest harvest will increase streamflow by reducing vegetation, and thus evapotranspiration, in proportion to the watershed area that has been cleared.
- About 3,000 point sources currently discharge treated wastewater into surface waters within the Southern Appalachian region. Seven percent of these National Pollutant Discharge Elimination System (NPDES) permit sources are considered major facilities, based on volume of discharge and pollutant loading.
- The majority of the permit sources with discharges greater than 1 million gallons per day, (132 out of 222) are municipal treatment facilities. Municipal sources constitute 40

percent of all permitted discharges.

- Urban areas are a large source of biological oxygen demand (BOD). Waters with estimated high BOD loading are often in watersheds that have more miles of stream that do not support designated uses.
- The three industries with the largest number of point discharges are mining, textile, and chemical. Of those industries, 4 mining, 19 textile, and 21 chemical sites are rated as major facilities.
- Some 30 NPDES permit facilities have discharged significant levels of toxic chemicals into SAA waters. These discharges do not meet water quality standards for those waters and require individual control strategies.
- A total of 17 fish consumption advisories have been issued in the SAA area, and each state has at least one of these advisories. Eleven of the warnings are for polychlorinated biphenyl (PCB) contamination, one is due to PCB and chlordane contamination, three are due to mercury contamination, and two are due to dioxin contamination. Of the 17 advisories, 10 are located on 4 rivers and a lake that cross state lines.

Data Sources, Data Quality, and Pre-analysis Treatment

The base GIS data layers for these analyses were the waterbodies (streams, rivers, and lakes) and watershed boundaries, both previously described in section 2.1. Information from other chapters used to interpret Question 4 are the land cover satellite data described under section 3.2, land ownership boundaries and data, such as critical species information, described in chapter 2. The results are categorized by state and county boundaries and by hydrological unit code (HUC) watersheds. Activities are assessed in terms of their ability to change the hydrology or the water quality of the aquatic system. Water quality effects are separated into those that are caused by nonpoint sources and by point sources.

Hydrologic Impacts

Hydrologic changes may be significant on a small watershed or at a stream site, but rarely are noticeable at the scale of a large watershed

or river basin. The stream channel size and shape are the result of the historic flow pattern, from droughts to floods, and of the sediment input from the uplands. When a hydrologic regime of the stream changes, the channel characteristics will adjust to the new regime. Publications that describe hydrologic processes in detail include Hewlett (1982), Anderson and others (1976), Ward (1975), and Brooks and others (1991). Leopold (1994) offers a lengthy discussion of stream adjustments that are due to changes in the hydrologic conditions of watersheds.

Nonpoint Sources

For the purposes of this report, any source of contamination that does not require an NPDES permit is considered a nonpoint source of pollution. Some source categories, such as acid mine drainage, include both point and nonpoint discharges and are also discussed in this section.

Industrial sites, landfills, and other locations that are potential origins of nonpoint source pollution are identified pursuant to CERCLA. The Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) database, maintained by EPA, is the source for this inventory of CERCLA sites and for related information on the extent of site contamination and status of remedial action. From the CERCLIS database, the NPL further identifies high-risk Superfund sites, which by definition have or can adversely impact human health or the environment and have been targeted for cleanup.

Landfills are included in the CERCLA list only if they are abandoned or closed and have not met federal and state sanitary landfill regulations. Rules require that existing landfills be properly closed and capped, with provision for long-term monitoring of groundwater for seepage. Location data provided by states and compiled by EPA is available for 90 percent of the sanitary landfill sites.

Mining activities that have adversely affected water quality are documented in the 305(b) Reports to Congress from SAA states and are identified according to river or watershed. Impacts are reported as miles of stream either partially supporting or not supporting designated uses. (see section 2.2).

The Natural Resource Inventory (NRI)

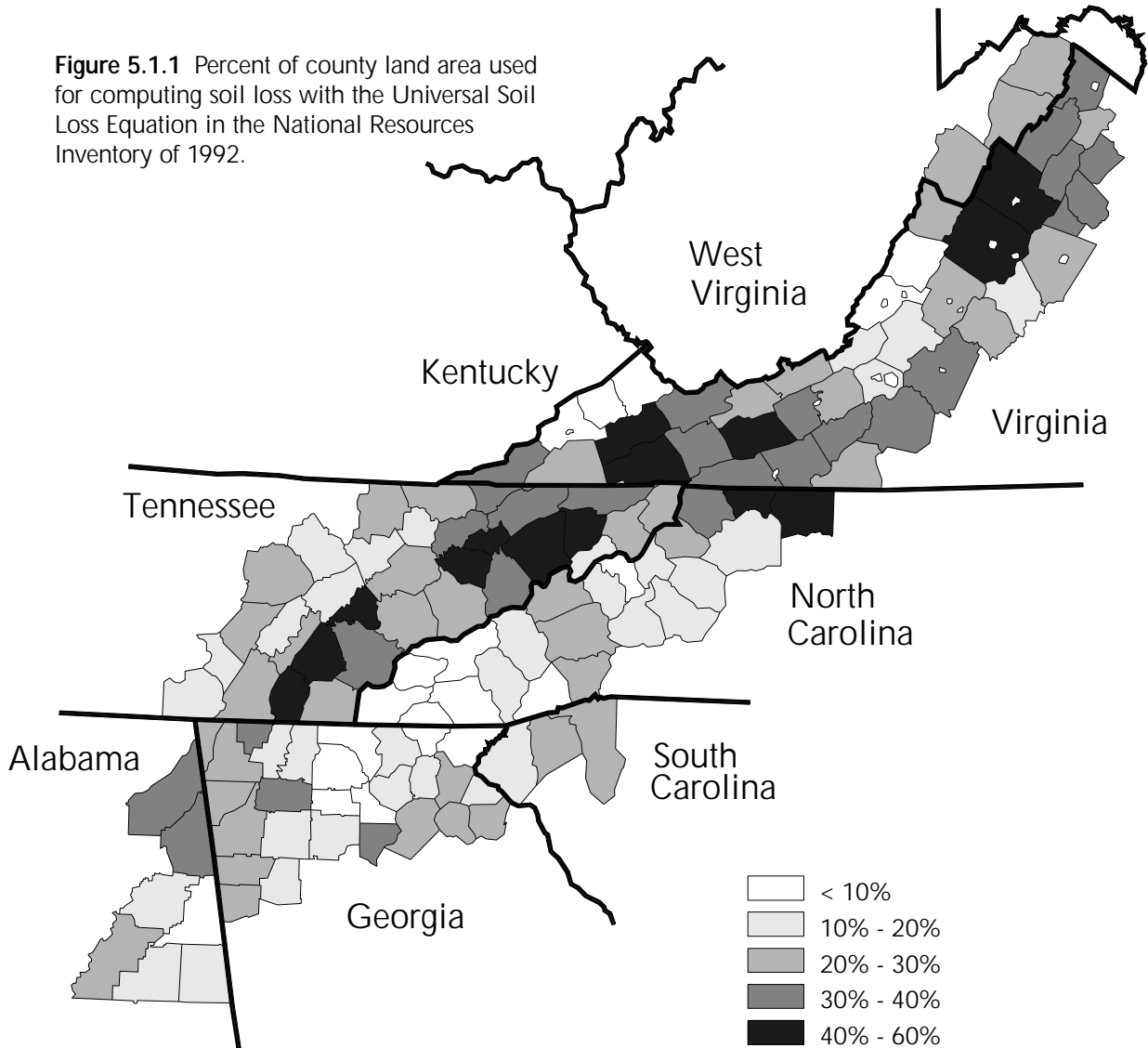
database, built by the NRCS (formerly the Soil Conservation Service), sampled each county in the SAA region for land use. For each sample point where agriculture was the land use, estimates of soil erosion potential were calculated (Soil Conservation Service 1994). These inventories were made at 5-year intervals in 1982, 1987, and 1992. The erosion potential from the NRI cannot be taken as a total measure of sediment that reaches waterbodies from agricultural practices. These are estimates of erosion potential on the cropland site and cannot be used to estimate the proportion of eroded soil that is carried to waterbodies or drainage channels. As such, these erosion potentials are a relative estimate of the sediment-producing opportunity and of the quality of agricultural land management practices in a county. A large portion of the SAA region is forested; thus, in two-thirds of the SAA counties, less than 30 percent of the land base is included in this analysis (fig. 5.1.1).

The Universal Soil Loss estimate, in tons/acre/year, and an area weighting factor for each sample point were extracted from the NRI database for the 3 inventory years. The erosion rates, weighted by their representative areas, were summed for each of the SAA counties and divided by the county area in agricultural use to determine an average erosion rate for each county.

Puckett (1995) found that commercial fertilizer and animal manure are the largest sources of nitrogen loading on southeastern United States watersheds. These nitrogen inputs are significantly greater in watersheds where agriculture is the dominant land use. However, he concluded that only a small part of the total nitrogen applied to the land reaches the aquatic system. Following the technique of Puckett, commercial fertilizer application rates found in the 1985 EPA National Database of Fertilizer Sales and 1987 animal population figures from the Census of Agriculture were used as estimators of potential nitrogen loading of the aquatic system.

Pesticides are routinely applied to agricultural lands, residences, lawns, and golf courses. This analysis estimates pesticide loading found only on agricultural land. Pesticide-use data were obtained from the same NRI database as used for erosion estimates and are based on pesticide sales by county. Agricultural pesticides include herbicides, insecticides, and

Figure 5.1.1 Percent of county land area used for computing soil loss with the Universal Soil Loss Equation in the National Resources Inventory of 1992.



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fungicides. Pesticides can reach surface waters from aerial drift, stormwater runoff, and careless handling. Pesticides that are present in surface waters can contaminate public drinking water supplies and sediments in aquatic habitats. Bioaccumulation of pesticides may appear at several levels in the food chain.

In Chapter 3, the distribution of land covers that are important to aquatic resources reflects differences in ecological regions. Agricultural land uses are more predominant in the Ridge and Valley, while forests are more dominant in the Blue Ridge. Federal and state agencies have monitoring and research programs that focus on the impacts that forests and forest uses have on aquatic resources in the SAA region. Information on these impacts is available in research reports from Coweeta Hydrologic Laboratory in Macon County, North Carolina (Stickney and others 1994); Fernow

Experimental Forest in Tucker County, West Virginia (Godwin and others 1993); Tennessee Valley Authority (TVA), Oak Ridge National Laboratory, National Park Service, and National Biological Service at Gatlinburg, TN, as well as numerous universities with forestry, fisheries, hydrology, and forest ecology programs in and near the SAA region. Other sources include reviews such as Waters (1995), Hackney and others (1992), and Swank and Crossley (1988).

Roads can be a major source of lowered water quality in the SAA region. During road construction, soil is exposed to erosion processes. Graveled and ungraveled roads provide a continuing potential for soil erosion. Periodic maintenance of road ditchlines and gravelled roadbeds reexposes soil to erosion. Where these roads are near streams, lakes, and rivers, this eroded soil easily can be washed into the aquatic habitat. In addition to sediment

reducing water quality, petroleum products and chemicals washed by storms from road surfaces can also pollute streams. For the purposes of this assessment, the amount of road length near to waterbodies is used as measure of a major potential for water quality degradation.

The road data were obtained from the USGS 1:100,000 Digital Line Graph (DLG) files. These were assembled for the SAA region into four files, based on road size and use. Class 1 includes all primary highways, both federal and state numbered routes. Class 2 is secondary paved routes, such as major county roads. Class 3 is the minor paved county roads and major gravel-surfaced roads. Class 4 includes paved streets in both cities and towns and lesser rural gravel roads. The DLG files also included a class for trails, which was retrieved for the SAA but not used in the road analysis (USGS DLG database).

The road classes would be most useful for this analysis if gravel or soil-surfaced roads were in classes that are distinctly separate from paved roads. The newest roads, built or reconstructed after the DLG file was created, are not in this database. Small rural and most forest access roads are also omitted. The newer DLG files that are being created by USGS from 1:24,000 scale maps will show more complete road detail. When road positions were drawn on the maps that were the source of this digital data, true positions may have been shifted to allow for space to print the adjacent road and stream symbols. This position error is not considered significant for the purposes of this analysis.

A drinking water source is one of the highest uses of the SAA aquatic resource. Thus the location of water intakes are focal points for assessing impacts on water quantity and quality. Drinking water intake data were obtained from EPA Drinking Water Supplies file. Stream information was obtained from EPA River Reach 1 (RF1) database.

Point Sources

Point sources are both municipal and industrial in origin. Every point source discharge to surface waters of the United States is required to obtain a permit to discharge under the NPDES. (See section 4.1 for further background on water quality laws and regulations.) These permits specify limits for mass or concentration

of specific pollutants, monitoring requirements, and other provisions such as spill prevention plans, which can all be used to assess pollution loading and risks. The database that stores the information on wastewater dischargers is the EPA Permits Compliance System (PCS). The PCS maintains data about individual dischargers, including location, allowed flows, limits for each pollutant allowed to be discharged, monitoring requirements, and information concerning permit violations. The PCS database contains location data for more than 85 percent of the individual point sources in the SAA region, however, precise locations are not available for the other, usually small, sources. For major dischargers and most minor dischargers, PCS has a record of the Discharge Monitoring Reports (DMR) of each source. The DMRs are required reports, usually monthly, that document the self-monitoring of permit limits by the discharger.

Facilities covered by Section 304(l) of the Clean Water Act (CWA) regulations are a subset of all PCS-listed facilities. The priority or "short" list of 304(l) facilities is the list of sites where discharges of toxic pollution are known to cause water quality problems. These facilities are proposed to EPA for Section 304(l) listing by state environmental programs.

Additional information on toxic discharges was obtained from the EPA Toxics Release Inventory (TRI). The TRI contains the annual records of releases of toxic or hazardous substances to air, water, and land. Reports of quantities released to water are based on a variety of techniques, including direct measurements or estimates that are provided by the individual facilities. The latest available data for 1993 were the basis for this analysis.

The protection of human health through the regulation of toxic pollutants in fish is a joint federal and state responsibility. The Food and Drug Administration (FDA) has direct enforcement responsibility over all contaminated food, including fish and shellfish, that is shipped in interstate commerce. The EPA is responsible for establishing tolerances (maximum permissible levels) for residues of pesticide chemicals that may appear in fish. Environmental agencies and health departments at the state and local levels are responsible for issuing public health advisories and regulations for local fisheries. States may determine a more appropriate level of concern or "trigger point" for a

chemical based on site-specific monitoring data or surveys. This analysis presents all the fish consumption advisories in the SAA area. These advisories are due to the presence of chlordane (a pesticide used for termite control until recently banned), dioxins (byproducts of the kraft mill paper bleaching process), mercury (used by chemical and munitions facilities), and PCBs (widely used in industrial and commercial equipment for power generation and distribution until banned in 1976). Generally, when a state issues an advisory on a stream or lake, a press release is issued that describes the associated health risks in detail. In most states, these advisories are published in the annual sport fishing regulations or biennial water quality reports of fish and wildlife or health agencies. This analysis consulted state 305(b) reports, a recently released national database entitled National Listing of Fish Consumption Advisories (NLFCA), and EPA's Fish Contamination Database (managed by the Environmental Services Division in Athens, GA) and (Alabama Department of Environmental Management 1994; Denton and others 1994; Georgia Department of Natural Resources 1994, 1995; Murphy and Stiber 1994; North Carolina Department of Environment, Health, and Natural Resources 1994; South Carolina Department of Health and Environment 1994; TVA 1995a; EPA 1992, 1995a, 1995b).

In addition, the EPA 1992 Needs Assessment for sewer and sewage treatment systems was used to provide estimates of the resources needed for upgrading municipal and community sewage collection and treatment over the next decade. This assessment includes both the estimated need to upgrade or replace existing facilities and the need for expansion to accommodate anticipated future demand.

Analyses, Spatial Patterns, and Trends

Hydrologic Impacts

Natural events will have the same hydrologic effects as human activities that create similar conditions. Floods may cause major changes in the stream channel system through the scouring action of peak flows and the transfer of sediment. The channel may be either eroded or filled, both of which would create long-term

effects on water quality by causing channel adjustments. Future runoff timing, peak and low flows, and flow volumes should not be changed.

Droughts minimize stream flows; thus, bed-load movement will be reduced and channels filled with deposits. Sediment loading can increase if surface runoff occurs where ground-cover is killed by drought.

Landslides often deposit a large volume of soil, rock, and organic debris in stream channels. Some material is immediately transported downstream; more will gradually move during successive storms, while the remainder stabilizes where the slide stops. Locally, the site of the slide will have increased runoff peaks and sediment loading.

The effects of wildfire, insects, disease, and wind and ice storms are dependent on the severity and extent of changes in evapotranspiration, infiltration, and vegetation growth. Immediate effects of wildfire include an increase in total runoff and storm flows if extensive areas of vegetation are killed and soil is exposed. Nutrient loading may be temporarily increased. Recovery from fires is typically rapid in the East within a few years (Anderson and others 1976).

Insects and disease will change the total volume of runoff only if extensive areas of vegetation are killed. Normally only a few species are attacked and the remaining vegetation quickly utilizes the extra soil moisture and nutrients that become available. Where riparian trees are killed, woody debris loading may be increased and stream temperature raised slightly. Insect droppings may significantly change the water quality. Wind and ice storms typically disturb patches of land of limited area and have little influence on streams except for possible increases in woody debris. Runoff characteristics should not change where the vegetation is not killed, large areas of soil are not exposed, and infiltration rates are not changed.

Urban and suburban development of forested watersheds creates a major impact on the hydrologic regime. Development can increase the percentage of impervious surfaces on a watershed from nearly zero in a rural setting to almost 100 percent in commercial or industrial areas. Lull and Sopper (1969) conclude that urbanization in forested watersheds tends to "...reduce interception, infiltration, soil-moisture storage and evapotranspiration, and to increase overland flow and runoff. Several studies of

peak flows have shown that they may be increased by 1.2 to 5 times over peaks from rural conditions.... During development and construction of suburban areas, sedimentation may be increased greatly; even after construction, sedimentation in these areas may be 5 to 10 times that from protected watersheds." They also find that annual maximum peak flows increase, although maximum daily flows decrease. Total flow volume increases because a greater percentage of summer precipitation appears as runoff.

Surface and underground mining cause similar effects on the hydrologic regime, although to differing degrees. Surface mining includes all forms of open mines, while underground mines utilize tunnels and shafts. Mining effects on the hydrology of an area depend directly on the areal extent of the operation and the implementation and effectiveness of runoff and pollution control practices. Mining typically alters the timing and volume of runoff and the chemical and physical quality of the runoff. In general, surface mining results in higher stream flow and storm flow volumes than underground mining (Nelson and others 1991). This is due to the greater areal removal of vegetation and soil, the volume of spoils created, and general compaction of the area. Channels will adjust to increased peak flows and higher loading of fine and coarse sediments. Channel adjustments may include enlargement, filling with sediment, or overflow and braiding (multiple channels).

The hydrologic effects of agriculture are directly dependent on the amount of soil exposed, season of exposure, level of soil compaction, the location of the disturbance relative to stream channels, and the proportion of watershed disturbed. Annual row crops expose large areas of soil. If a compacted soil layer develops below the plow zone, water infiltration is restricted and surface runoff increases. Peak flow rates from watersheds with extensive row cropping will be greater than from forested watersheds. The lower evapotranspiration of row crops will result in a total water yield that is somewhat higher than with forest cover. If fields are cropped to the edge of stream channels, stream temperature will be increased (Swift and Messer 1971) and woody debris loading of the streams will be greatly decreased.

Pasture effects on hydrology depend directly on management. Pasture management for good ground cover, high infiltration rates, and

protected stream banks will yield minimum impacts. Typically, however, pastures are overgrazed, have compacted soils, and allow animals free access to riparian areas and streams. Riparian areas are often more heavily grazed than upland areas because they consist of flatter terrain, water, shade, and more succulent vegetation (Platts 1991). There, surface runoff occurs during most storms, resulting in increased peak flows and associated water quality problems. Animal feedlots concentrate impacts and accentuate the hydrologic and water quality problems.

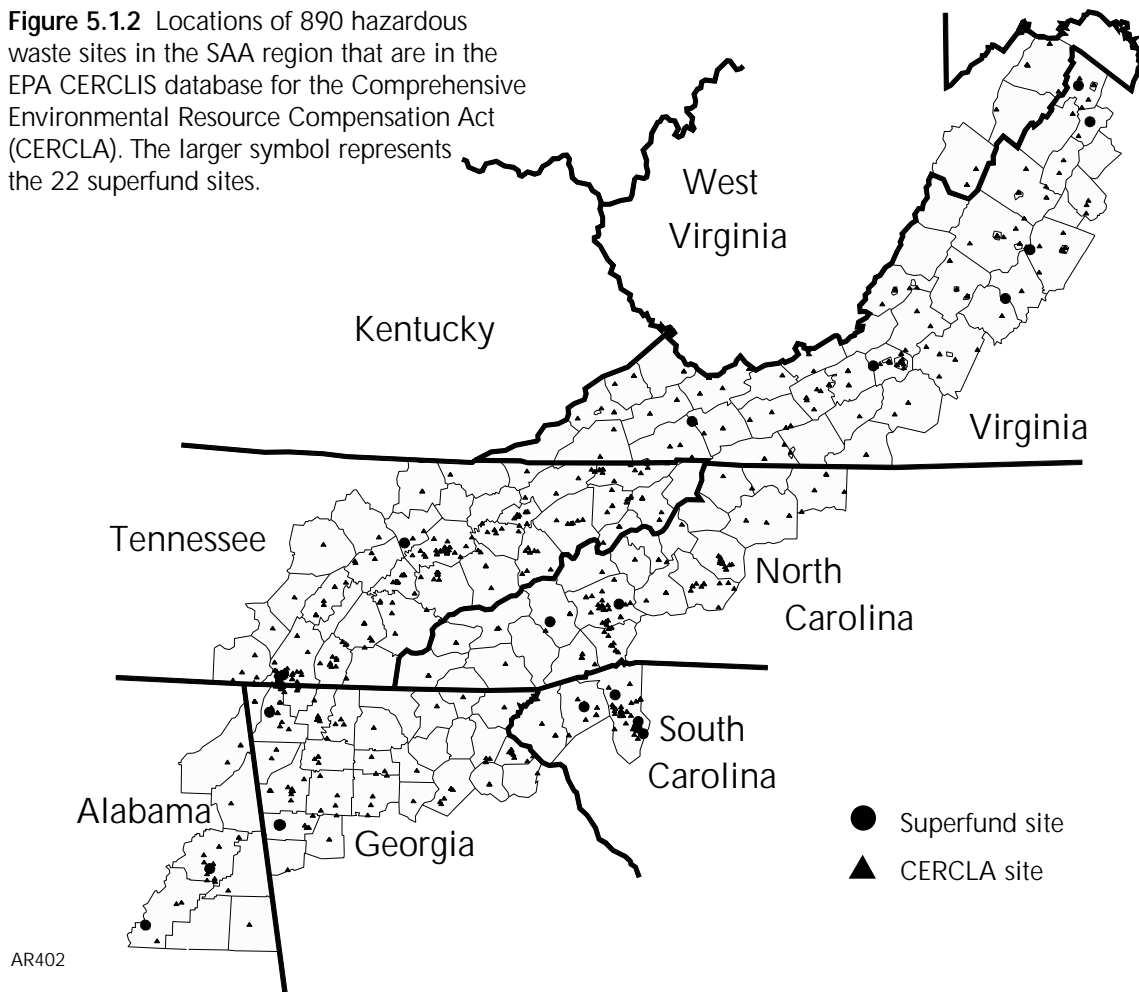
Orchard effects will vary greatly, depending primarily on the amount of bare soil and roading. Soils within well-established orchards should have high infiltration rates. However, the road system may produce rapid surface runoff.

Forest management Best Management Practices (BMP) are practices that are applied to the land for the production of trees while protecting aquatic, vegetation, wildlife, and recreation resources within a forested area. Each practice may have significant or insignificant effects on hydrologic processes, depending on the intensity and areal extent of the activity.

Timber harvesting reduces evapotranspiration in the short term, thereby increasing soil moisture and the potential for increased stream flow. Flow increases occur when soil moisture normally would be depleted by growing trees. Stream flow increases are greatest during the first year after harvesting and decline quickly with tree regrowth. Research studies in or near the SAA area indicate that first year stream flow increases up to 16 area-inches for clearcuts (100 percent of trees) and up to 4 inches for selection cuts that remove 30 percent or less of the trees (Swank and others 1988). Typically, cutting less than 20 percent of a well-stocked timber stand will not increase stream flow (Douglass 1967). Peak flow rates from clearcut watersheds are rarely increased for small storms unless the soils have been greatly compacted and infiltration is severely reduced. Large storms are more likely to result in higher peak flows, not due to the timber harvest, but due to the large excess of precipitation relative to available soil moisture storage.

Site preparation is a group of forestry practices used to regenerate a new forest stand. Techniques range from simply cutting the residual woody vegetation to mechanical clearing and cultivation. Herbicides and fire are

Figure 5.1.2 Locations of 890 hazardous waste sites in the SAA region that are in the EPA CERCLIS database for the Comprehensive Environmental Resource Compensation Act (CERCLA). The larger symbol represents the 22 superfund sites.

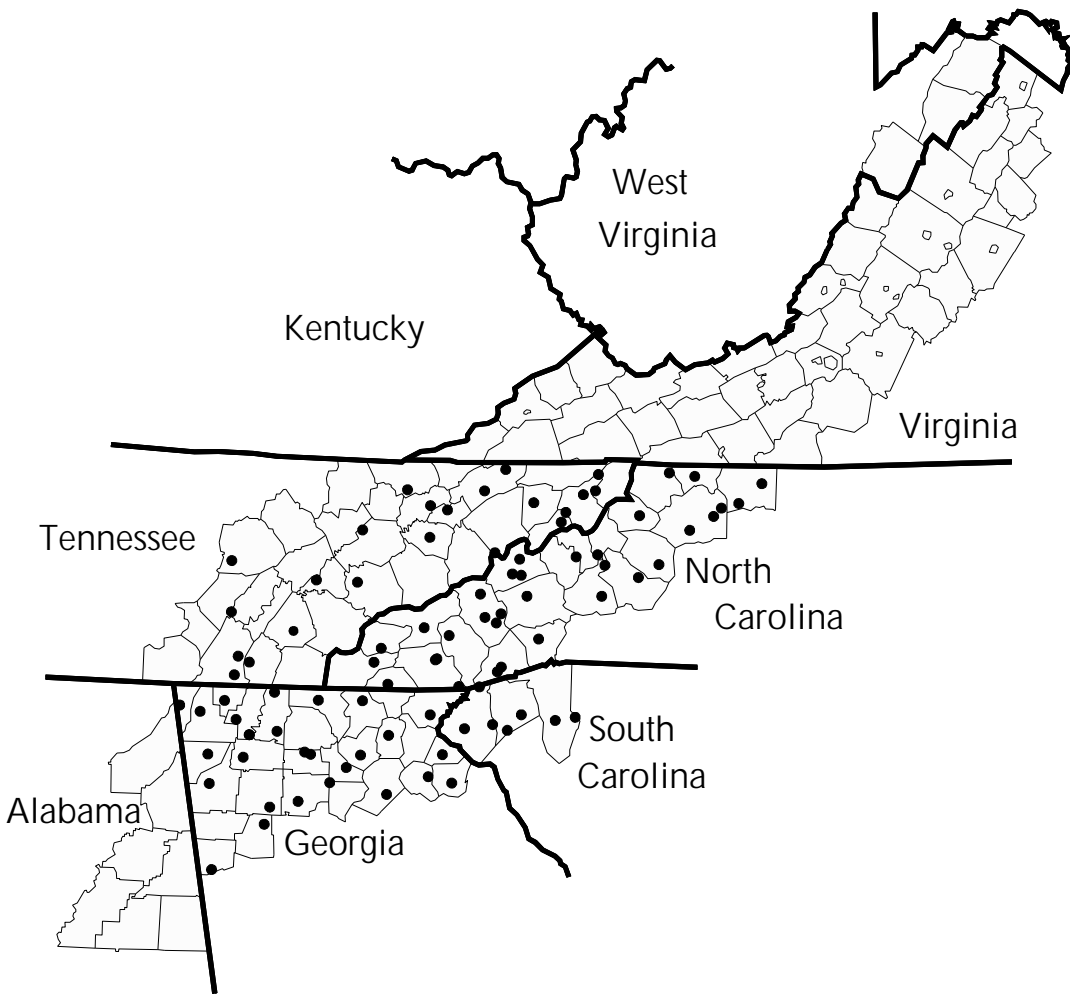


sometimes used. Site preparation effects on hydrology are directly related to the amount of soil that is compacted and the amount of organic surface layers that are removed from the disturbed soil. Prescribed fire is the controlled burning of unwanted material within the forest. The effects of fire on hydrology depend on how much vegetation is killed, the amounts of organic soil layers that are consumed, and whether soil is exposed. Intense fires may lead to increased peak flows due to surface runoff and increased total water yield due to evapotranspiration reduction. The duration of any effects from fires is strongly influenced by the rate of revegetation (Anderson and others 1976).

Roads that cross or lie near natural drainage channels affect the path and time in which storm water takes to reach the aquatic system. This extra water will accelerate erosion, increase sediment loading, and change runoff characteristics. Compared with vegetated land, precipitation runs off roads quickly instead of infiltrating, which will increase peak flow rates and shorten storm flow duration. However, unless roads occupy a significant proportion of

the watershed, total water yield and flow timing will not be observably affected.

Dams and their reservoirs can change the regime and water quality of a stream. The magnitude of the changes will depend in part on the size of the stream, the volume and depth of the reservoir, and the location of the outlet. Reservoirs may stop virtually all downstream movement of sediment and may initiate downstream channel erosion by releasing clean outflow with sediment carrying capacity. Downstream productivity can be reduced when drifting organic material and food organisms are trapped. Downstream water temperature is influenced by the location of the outlet of a reservoir. Water released from the top of a reservoir is warmest and water released from the bottom is coldest. Dissolved oxygen content of the released water may also be affected. Unless bypasses are provided, fish movement is stopped totally, preventing upstream or downstream migration for spawning and growth. Flooding of streams by impoundments has destroyed shallow-water habitats for fish and molluscs, resulting in loss or imperilment of



species (section 2.4). Where the volume of water in a reservoir is allowed to fluctuate, it will absorb and reduce high or peak flows and supplement low flows. These flow changes may have secondary effects downstream, such as changes in aquatic plant species, increased plant growth, and changes in channel size and shape. A somewhat more detailed discussion is presented by Hynes (1970).

Nonpoint Sources

Based on the 305(b) Water Quality Reports to Congress from SAA states, two-thirds of the reported water quality impacts in the SAA area are due to nonpoint sources.

The CERCLA program began in 1980 and is continuing to identify sites nationally that require further evaluation as Superfund sites. Inventory of the pollution sources in the SAA area found 890 CERCLA sites, and evaluated environmental impacts, from 22 Superfund sites. Currently, the rate of identification of new CERCLA sites is low. Furthermore, CERCLA sites are not usually significant sources of the

types of pollution that are causing widespread impacts in the SAA area. Many sites in the CERCLIS database will not require immediate action and most are low priority for future remedial action. However, the 890 CERCLA sites (fig. 5.1.2) do show the potential to cause locally significant impacts and are more prevalent in urban areas. Abandoned or closed landfill sites account for 84 of these CERCLA sites.

Of the 22 Superfund sites, Records of Decision are in place at 19 sites to direct remedial actions. Impacts on surface or groundwater bodies have been documented for eight of these sites. The Superfund sites are found in developed areas, such as Greenville County, South Carolina, which has 5 of the 22 Superfund sites. The Superfund sites are plotted with larger symbols in figure 5.1.2.

Sanitary landfills are located in most counties in the SAA area and are found in both urban and rural settings. Figure 5.1.3 shows locations of most of the 170 active sanitary landfills in the SAA area. Landfills historically have been a significant source of CERCLA sites. Therefore, to avoid future environmental