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Virginia Water Resources Progress Report 2020

Natural Resources Conservation Service

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Acknowledgement

The 2020 Virginia Water Resources Progress Report offers a comprehensive overview of the State's Small Watershed Program from 1944 to the present. The projects documented here demonstrate the breadth and depth of the Natural Resources Conservation Service's commitment to protecting the safety and well-being of the communities we serve.

Countless hours were invested in investigation, analysis, decision-making, reporting, and implementing these works of improvement. Staff from every level of the agency made vital contributions to the effort. Alica J. Ketchem, Planning/Environmental Engineer, prepared this watershed project summary. Virginia NRCS would like to acknowledge the many years of hard work invested to establish a legacy of which we can all be proud.

INTRODUCTION

The Water Resources Progress Report documents the efforts that have been made by the Natural Resources Conservation Service (NRCS) in the protection of water resources in Virginia. The work described in this report began in the mid-1940's with the completion of the flood protection plan for the South River in the Shenandoah-Potomac Watershed. Projects have ranged from large scale efforts, such as River Basin Studies, to flood prevention plans for individual communities to land treatment in the watershed. Over 150 studies and plans have been completed. As of 2020, there are still four ongoing projects for land treatment and flood control.

GENERAL SETTING

Virginia is bounded on the east by the Atlantic Ocean, on the north by Maryland, on the west by West Virginia and Kentucky, and on the south by Tennessee and North Carolina. Virginia's surface area totals 27,087,100 acres. About 1,910,500 acres, or 2,985 square miles, are inland water, predominantly in estuaries, tidal fresh water, manmade reservoirs, and two natural lakes (Drummond and Mountain).

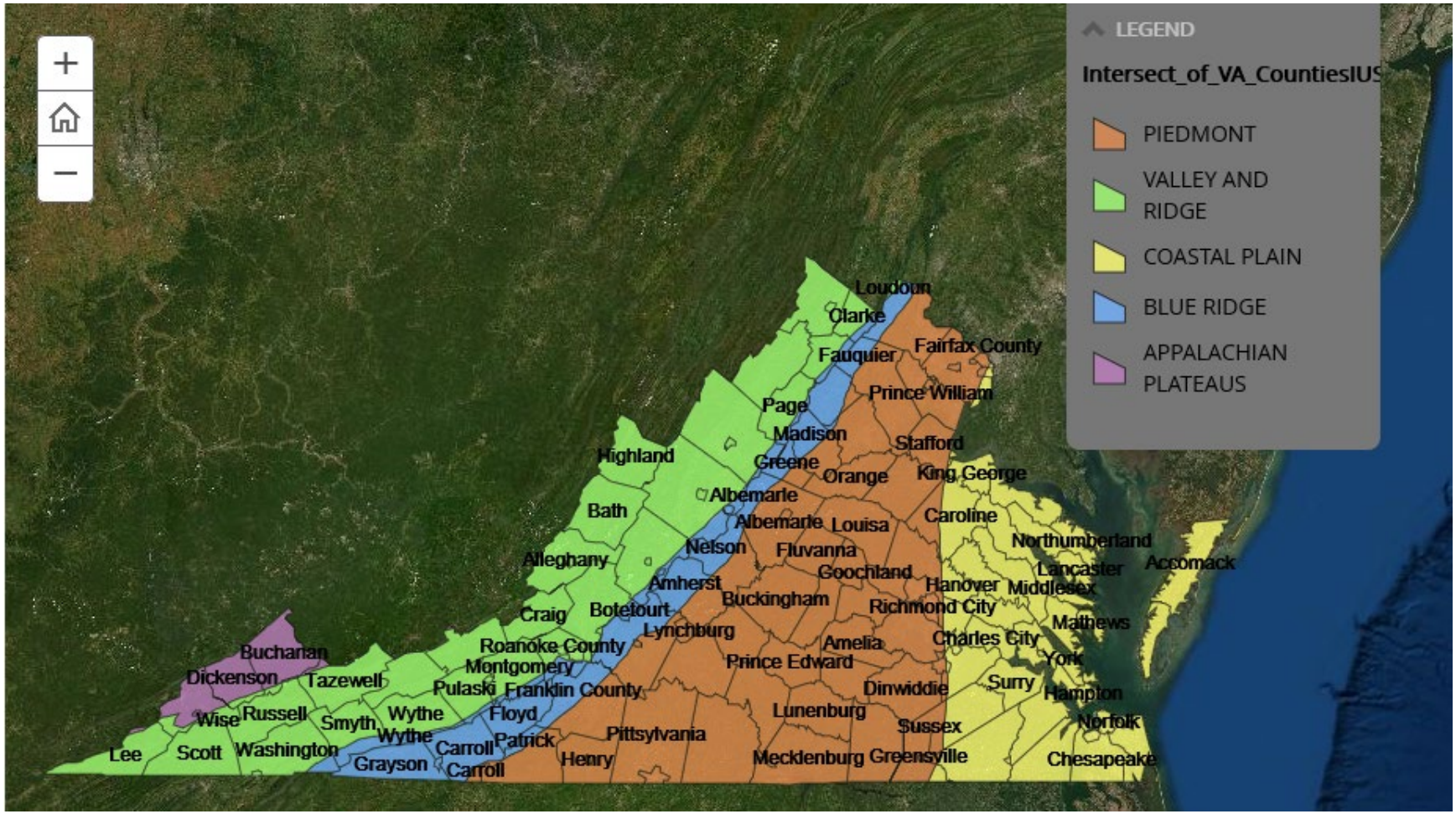
The State lies within five physiographic provinces, each of which is characterized by distinct geologic features (fig. 1). The eastern-most region of the State is in the Coastal Plain, which has alluvial soils and a relatively flat terrain. Going west, the next region is the Piedmont Province, which is characterized by gently rolling terrain of farms and woodlands. Continuing westward, the Blue Ridge Province is mostly mountainous; elevations can reach to more than 5,000 feet above sea level. The Valley and Ridge Province occupies most of the western portion of the State and is characterized by rolling hills and valleys. The Appalachian Plateau region extends over the upper southwest corner of the State and generally has rugged terrain.

Virginia is drained by ten major river basins (fig. 2). The Potomac-Shenandoah, Rappahannock, York, James, Chowan-Dismal Swamp, Yadkin, and Roanoke Basins eventually drain into the Atlantic Ocean, the first four via the Chesapeake Bay and the last three via the Albemarle Sound. Runoff from the New, Tennessee and Big Sandy Basins eventually flows via the Ohio River and Mississippi River into the Gulf of Mexico.

POPULATION

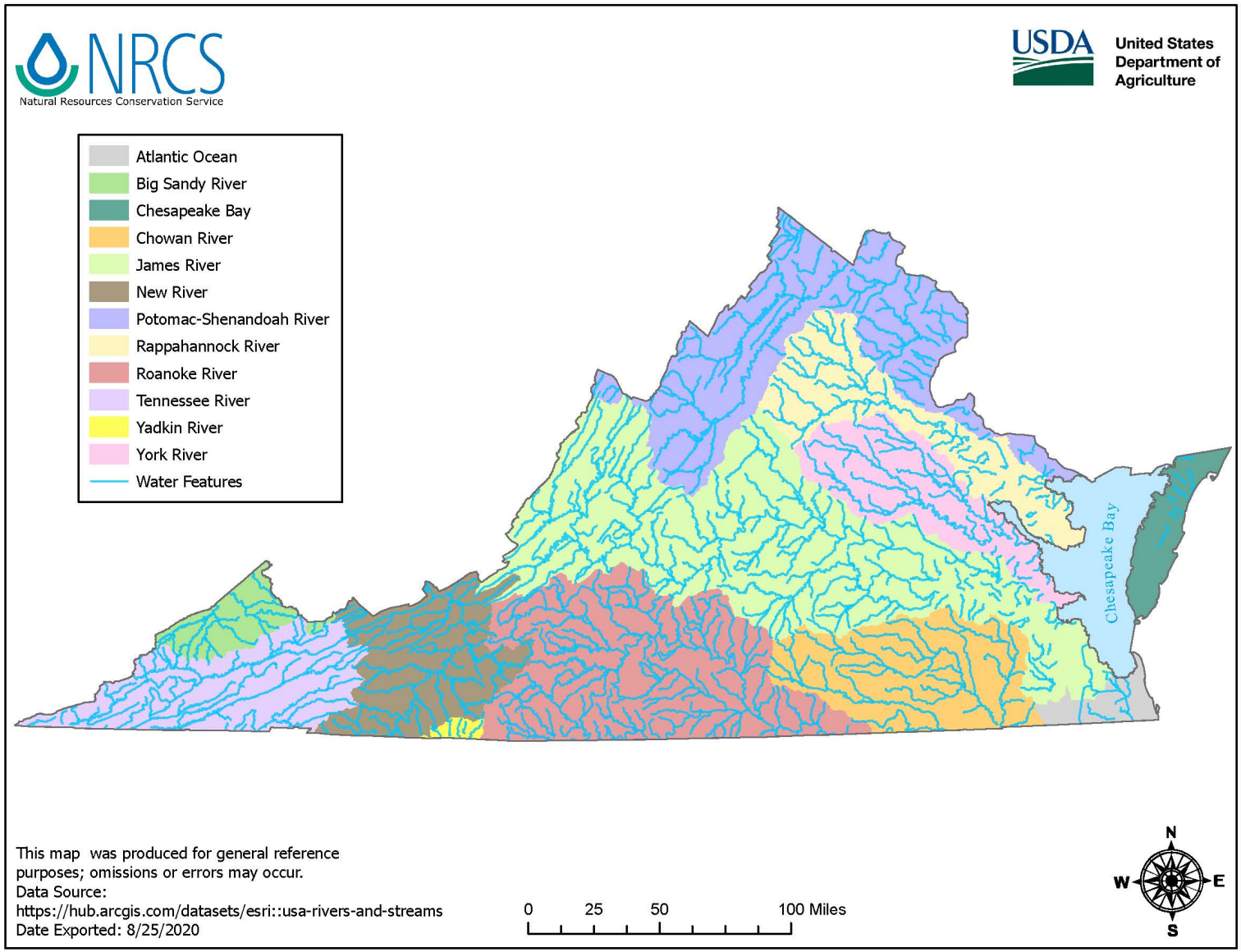
According to the U.S. Census Bureau, Virginia's population in 1990 was approximately 6.2 million. By 2000, the state's population had increased by about 900,000 to 7.1 million. By the 2010 census, Virginia's population had increased by 923,000 to a total of just over 8 million. The Census Bureau estimates the total population for 2019 was 8.53 million. The population growth since 2010 was 6.7% and is the slowest rate of growth in recent history. The projected total population of the state is expected to reach 9.33 million by the year 2030 and 9.88 million by the year 2040. Virginia ranks as the 12th most populous state.

Figure 1. Virginia physiographic provinces.



Upstar Geographics [https://www.arcgis.com/apps/MapJournal/index.html?appid=57d273243e8642acbeda40028d79c053]

Figure 2. Major watersheds in Virginia.



VIRGINIA LAND RESOURCES

The following information is from the 2015 National Resources Inventory (NRI). The National Resources Inventory is a statistical survey of natural resource conditions and trends on non-federal land in the United States. Non-federal lands include privately owned lands, tribal and trust lands, and lands controlled by State and local governments. The NRI collects updated information every year on the condition of Virginia's soil, water, and related resources. The NRI includes data on land use, land cover, erosion by water, prime farmland, water bodies, wetlands, selected conservation practices, and related resource attributes.

MAJOR SURFACE AREAS

Virginia's surface area totals 27,087,100 acres. This area consists of four broad categories. Rural land is the largest followed by developed land, federal land, and water. From 1982 to 2015, the amount of non-federal, rural land declined by 6.94%, a decrease of 1,462,000 acres (table 1). During the same years, the amount of non-federal, developed land increased by 1,372,500 acres (74.57%). Water areas increased by 27,700 acres (1.49%). The federal land accounted for 2,354,400 acres or about 8.7% of the State.

Table 1. Total surface area in Virginia from 1982 to 2015, by Land Cover/Use.

	1982, acres	Percent change from 1982						Percent change from 1982 and acres
		1987	1992	1997	2002	2007	2012	2015
Federal Land	2,292,600	0.74	1.66	1.66	2.40	2.66	2.66	2.66 2,354,400
Water areas	1,882,400	0.11	0.58	0.64	0.90	1.22	1.43	1.49 1,910,100
Non-federal - developed	1,839,900	13.04	23.97	42.61	56.52	66.30	71.90	74.57 3,212,400
Non-federal - rural	21,072,200	-1.23	-2.33	-3.95	-5.27	-6.19	-6.70	-6.94 19,610,200

LAND COVER/USE

Non-federal rural land, which includes cropland, grazing land and forest land, accounted for about 77.8 percent of the total land use in 1982 but about 72.4 percent of the total land use in 2015. Figure 3 shows how the land use has changed from 1982 to 2015.

Cropland

Non-federal, rural cropland includes areas used for the production of adapted crops for harvest. Two subcategories of cropland are recognized: cultivated and non-cultivated. Cultivated cropland comprises land in row crops or close-grown crops and also other cultivated cropland, such as hay land or pastureland that is in a rotation with row or close-grown crops. Non-cultivated cropland includes permanent hay land, apples, vineyards, and other horticultural cropland.

From 1982 to 2015, the total acres of non-cultivated cropland increased by 49.4 percent, and the total acres of cultivated cropland in Virginia declined by 40.5 percent. The total cropland decreased by 18.2% with losses to forest, pasture, and development.

Grazing Land

Total non-federal grazing land, pastureland and grazed forestland have all declined in Virginia in the years between 1982 and 2015. An analysis of this period shows a decline in total grazing land of 22.4%, a decline in pastureland of 13.8% and a 55.7% decline in grazed forest land. Some pasture acreage has been gained by a conversion from cropland, but this is offset by the losses to forest and development.

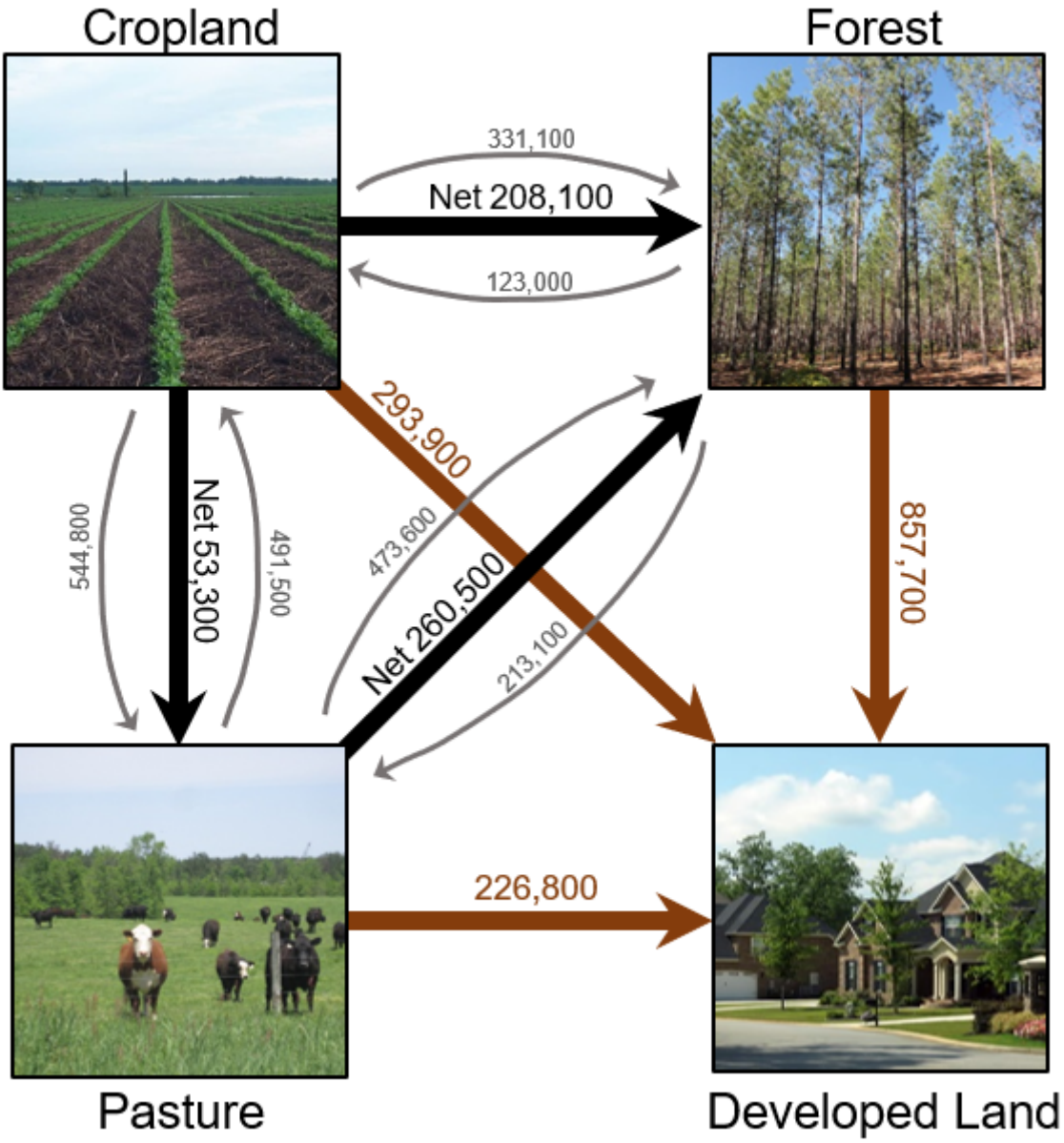
Forest Land

In 2015, about 49% of the non-federal land in the State was covered by forest land. The trend shows a slight decline, about 3.3%, in forest cover since 1982. The net increase in the conversion of cropland to forest of 208,100 acres and the conversion of pasture to forest of 260,500 acres are offset by the net loss of 857,700 acres to development.

Developed Land

From 1982 to 2015, the amount of large urban and built-up areas in Virginia more than doubled to encompass 2,457,900 acres. The amount of land in small built-up areas and rural transportation has increased by 46% and 5%, respectively. The gains in developed land have come from cropland, pasture, and forest.

Figure 3. Cover/Use changes, in acres, for non-federal land in Virginia from 1982 to 2015.



Source: 2015 NRI.

VIRGINIA WATER RESOURCES

WATER QUALITY

Many of the recent public concerns over water resources in Virginia have focused on the quality of water and its use and benefits to people. The sources of contaminants which impair water quality have been subdivided into point sources and non-point sources. The NRCS, through its technical and financial assistance programs, is primarily involved in the reduction of pollutants from non-point sources, such as cropland fields, and point sources, such as concentrated livestock areas.

In 2008, Virginia prepared a Rapid Watershed Assessment of the North Fork of the Shenandoah River Watershed. This report documented, by subwatershed, the issues and concerns for topics such as water quality. As a result of this report, the Smith Creek Subwatershed, in Rockingham County, was designated as a Showcase Watershed in 2009. The purpose of this project was to demonstrate the effect of conservation practices on water quality. More than 8,115 acres in the watershed were treated with conservation practices in the first ten years of the project.

The Virginia Department of Environmental Quality extensively tests Virginia's rivers, lakes, and estuaries for a variety of pollutants. The 2014 305(b)/303(d) Water Quality Assessment Integrated Report was released on June 13, 2016. This report summarizes the water quality conditions in Virginia from January 1, 2007 through December 31, 2012. The following six designated uses are applicable for surface water quality conditions: aquatic life, fish consumption, shellfish harvest, recreation, public water supply, and wildlife. Waters that cannot support one or more of their designated uses because of a variety of pollutants are considered to be “impaired”. Since 1998, DEQ has developed plans, with public input, to restore and maintain the water quality for the impaired waters. These plans are called "Total Maximum Daily Loads," or TMDLs. TMDL is a term that represents the total pollutant a waterbody can assimilate and still meet water quality standards.

NRCS uses the information about the TMDLs in a watershed as one component of the determination of conservation needs and priorities in conservation spending.

WATER QUANTITY

Virginia’s water supply comes from precipitation with most of the demand from surface water sources. Average annual precipitation varies across climatic regions of Virginia from approximately 38 inches in northern Virginia to 47 inches in the southwest mountain region. A portion of the water falling as precipitation runs directly into streams and rivers, some infiltrates into the ground and becomes ground water, and the rest evaporates or transpires through vegetation. Some ground water eventually flows towards streams or other surface water bodies, and during the dry periods, may be the only source of flow in some streams. The remaining amounts feed and recharge the deep aquifers.

Virginia’s ground water resources are generally characterized by the geology of the five physiographic provinces (fig. 1). In general, the flat-lying Coastal Plain contains large amounts of high-quality ground water. In the Piedmont Province, the amount of ground water is modest, but the quality is generally good. High quality ground water is also widely available in small volumes from wells and springs. Wells located in the Blue Ridge region generally have low yields. In the Valley and Ridge Province, limestone deposits produce large volumes of chemically hard water,

while only small quantities are found in shale and sandstones formations. In the Appalachian Plateau, wells generally produce only modest amounts of ground water, of lesser quality, in many locales.

Despite typically generous rainfall and Virginia's efforts to better manage water resources, significant multi-year drought events occurred in 1930-1932, 1962-1971, 1985-1988 and 1999-2002. During the drought of 1999-2002, some localities were unprepared for a dwindling water supply. Several public water supply systems across the Commonwealth were on the brink of failure and a number of large municipal systems had less than 60 days of water supply capacity remaining in reservoirs.

According to the Virginia Water Resources Plan published by DEQ in October 2015, there will be a 32% increase in water supply demand from 2010 to 2040. An estimated 450 million gallons per day of additional water will be needed to meet the projected demands in 2040. This is consistent with the Commonwealth's expected population increase over the same time period. Of this projected demand, about 77% will come from surface waters and 23% from ground water sources. This increase in projected demand is a special concern with ground water withdrawals in the Coastal Plain of Virginia since the groundwater resources are already oversubscribed, not sustainable for the long term at current use, and are contributing to increased land subsidence and saltwater intrusion potential. The Virginia Water Resources Plan documents approximately 800 surface water withdrawals (reservoir, stream and spring sources) and 2,900 ground water well withdrawals (excluding private ground water wells) statewide. An estimated 1.6 million people in the Commonwealth use private ground water wells for residential water supply.

Under the Small Watershed Program, NRCS can assist with providing water supply to rural communities as a secondary purpose to flood prevention. Of the 150 reservoirs constructed by NRCS since 1954, 25 structures have water supply storage in them that offer substantial amounts of water for local use.

FLOODING

Virginia has a long history of damaging storms and flooding. Many of the Watershed Plans prepared by NRCS identify the years that flooding was recorded in the community. For example, when the plan for the Upper Clinch Valley was written in 1965, the flood of record had occurred in 1901 with major flood events occurring in 1944, 1955, 1963, and 1965. The watershed plan for the Pilot Watershed, East Fork of the Falling River, noted 158 out-of-bank events in the years from the mid-1930's to the mid-1950's. Some of the flood events in Virginia were local and some occurred over broad sections of the State. Since 1969, Virginia has experienced millions of dollars in damages due to named hurricanes such as Camille, Agnes, Juan, Fran, Floyd, Isabel, Jeanne, and Michael.

Since the enactment of the Watershed Protection and Prevention Action of 1954, NRCS has carried out many projects in Virginia to reduce flood damages. Sixty-one watershed plans were prepared, which were used to build flood control structures and to apply land treatment to control runoff in many areas of Virginia. There were six projects with the primary purpose of channel improvements and 15 projects with the primary purpose of land treatment through the accelerated installation of conservation practices. The 35 completed watershed projects with flood control dams always had a land treatment component, and many also were planned to incorporate some channel improvements.

Construction has been completed on 52 watershed projects. Four projects are still active and five have been deauthorized. Appendix C contains a description of each project and its current status.

WATER RESOURCE DEVELOPMENT IN VIRGINIA

The NRCS Natural Resources Planning Team (Planning Team) provides technical and financial assistance to the following key watershed programs:

- Watershed Surveys and Planning
- Watershed Operations
- Watershed Rehabilitation
- Emergency Watershed Protection Program

The Resource Conservation and Development (RC&D) Program and the Rural Abandoned Mine Program (RAMP) have been defunded and are no longer actively supported by NRCS.

WATERSHED SURVEYS AND PLANNING

Until 2020, NRCS in Virginia had an interdisciplinary Planning Team which consisted of professional employees with specialized training in natural resources, biology, economics, environment, engineering, soils, geology, GIS, fund management, and contract administration. As of 2020, this capacity no longer exists due to a lack of staffing. The Planning Team uses the 9-step planning process to support local government agencies and organizations (called Sponsors) to analyze and solve complex natural resource issues at the watershed level. The process promotes "planning with people" in the identification of problems and the development of alternative solutions to meet their objectives. A preferred alternative is selected, and a planning document is prepared. The project is then implemented through various ways - some of which includes federal funding through cost-share or financial incentives such as the PL-566 Small Watershed Program.

The NRCS Planning Team helps with formal and informal watershed planning activities. Staff assistance is provided for site assessments, field investigations, pre-application support, and all planning phases for the development of resource reports, watershed plans and dam rehabilitation plans. The Team develops water quality plans, watershed protection plans, structural and non-structural flood control plans, river basin studies, or plan supplements for active projects.

River Basin Studies

The River Basin Program, described in Section 6 of Public Law 83-566, authorized the Secretary of Agriculture, in cooperation with other federal, State, and local agencies, to make investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs. In Virginia, the River Basin Program has been used to identify upstream areas that would benefit from a flood prevention and watershed protection project and to assist with inventory and evaluation of resources to address future conservation program needs. There have been thirteen cooperative River Basin Studies in Virginia. See Appendix A for a list and a map of the completed river basin studies in Virginia.

Multiple Watershed Investigation Reports were conducted as part of the different River Basin studies. A partial listing is included in the list of Other Studies in Appendix A.

Regional Studies

Regional studies, also known as Framework Studies, are used to document the overall issues for very large areas. Virginia participated in two of these studies (Appendix A).

Other Studies

NRCS also prepared a number of studies and plans that provided information to a community or watershed but did not result in construction or practice installation. An example would be the Port Republic Flood Study, in 1997, which concluded that it was not economically feasible to establish flood protection in the town. In some cases, planning was started but terminated due to a change by the sponsors or lack of reasonable alternatives to solve the identified problems. Other documents included a Hydrologic Unit Report and a Modelling Report to document the effects of practice installation. Appendix A contains a list of these documents.

Floodplain Studies

In Virginia, SCS/NRCS has participated in several types of floodplain studies. Flood Insurance Studies were prepared for the U.S. Department of Housing and Urban Development under the Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. The information collected in the studies was initially used to convert communities to the regular program of flood insurance by the Federal Insurance Administration. The information was further used by local and regional planners in their efforts to promote sound land use and floodplain development.

The authority for Flood Hazard Analyses and Floodplain Management Studies is provided by Section 6 of Public Law 83-566. The objective of a flood hazard analyses was "to reduce potential flood losses caused by unwise development of floodplains." The purposes of a Floodplain Management Study were to first define the floodplain and identify potential flood losses. The information from these reports was used to help the sponsors develop a floodplain management program which provides alternatives for land use planning and regulations for managing the floodplains to reduce flood damage and minimize loss of life and property from future flooding. These studies were carried out as a cooperative effort with state and local units of government. A state agency responsible for floodplain management activities had to enter into a joint agreement with the NRCS to establish objectives, coordinate activities, outline responsibilities and commit funds. The NRCS has completed several Flood Insurance Studies and 32 Floodplain Management Studies since 1971. See Appendix B for a list and a map of floodplain management studies in Virginia.

The Small Watershed Program (PL-534, Pilot Watershed, and PL-566 Programs)

The NRCS administers the Small Watershed Program with cooperation of the Virginia Soil and Water Conservation Board; Soil and Water Conservation Districts; and the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation and Division of Dam Safety and Floodplain Management; and local units of government. The program provides technical and financial assistance to local sponsors for solving land and water resource problems.

Public Law 78-534

The United States Congress enacted Public Law 78-534 (PL-534), the Flood Control Act, in 1944. Under PL-534, Virginia initiated the Potomac Flood Prevention Project, which addressed flood prevention and watershed protection activities in the seven county area of Virginia known as the

Upper Potomac River Watershed. These counties are Augusta, Page, Rockingham, Shenandoah, Warren, Clarke, and Frederick.

The South River Subwatershed in Augusta County was the first flood control project planned in Virginia. This plan was approved for operations in 1955. Additional flood control plans were approved on eight other watersheds in the Potomac River Basin. Two of these plans, Gap Run in Rockingham County and Tumbling Run in Shenandoah County, were for channel improvements to reduce flooding. A total of 29 dams have been completed in Virginia under the PL-534 Program. Eight of the flood control plans have been completed and closed out. The ninth plan was deauthorized.

The Mill Creek Watershed Project in Page County was approved for operations in 1983 as the first watershed protection land treatment project in Virginia. That plan was followed by the Moffett Creek Watershed in Augusta County and the Linville Creek Watershed in Rockingham County. These land treatment projects have all been completed and closed out.

About $52 million has been invested by the NRCS in Virginia through PL-534 to install structural measures within the Potomac River Basin. An additional $1 million dollars has been invested to install conservation practices as part of watershed protection efforts within the Potomac River Basin. See Appendices C and D for information about these projects.

Pilot Watershed Program

The Pilot Watershed Program was established by Congress in 1953. The Secretary of USDA assigned the leadership of this program to the NRCS, including the responsibility for approving the areas to serve as pilot watersheds in a cooperative program and for helping groups with technical phases of the work. Sixty-two watersheds were selected from around the nation and a plan was written for each one. The plans were designed to demonstrate the practicality of complete watershed protection as a means of conserving soil and water by reducing floodwater and sediment damages, silting of reservoirs, and impairment of stream channels. These projects were also used to provide a basis for hydrologic and economic evaluation of the effects of the planned and installed works of improvement.

Virginia had one pilot watershed which was located on East Fork Falling River in Appomattox County. Three dams were constructed in 1957 and 1958. Land treatment was also installed in this watershed. Total cost of the construction for the three dams was $93,085. The project was completed and closed out in November 1958. See Appendices C and D for information about this project.

The Pilot Watershed Program was the forerunner of PL-83-566, the Watershed Protection and Flood Prevention Act, also known as The Small Watershed Program.

Public Law 83-566

The United States Congress enacted Public Law 83-566 (PL-566), the Watershed Protection and Flood Prevention Act, in 1954. This Act authorized the Small Watershed Program administered by the USDA NRCS. Under the PL-566 Program, local sponsoring organizations develop a watershed plan with technical assistance from the NRCS and other agencies. Plans include one or more purposes: watershed protection, flood prevention, drainage, irrigation, rural water supply, fish and wildlife, municipal and industrial water supply, water quality management, and recreation. Once a watershed plan is approved and authorized for operation, the sponsors are eligible for financial and technical assistance from NRCS for installation of the works of improvement.

Under the PL-566 program, 48 projects were approved in Virginia; four for channel improvements, 32 for flood control, and 12 for watershed protection (land treatment). Forty of these watershed projects have been completed (29 flood control and 11 watershed protection). There are currently three active flood control projects (Buena Vista, Cedar Run, and Stewarts Creek-Lovills Creek) and one active watershed protection project (North Fork Powell River). Four flood control projects were deauthorized due to local issues that could not be overcome (Lick Creek, Nibbs Creek, South Fork of Roanoke River, and Watkins Branch).

Completed projects and operational projects are protecting more than 120,000 acres of land from flooding. Through the PL-566 Small Watershed Program, 118 dams have been completed, 100 miles of channel improved, and over 425,000 acres of land adequately protected from soil erosion. The NRCS has expended almost $99 million to build these structures and associated works of improvement. In addition, the NRCS has expended in excess of $5 million in support of land treatment measures for watershed protection. See Appendices C and D for information about each project.

WATERSHED OPERATIONS

From 1954 to 2001, NRCS assisted local Sponsors to construct six channel improvement projects for flood control and 15 plans for watershed protection (land treatment) (fig. 4 and Appendix C). All but one of the channel improvement projects were initiated in the 1950's or 1960's and were completed by 1981. The plan for the Buena Vista Channel Improvement Project was started in 1993 and the project was authorized for operation in 2003. The North Fork Powell River Land Treatment Project is the only active watershed protection project (Appendices C and G).

NRCS also installed 150 flood control dams in 35 watersheds and 27 counties (fig. 5 and Appendix C). Appendix F contains papers about the activities associated with dams.

Figure 4. Projects for channel improvement and watershed protection (land treatment).

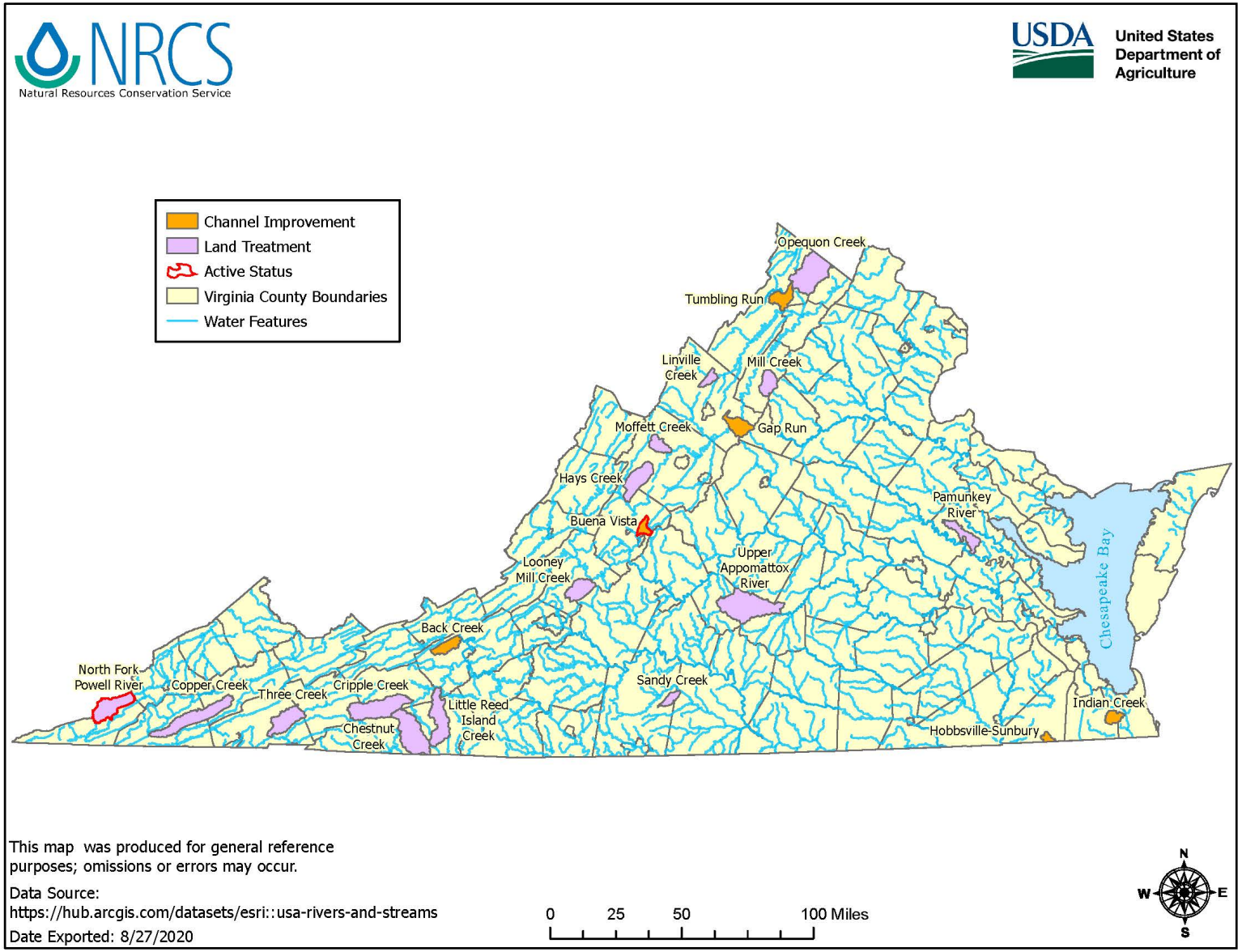
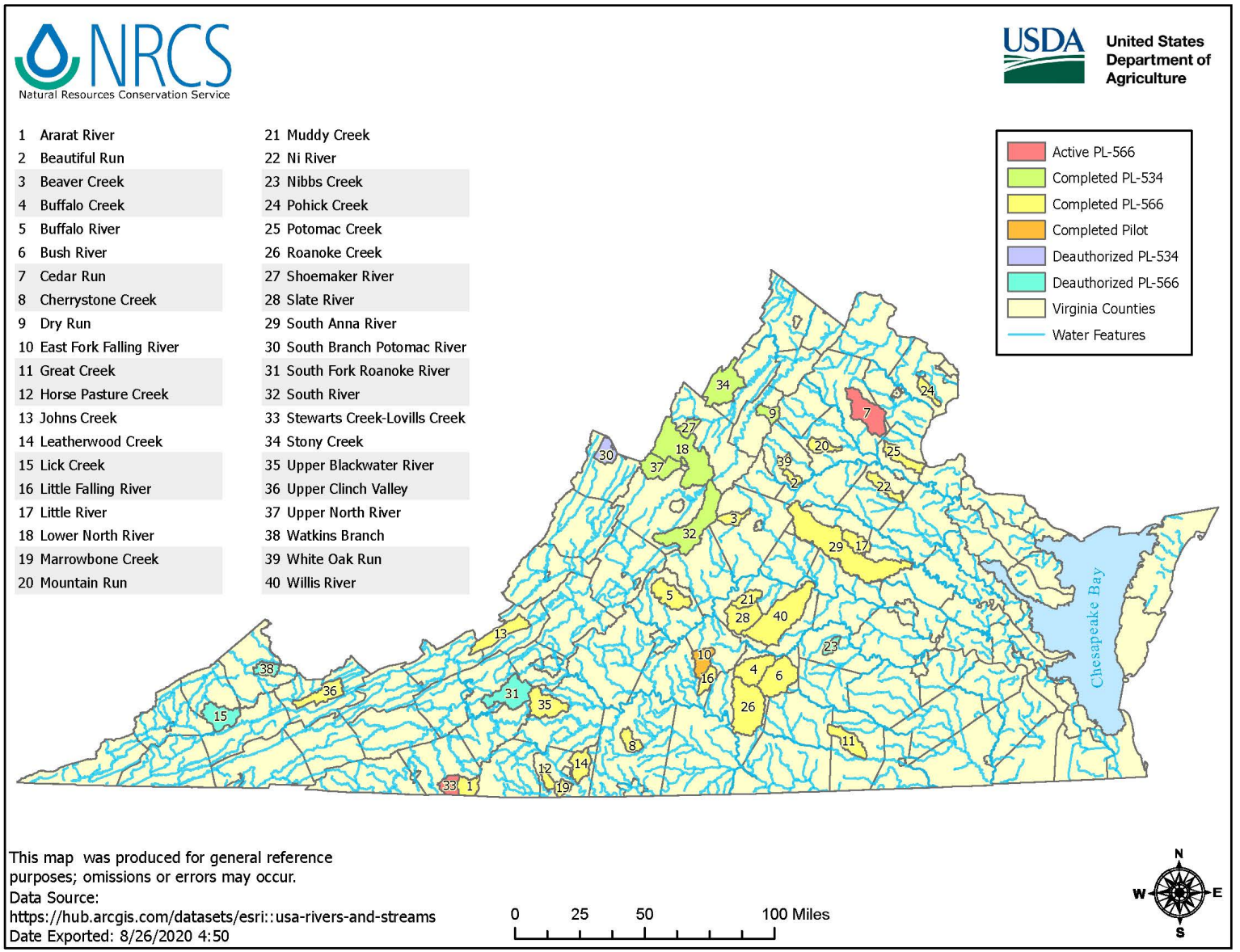


Figure 5. Watersheds with flood control dams.



The dams were constructed from 1954 to 2001 (fig. 6). While all of the dams were constructed for flood control, 43 dams also have one or more secondary purposes (fig. 7). Recreation and public water supply were the most common uses. Public recreational uses are discussed in the second paper in Appendix F.

Active/Ongoing Water Resources Projects

Virginia has four PL-566 watershed projects that remain "active" and in operational status:

- Buena Vista (Rockbridge County and the City of Buena Vista) – flood control (channel improvements)
- Cedar Run (Fauquier County) – flood control dam
- North Fork Powell River (Lee County) – watershed protection
- Stewarts Creek-Lovills Creek (Carroll County, VA and Surry County, NC) – flood control (dams and channel improvement)

Figure 6. Number of NRCS dams constructed each year from 1954 to 2001.

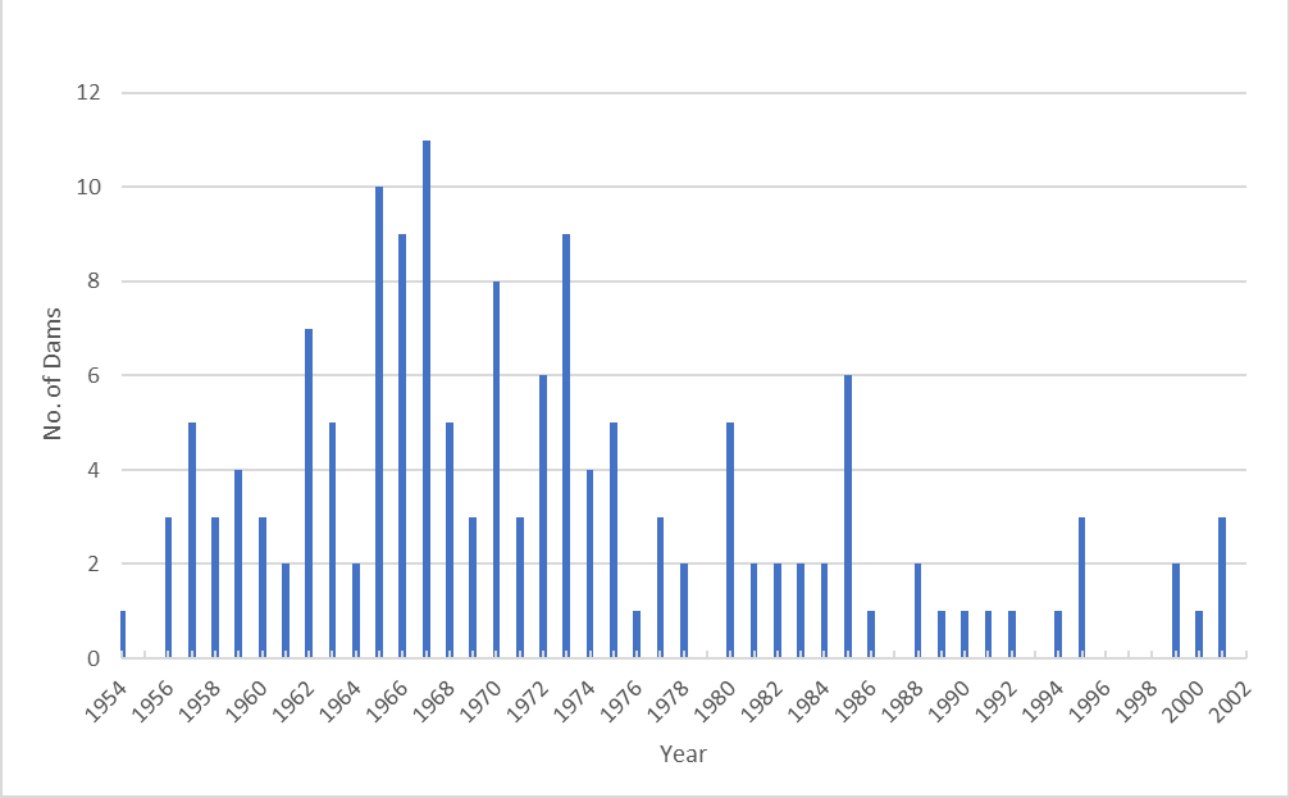
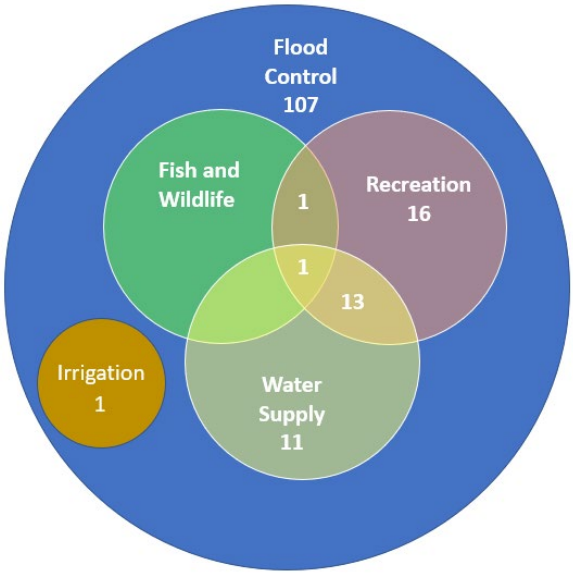


Figure 7. Secondary purposes for the 150 flood control dams in Virginia.



Completion of Federal Interest

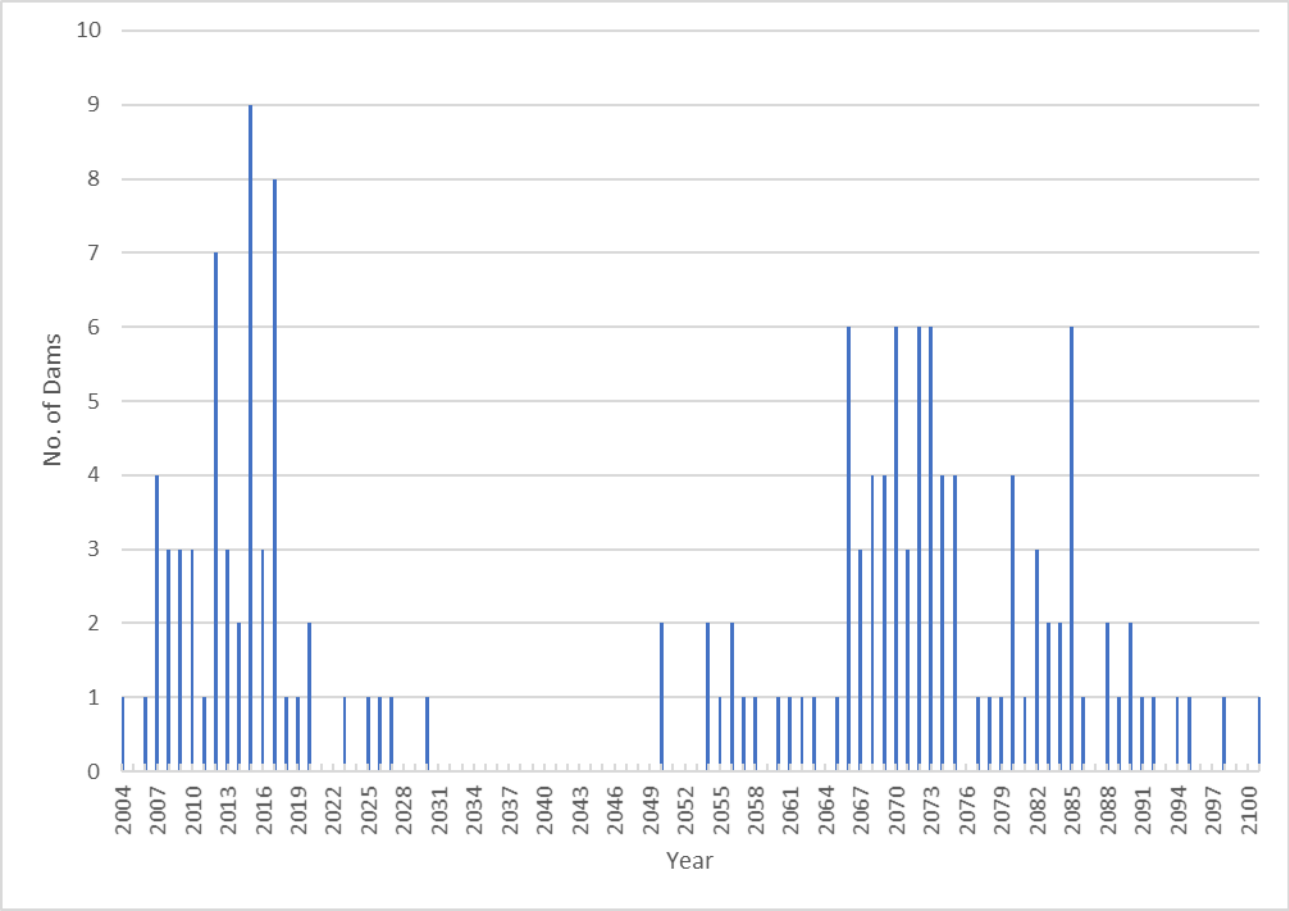
Sponsoring local organizations have the operation and maintenance (O&M) responsibility on all structures built with NRCS financial assistance under the PL-566, PL-534, and Pilot Watershed Programs. An O&M agreement has been executed between NRCS and the Sponsors for all 150 structures in the State. The active channel improvement project and land treatment project also have ongoing O&M agreements for the structural works completed to date.

The Sponsor's obligation for Federal O&M on a structure is complete when the structure reaches its evaluated economic life (fig. 8). This is referred to as completion of the Federal interest. The evaluated economic life is documented in the Watershed Work Plan for each structure. When a dam is rehabilitated, a new economic life for the structure is established, and a new O&M agreement between NRCS and the Sponsors is executed.

When the evaluated economic life of the structure has been met, the NRCS State Conservationist provides a letter to the Sponsor indicating that the O&M agreement with NRCS has expired and reminding the Sponsor that they may have continued O&M responsibilities in order to remain in compliance with applicable Federal, State, and local laws, regulations, and ordinances.

As of June 2020, 52 structures have met their evaluated economic lifespan. Appendix E contains a list of the dams, by expiration date.

Figure 8. Expiration dates of O&M agreements for watershed dams, by year.



Status of Applications for Watershed Planning Assistance

The Virginia NRCS has received valid applications for watershed planning assistance in the following watersheds:

- Town of Glasgow in Rockbridge County for flood prevention
  - Sponsors – Town of Glasgow and Natural Bridge Soil and Water Conservation District
  - Application date was June 14, 2005
- Gross Creek in the Town of Farmville for flood prevention
  - Sponsors – Town of Farmville and Piedmont Soil and Water Conservation District
  - Application date was February 28, 2006

NRCS in Virginia has not received funding for watershed planning assistance to local sponsors since 2006. On a national basis, the entire Watershed Surveys and Planning Program has been zeroed out since 2008. The current position of NRCS and the administration regarding watershed planning is to minimize and/or stop adding projects to the backlog of unfunded PL-566 watershed

projects. There are already millions of dollars on the books in unfunded watershed projects nationwide. New requests for planning are not currently being accepted by the agency.

Due to a lack of funding and a shift in priorities to work on dam rehabilitation projects, these watershed plans have not been initiated.

WATERSHED DAM REHABILITATION PROGRAM

The Small Watershed Rehabilitation Amendments to the Watershed Protection and Flood Prevention Act were passed by Congress in 2000. These Amendments were in response to a growing national concern that many of the flood control dams built under the Small Watershed Programs are at or near the end of their design life.

Although most of the 150 dams in Virginia are only beginning to show their age by the deterioration of the principal spillway riser components, the primary reasons for dam rehabilitation in Virginia have been for a hazard potential classification change or a structural issue identified through an engineering review. The structural issues seen thus far have been have not been because of a failure of design or construction but as a result of new evaluation techniques. The integrity of the vegetated earth auxiliary spillway, the filter incompatibility between zones in the embankment, and the riser stability for earthquake loads are the three main issues.

Hazard class changes have become common as the population of the State has increased and homes and businesses have been built in the potential breach inundation zone in place of the original agricultural land use. Most of the rehabilitation need is due to a change in hazard classification from Low or Significant hazard to High hazard. Figure 9 shows the number of dams in each hazard class as designed and as identified in 2020.

All of the 150 dams (except South River 27, which is a federally-owned dam) built with the Pilot, PL-566 and PL-534 funds in Virginia are regulated by the Virginia Dam Safety Law, passed in 1976 and amended in 1982. Regulations were promulgated in 1978, and changed in 1983, 1989, and again in 2008. As of July 2020, only 49 dams had regular Operation and Maintenance Certificates. Seventeen dams had Conditional One-Year Certificates and 81 dams have Conditional Two-Year Certificates. A Conditional Certificate serves as a notice that the dam does not meet state dam safety criteria required for the structure. In the case of an increase in hazard potential class, the primary issue is that the auxiliary spillway has insufficient capacity to pass the volume of water associated with the Probable Maximum Precipitation (PMP) storm event.

Figure 9. Comparison of as-designed hazard class with 2020 hazard class.

The Virginia Department of Conservation and Recreation (DCR) has analyzed all the SWCD dams utilizing updated PMP data and temporal distribution curve data as well as updated hydrologic data. The DCR High Hazard Dam Rehabilitation List currently has 36 High Hazard dams in need of rehabilitation in order to bring them into compliance with State law and regulation. These dams have been ranked according to the Priority Ranking System for Rehabilitation of Aging Watershed dams, developed by NRCS.

DCR has contracted with Freese and Nichols, Inc. for the engineering design of South River #19 and Leatherwood Creek #5 to bring these structures into compliance with state dam safety criteria. Current State funding only covers the design of these two dams. There is a need for technical and financial assistance to design and construct improvements to bring these deficient dams into compliance with State laws and regulations.

Dam Rehabilitation Progress

From 2005 to 2020, NRCS assisted local Sponsors to rehabilitate 13 dams in five watersheds in four counties at a total project cost of over $22.3 million. Planning is complete for the rehabilitation of three other dams. Assistance was provided in the order determined by the results of the Risk Assessment performed when the application was received. Additional requests for NRCS assistance on 16 other dams are awaiting federal funding and sufficient staffing to perform the Risk Assessment. Figure 10 shows the locations of these structures.

NRCS assisted local sponsors to complete dam rehabilitation on the following dams:

- Marrowbone Creek No. 1 in Henry County - 2005
- South River No. 23 (Robinson Hollow) in Augusta County - 2007
- South River No. 26 (Inch Branch) in Augusta County - 2008
- Pohick Creek No. 4 (Royal Lake) in Fairfax County - 2009
- Pohick Creek No. 3 (Woodglen Lake) in Fairfax County - 2010
- South River No. 25 (Toms Branch) in Augusta County – 2010
- Pohick Creek No. 2 (Lake Barton) in Fairfax County - 2011
- South River No. 10A (Mills Creek) in Augusta County – 2013
- Pohick Creek No. 8 (Huntsman Lake) in Fairfax County – 2014
- Upper North River No. 10 (Todd Lake) in Augusta County – 2016
- Mountain Run No. 11 (Mountain Run Lake) in Culpeper County – 2019
- Mountain Run No. 50 (Lake Pelham) in Culpeper County – 2019
- Upper North River No. 77 (Hearthstone Lake) in Augusta County – 2020

DCR assisted the Sponsor with state funded modifications to bring the structures into compliance with state dam safety criteria on the following dams:

- Stony Creek No. 9 (Lake Laura) in Shenandoah County – 2016
- Stony Creek No. 10 (Lake Birdhaven) in Shenandoah County – 2016

Dam Rehabilitation Plans have been completed on the dams below. These projects have not moved into the design and/or construction phases since there have been no requests for assistance.

- Cherrystone Creek No. 1 (Cherrystone Lake) in Pittsylvania County
- Cherrystone Creek No. 2A (Roaring Fork Lake) in Pittsylvania County
- Johns Creek No. 1 in Craig County

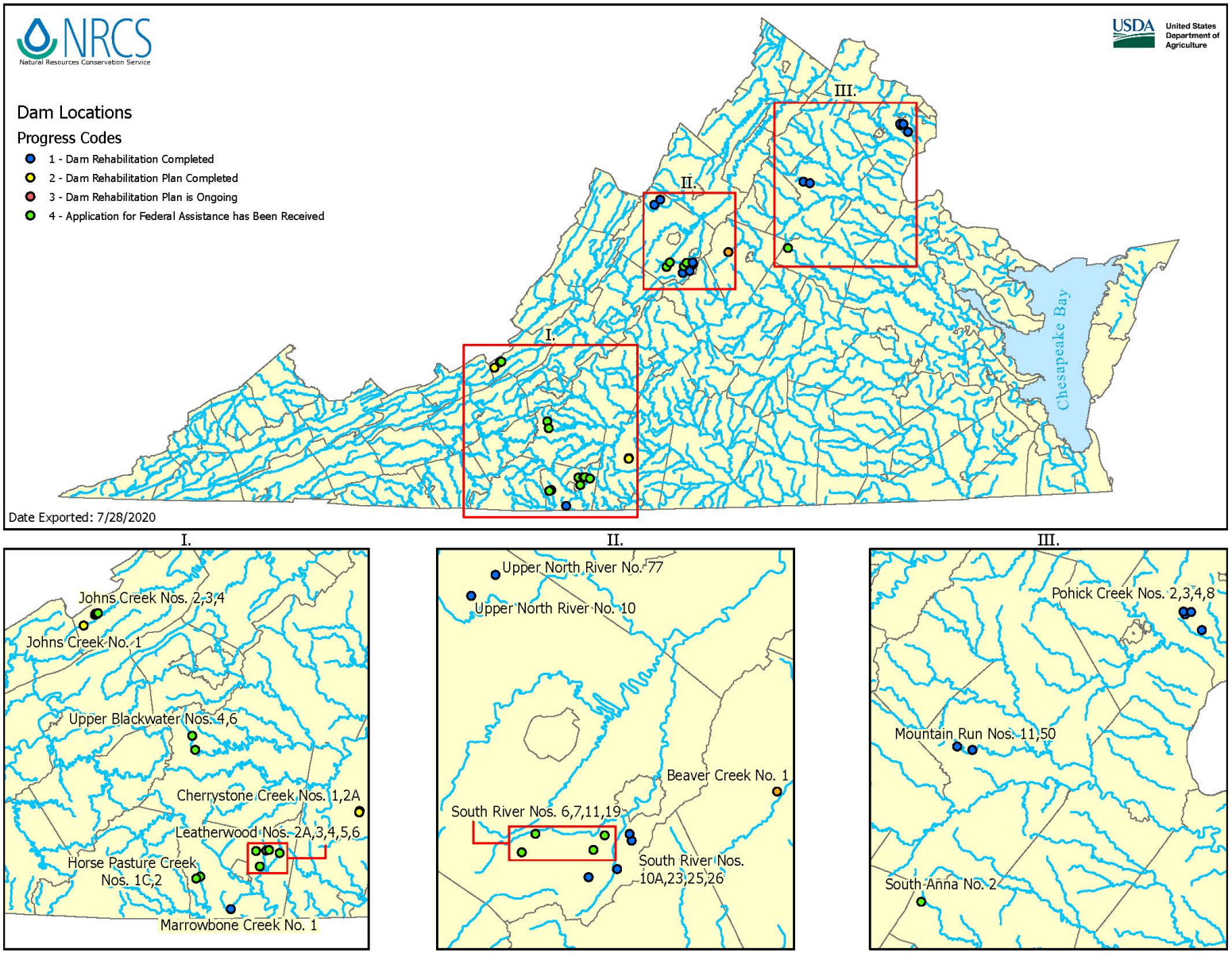
Beaver Creek No. 1, in Albemarle County, has an agreement with NRCS to perform the planning for rehabilitation.

In addition, Applications for Federal Assistance on Dam Rehabilitation have been received on the following dams in Virginia. No technical assistance funding has been received for these dams at this time.

- Johns Creek No. 2 in Craig County
- Johns Creek No. 3 in Craig County
- Johns Creek No. 4 in Craig County
- South River No. 6 (Stony Creek) in Augusta County
- South River No. 7 (Lake Wilda) in Augusta County
- South River No. 11 (Canada Run) in Augusta County
- South River No. 19 (Waynesboro Nursery) in Augusta County
- South Anna River No. 2 (Bowlers Mill Lake) in Louisa County
- Leatherwood Creek No. 2A (Walker) in Henry County
- Leatherwood Creek No. 3 (Finney) in Henry County
- Leatherwood Creek No. 4 (Barrow Brothers) in Henry County

- Leatherwood Creek No. 5 (Lawrence Lake) in Henry County
- Horse Pasture Creek No. 1C (Stanley) in Henry County
- Horse Pasture Creek No. 2 (Seale's) in Henry County
- Upper Blackwater No. 4 (Dillon) in Franklin County
- Upper Blackwater No. 6 (Bowman) in Franklin County

Figure 10. Status of dam rehabilitation, as of 2020.



EMERGENCY WATERSHED PROTECTION PROGRAM

The Emergency Watershed Protection (EWP) Program is authorized by Section 216 of Public Law 81-516 and sections 403-405 of Public Law 95-334. When funding is available, EWP Program assistance may be made available when a sudden watershed impairment occurs that creates an imminent threat to life and/or property, as determined by the NRCS State Conservationist. Assistance is available only when eligible sponsors document that they have exhausted other resources or have insufficient funding available to provide adequate relief from applicable hazards.

NRCS will only assist with emergency measures that:

- Reduce threats to life and/or property from a watershed impairment (caused by floods, tornadoes, hurricanes, etc.), including sediment and debris removal;
- Provide protection from additional flooding or soil erosion by retarding runoff;
- Remove debris deposited by natural disaster that would affect runoff or erosion;
- Restore the hydraulic capacity to the natural environment to the maximum extent practical based upon pre-event conditions; and
- Are economically, socially and environmentally defensible and technically sound.

NRCS participates in the Silver Jacket Program, which is a team of individuals from State, federal, and sometimes tribal and local agencies, whose objectives are to come together to facilitate collaboration, share information, and leverage resource to identify and implement solutions to reduce flood risk in the Commonwealth of Virginia. Participating agencies include the Virginia Department of Emergency Services; Virginia Department of Conservation and Recreation; the National Weather Service; the Federal Emergency Management Agency; NRCS; the US Geological Survey; and the US Army Corps of Engineers. The primary goals: better collaborative solutions; improved risk communication; leverage information and resources; coordinated hazard mitigation assistance; and identify gaps.

RESOURCE CONSERVATION AND DEVELOPMENT

The Resource Conservation and Development (RC&D) Program was created by the Agriculture Act of 1962 by two laws: Public Law 74-46 and Public Law 97-98. These laws authorized NRCS to administer the program and provide technical and financial assistance in approved RC&D areas. An RC&D area was typically formed when local units of government shared similar problems and joined together in a non-profit organization to address those concerns. Local councils identify unmet needs in their communities and work to solve them. Historically, community development, natural resource problems, soil conservation, land management, and water quality have been a major focus of the councils. There were seven authorized RC&D Areas in Virginia and one applicant area (Table 2, fig. 11). NRCS discontinued support for the RC&D Program in 2011.

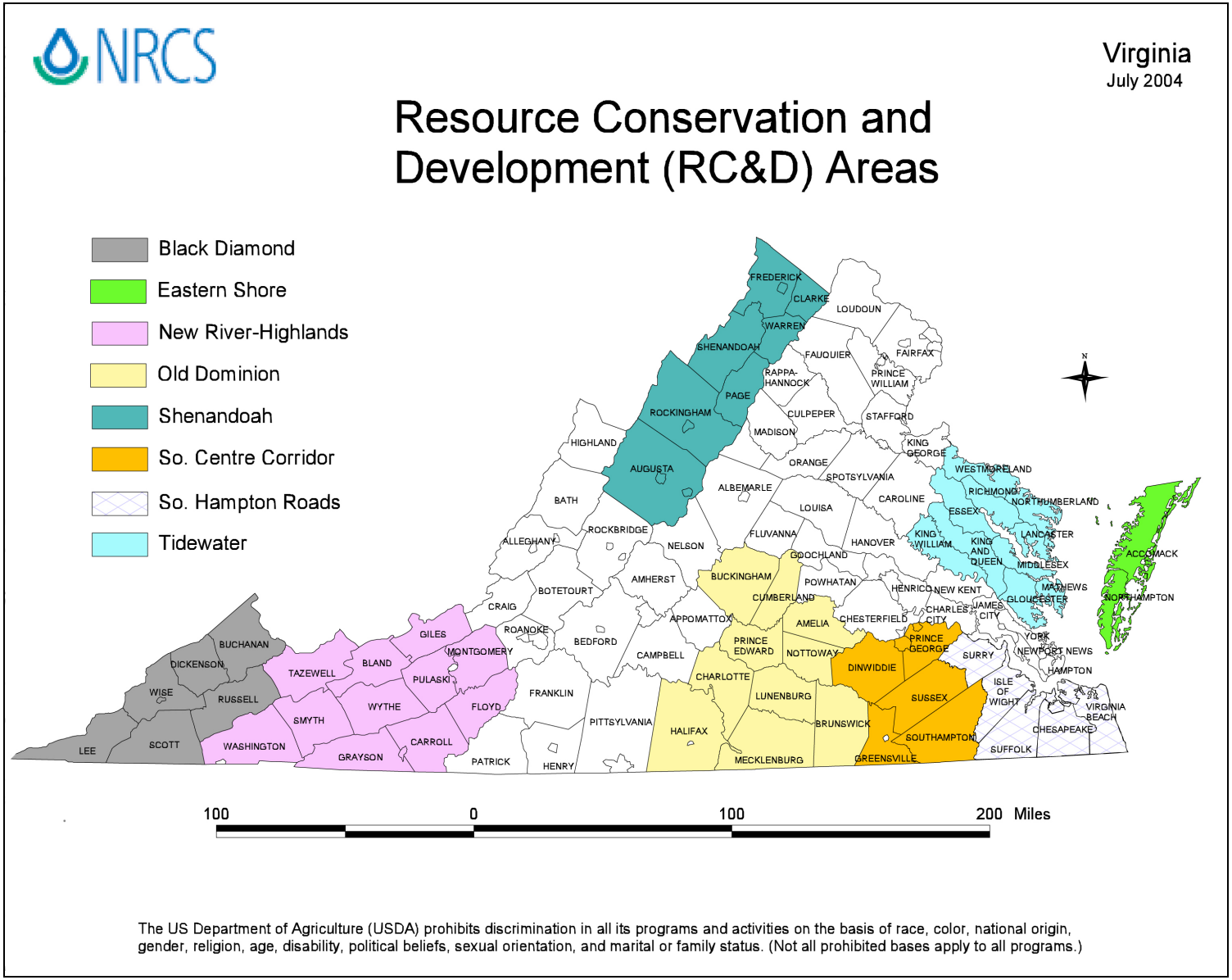
NRCS assisted the RC&D councils by providing staff, such as a coordinator. Although the NRCS sponsorship of RC&Ds ended in 2011, the work of the Councils in Virginia continues. The RC&D Councils in Virginia have developed a variety of projects within the State, which include installation of flood prevention structures, watershed protection measures, critical area treatment, land drainage measures, and other associated measures. More recent projects include sponsoring and conducting educational workshops and conferences, producing conservation publications,

promoting tourism and economic development based on available natural resources, and the establishment of farmers markets.

Table 2. Virginia RC&D Councils, date, size, and location.

Council	Start Date	Size, acres	Location
Eastern Shore	1975	706,904	Accomac and Northampton Counties
New River-Highlands	1983	3,042,105	The counties of Giles, Montgomery, Floyd, Pulaski, Bland, Wythe, Tazewell, Smyth, Washington, Carroll, and Grayson; the City of Galax
Old Dominion	1991	3,138,110	The counties of Amelia, Brunswick, Buckingham, Charlotte, Cumberland, Halifax, Lunenburg, Mecklenburg, Nottoway, and Prince Edward
Tidewater	1992	1,518,841	The counties of Essex, Gloucester, King and Queen, King William, Lancaster, Mathews, Middlesex, Northumberland, Richmond, and Westmoreland
Black Diamond	1994	1,729,237	The counties of Buchanan, Dickenson, Lee, Russell, Scott, and Wise; the City of Norton
South Centre Corridors	2002	1,427,544	The counties of Prince George, Dinwiddie, Sussex, Greensville, and Southampton; Cities of Hopewell and Petersburg
Shenandoah	2003	2,255,113	The counties of Augusta, Clarke, Frederick, Page, Rockingham, Shenandoah, and Warren; the Cities of Harrisonburg, Staunton, Waynesboro, and Winchester
South Hampton Roads	Applicant	1,204,000	The counties of Isle of Wight and Surry; the Cities of Chesapeake, Norfolk, Portsmouth, Suffolk, and Virginia Beach

Figure 11. Resource Conservation and Development Areas in Virginia.



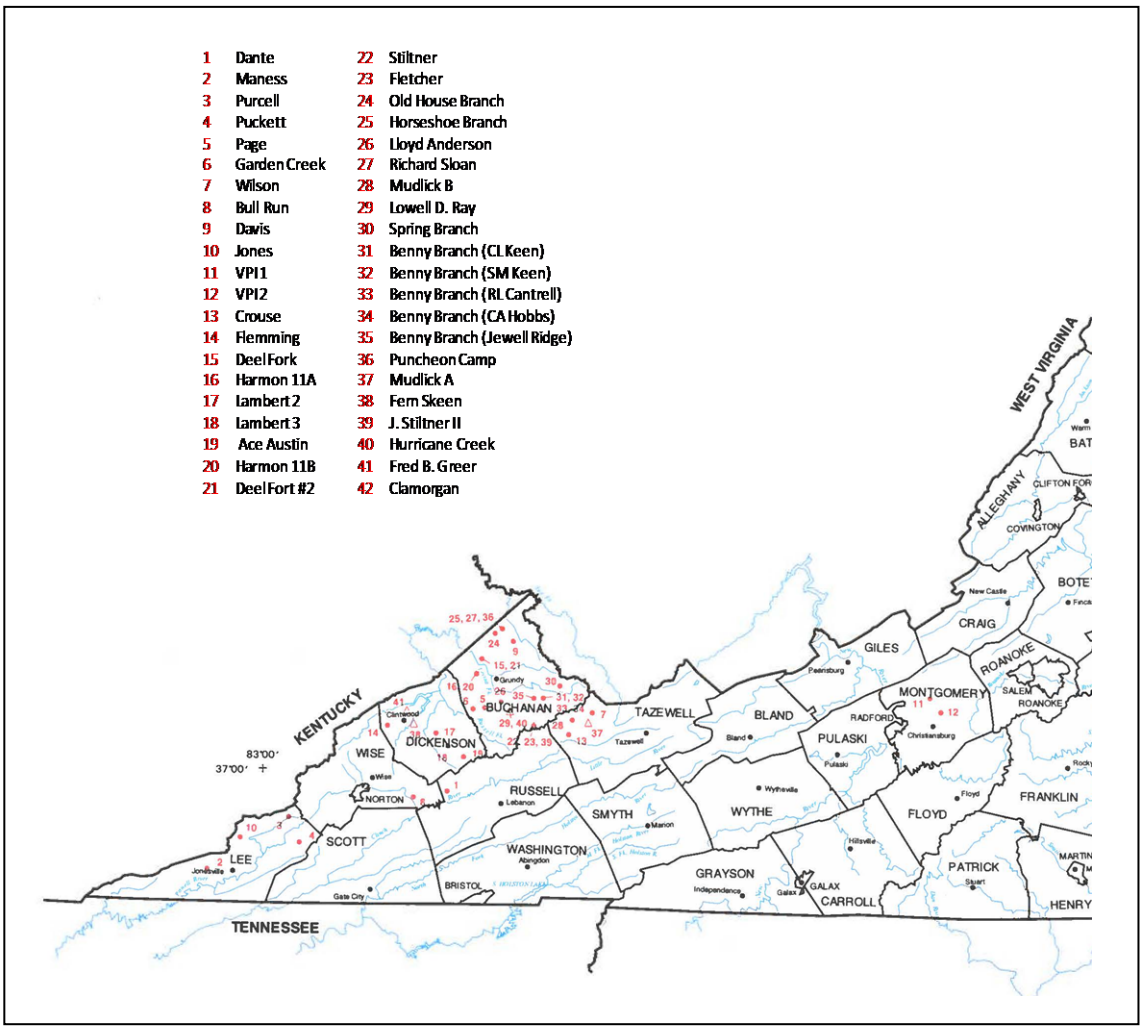
The US Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.)

RURAL ABANDONED MINE PROGRAM

The Rural Abandoned Mine Program (RAMP) was authorized by Section 406 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977. As initially authorized, NRCS was assigned the responsibility for administration of the program. After NRCS ceased to participate in the program in the mid-1990's, the responsibility was assigned to the Office of Surface Mining Reclamation and Enforcement (OSMRE). The RAMP was supposed to be funded from the Abandoned Mine Trust Fund. According to a March 2020 Congressional Research Service Report, this fund, made up of tax money collected from active mining companies, had approximately $2.3 billion as of November 2018. The unfunded reclamation costs are estimated to be $12.2 billion. However, Congress has not appropriated funds for this program for several years.

The RAMP in Virginia was very active in the six southwestern counties of the Appalachian Plateau that contain coal. As of 1997, 42 projects were completed, and 166 acres were reclaimed at a cost of $4,235,196. After the last five projects were completed in FY98, NRCS ended involvement with the active reclamation of abandoned mine land in Virginia under the RAMP (fig. 12). The abandoned mine land reclamation in North Fork Powell River Project was planned under PL-566 as a land treatment watershed (fig. 4).

Figure 12. Completed RAMP sites.



SPONSORS AND COOPERATING AGENCIES

The local sponsoring organizations (sponsors) are key to land and water resource project development. The leadership, local interest, local coordination, implementation, and future project operations are effectively handled by local sponsors.

Present sponsors of land and water resource projects are the Soil and Water Conservation Districts, and county, town, and city governments. These sponsors are knowledgeable of NRCS land and water resource programs and provide leadership and needed resources. It is expected that they will continue to sponsor land and water resource development projects.

The Virginia Soil and Water Conservation Board was established by the General Assembly to help guide the delivery of soil and water conservation services to citizens of the commonwealth. The board's responsibilities include:

- Oversight and support of Virginia's soil and water conservation districts (SWCDs), including financial support, coordination, information exchange, and other duties.
- Oversight and enforcement of dam safety and floodplain management programs and regulations.
- Approval of loan criteria for loans from the Dam Safety, Flood Prevention and Protection Assistance Fund.

State agencies play a very important role in cooperation and sponsoring of Land and Water Resource Projects in the State. Partners include—

- Department of Conservation and Recreation (DCR)
    - Division of Soil and Water Conservation
        - Virginia Soil and Water Conservation Board
    - Division of Dam Safety and Floodplain Management
    - Division of Natural Heritage
- Department of Forestry
- Department of Wildlife Resources (formerly Game and Inland Fisheries)
- Department of Mines, Minerals, and Energy
    - Division of Mined Land Reclamation
- Department of Environmental Quality

Other cooperating agencies that are or can be involved:

- U. S. Army Corps of Engineers — provides guidance to avoid overlap of activities. The Corps issues the Section 404 Permit needed before most project construction can begin.
- U. S. Fish and Wildlife Service — makes surveys and investigations and provides a report with recommendations for conservation and development of wildlife resources. They may be involved in the preparation of the watershed plans.
- USDA, Rural Development —administers the watershed loan and advance provision of PL-83-566. They provide grants and low interest loans.
- U. S. Forest Service — oversees national forest lands and assists federal and State forestry agencies in management of private forest lands.

SPONSOR RESPONSIBILITIES

Sponsoring local organizations have the operation and maintenance (O&M) responsibility on the 150 structures built with NRCS technical and financial assistance under the PL-566, PL-534 and Pilot Watershed Programs. Of the 150 existing dams, 56 percent are maintained solely by Soil and Water Conservation Districts (SWCDs). The SWCD and project cosponsors jointly maintain 23 percent of the dams and 21 percent are maintained by units of government, such as cities or counties, only. One dam is owned by the US Forest Service, who is also responsible for maintenance.

CONCLUSION

A great deal of technical and financial resources have been used in developing the water resources program in Virginia. A lot more will be necessary in the future. There are great benefits in planning and implementing watershed projects using a locally-led watershed approach. Leadership at the local level is critical to the success of these projects. Equally important is the technical and financial assistance provided by the NRCS Natural Resources Planning Team. Through the utilization of a local, State and Federal partnership, many natural resource problems can be addressed in Virginia.

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Virginia NRCS Project Dam Important Dates spreadsheet.

APPENDIX A: RIVER BASIN AND PLANNING STUDIES

USDA COOPERATIVE STUDIES

The **Potomac River Basin Report** – This comprehensive plan for flood control and resource development included 14,066 square miles of Virginia, Maryland, West Virginia, Pennsylvania, and the District of Columbia. It was completed in 1963.

The **James River Basin Water and Related Land Resources Report** – This cooperative study covered 10,066 square miles of the James River Basin in Virginia and 75 square miles in West Virginia. It was completed in 1974.

The **Delmarva River Basin Survey** – This cooperative study covered a 7,500 square mile area of the Delaware, Maryland, and Virginia peninsula, which drains into the Chesapeake Bay and the Atlantic Ocean. It was completed in 1978.

The **Chowan-Pasquotank River Basins Study** – This cooperative study involved the US Army Corps of Engineers, the Virginia State Water Control Board, the North Carolina Soil and Water Conservation Commission, and the Virginia Soil and Water Conservation Commission. This study covered a 9,073 square mile area and was completed in 1981.

The **Pocomoke River Special Study** – This cooperative study covered a 316,00 acre area draining into the Chesapeake Bay in the States of Virginia, Maryland, and Delaware. It was completed in 1982.

The **Upper Virginia River Basin Study** – This cooperative study involved the Virginia Department of Forestry and the Virginia Soil and Water Conservation Commission and covered an 11,700 square mile area in Virginia. It was completed in 1984.

The **South Central Roanoke River Basin Study** – This was a cooperative study with the USDA Forest Service and the Virginia Department of Forestry to inventory highly erodible lands and accelerated planning in 1,170,477 acre area of south-central Virginia. This study was completed in 1990.

The **Southwestern Virginia River Basin Study** – This was a cooperative study between NRCS; the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation; and the USDA Forest Service to provide an appraisal of the land and water resources of seven river basins. The study area included the Clinch (1992), Powell (1992), New (1992), Upper Roanoke (1993), Middle Staunton (1994), Banister (1993), and Nottoway River (1994) Basins. In Phase I (broad) studies of the seven basins were completed with separate Phase II studies for each basin. The Closeout Summary for Phase I was published in 1989. The Phase II studies were completed between 1992 and 1994.

The Closeout Summary focused on four sub-basins that had identified issues with flooding, loss of productive capacity due to erosion and sedimentation, and water quality: Laurel Fork (Tazewell County), Town Hill Creek (Tazewell County), Lick Creek (Russell and Tazewell Counties), and Hays Creek (Augusta County).

Virginia Hydrologic Unit River Basin Study – This cooperative study between NRCS; the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation; the Virginia Department of Environmental Quality; and Virginia Tech developed a process to define, delineate, and digitize the hydrologic units of Virginia. County, city, and State maps, and a Hydrologic Unit Atlas were produced. The study was completed in 1994.

Virginia Flood Prone Area Study – This cooperative study between NRCS; the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation; and Virginia Tech identified the frequent and occasionally flooded areas within the individual hydrologic units in Virginia. The study was completed in 1995.

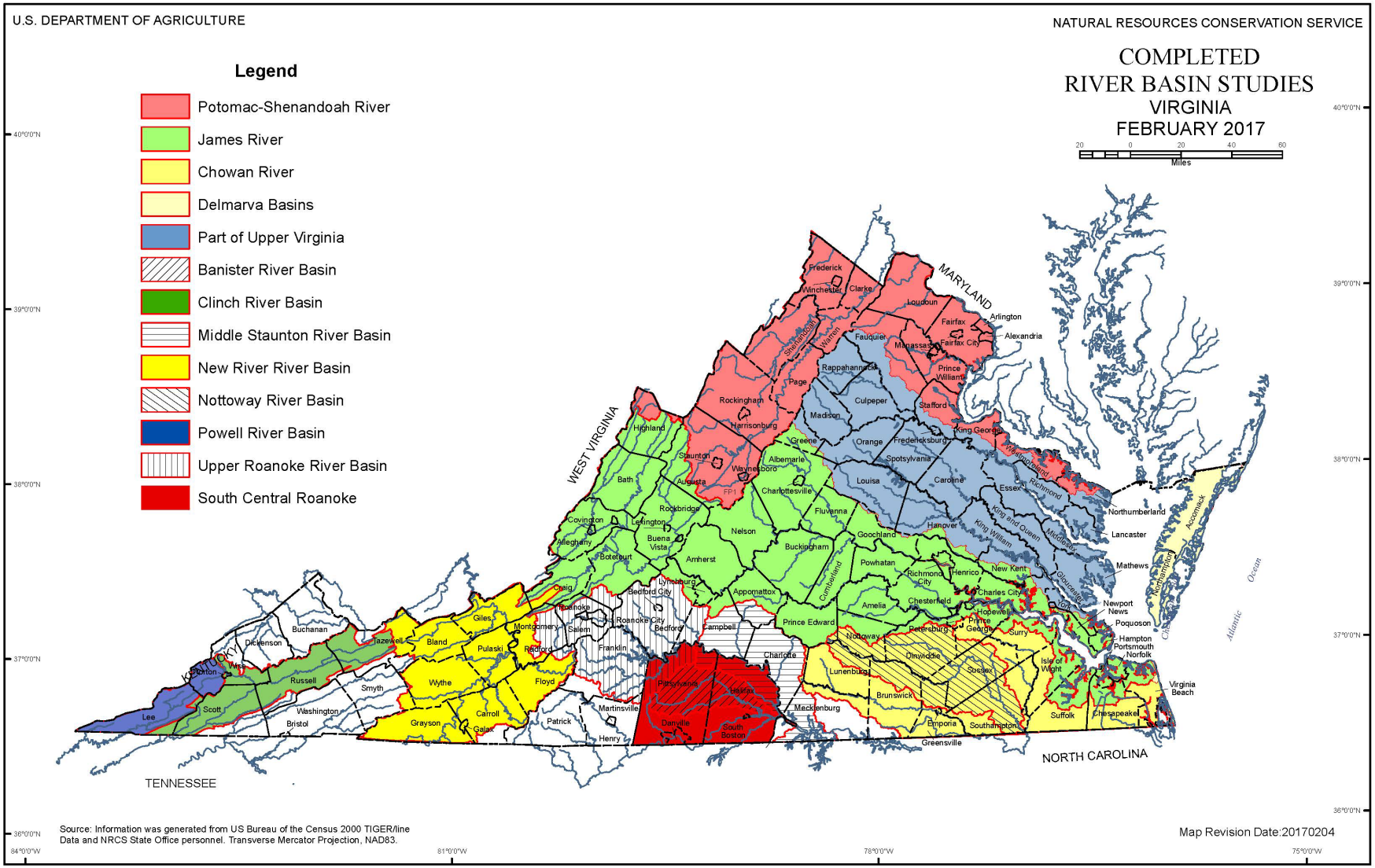
REGIONAL STUDIES

The Ohio River Basin Comprehensive Survey – This study covered a 163,000 square mile area and was completed and submitted to the Water Resources Council in 1968.

The North Atlantic Region Water Resources Study – This study covered 183,400 square miles of the James, York, Rappahannock, and Potomac Rivers plus the tidal and coastal drainage areas of the Chesapeake Bay and the Delmarva Peninsula. It was completed in 1972.

APPENDIX A

Figure A-1. Completed River Basin Studies.



OTHER STUDIES AND REPORTS

Naked Creek – Naked Creek is a tributary to the North River in Augusta and Rockingham Counties. The watershed is 14,685 acres. The watershed plan, prepared in 1958, called for accelerated land treatment, critical area stabilization, and two floodwater retarding structures. This plan was never implemented. Sponsors: Shenandoah Valley Soil and Water Conservation District and the North River Land & Water Conservation Association.

Kettle Run – Problems in this watershed included lack of water supply and flooding of agricultural land. Planning in this 16,413-acre watershed was authorized in 1966. Planning was suspended in 1967 when the sponsors identified other potential water supply sources. Sponsors: Culpeper Soil and Water Conservation District, Northern Virginia Soil and Water Conservation District, and Prince William County.

Appalachian Water Resources Survey – This survey was prepared by three USDA agencies, the Economic Research Service, the Forest Service, and the Soil Conservation Service, under the authority of Section 206 of the Appalachian Regional Development Act of 1965. Watershed Investigation Reports were prepared in 1967 for Headwaters Clinch River (Tazewell County), Headwaters Holston River (Bland, Smyth, and Tazewell Counties), and Indian Creek (Lee County). Seven subwatershed inventories were completed for Russell and Scott Counties. One of these was for Copper Creek.

Mill Creek (Giles County) – This PL-566 project (4,425 acres) was authorized for planning in 1968 and terminated in 1970. Sponsors: Skyline Soil and Water Conservation District, Giles County, and the Town of Narrows.

Carter Run – This PL-566 project was authorized for planning in 1975 and terminated in 1981. Sponsors: John Marshall Soil and Water Conservation District and Fauquier County.

Catoctin Creek – Planning was authorized in 1976 for the 36,567-acre watershed in Loudoun County. Identified problems included flooding and sediment in rural areas and a lack of water supply and recreation opportunities. Preliminary investigations initiated in October 1976 found that there were no economically feasible structural solutions for water supply and flood control. Nonstructural alternatives were not acceptable to the sponsors. A Final Preliminary Investigation Report was prepared. Planning was terminated in 1979. Sponsors: Loudoun Soil and Water Conservation District and Loudoun County Board of Supervisors.

Fisher River – Planned by North Carolina. Planning terminated.

Pocomoke Creek – Planned by Maryland.

Bull Run – Planning was authorized in 1982 for this 124,500-acre watershed in Fairfax, Loudoun, and Prince William Counties. Planning was terminated in 1983 due to infeasibility of solutions for flooding, sediment, and erosion problems. Water quality and loss of prime farmland issues occurred. Sponsors: Boards of Supervisors for Fairfax, Loudoun, and Prince William Counties, Northern Virginia Soil and Water Conservation District, and Prince William Soil and Water Conservation District.

Mobjack Bay Watershed Investigation Report – This report was prepared in 1983 as part of the water and related land resources study for the Upper Virginia River Basin. Mobjack Bay is located in Gloucester and Mathews Counties and drains to the Chesapeake Bay. The report was prepared by three USDA agencies: the Economic Research Service, the Forest Service, and the Soil

Conservation Service. Other groups providing aid and information in this study included the Tidewater Soil and Water Conservation District, Gloucester and Mathews Counties, Virginia Institute of Marine Science, and the Virginia Department of Health, Shellfish Division. Although problems and concerns were delineated, it was determined that the best course of action was to rely on continued use of existing programs, with some suggested redirection.

Shenandoah Valley Erosion Control Area, Virginia Expansion of the West Virginia East Targeted Area – This document was prepared by the Agricultural Stabilization and Conservation Service and the Soil Conservation Service to expand the FY84 approved East Target Area of West Virginia, which consisted of the 13 adjoining counties in West Virginia. The purpose was to target assistance to designated critical erosion areas.

Shenandoah Valley Erosion Control Target Area – This document was prepared by the Soil Conservation Service and applied to the counties of Augusta, Clarke, Frederick, Page, Rockingham, Shenandoah, and Warren. The document addressed the years from 1986 to 1990.

Washington and Lee Watershed Resource Plan – This study of the erosion and water quality problems on the highly erodible lands in King George, Richmond, and Westmoreland Counties was completed in 1990. Cooperating partners were NRCS, U.S. Forest Service, Virginia Department of Forestry, and the Virginia Division of Soil and Water Conservation. Sponsors: Richmond County Board of Supervisors, Westmoreland County Board of Supervisors, and Northern Neck Soil and Water Conservation District.

North River Watershed, Water Quality Initiative – this report described an initiative to better identify, quantify, and evaluate the water quality problems in the North River Watershed (Augusta and Rockingham Counties). The goal was to identify, evaluate, and demonstrate alternative waste disposal methods and other nonpoint source pollution controls. The report was completed in 1991 in cooperation with Headwaters Soil and Water Conservation District, Shenandoah Valley Soil and Water Conservation District, Virginia Division of Soil and Water Conservation, Virginia Cooperative Extension Service, Virginia Department of Forestry, and the U.S. Forest Service.

Middle River – This 239,319-acre PL-534 project in Augusta County addressed flooding of agricultural lands and highways, erosion and sediment damage, and potential water supply for Augusta County and the City of Staunton. Two floodwater retarding structures were planned. The report was completed in September 1983. No PL-534 funding was requested. Sponsors: Shenandoah Valley Soil and Water Conservation District, Augusta County, and the City of Staunton.

Upper Christians Creek, Natural Resource Report – This resource report was a summary of the findings, conclusions, and recommendations for the Upper Christians Creek Watershed in Augusta County. Upper Christians Creek is a tributary to the Middle River. The study was completed in 1993. Sponsors: Augusta County Board of Supervisors and Headwaters Soil and Water Conservation District.

Upper Meherrin River Watershed, Natural Resources Inventory Report - The study identified natural resource issues in the watershed, which covers Lunenburg, Mecklenburg, Charlotte, and Prince Edward Counties. The information could be used by local sponsors to address future conservation needs, socio-economic development, and environmental quality enhancements. The study was completed in 1994. Sponsors: Charlotte County Board of Supervisors, Lunenburg

County Board of Supervisors, Mecklenburg County Board of Supervisors, Southside Soil and Water Conservation District, and the Old Dominion Resource Conservation and Development Council.

North Fork of the Shenandoah River Subwatershed – Problems in the 238,000-acre watershed in Rockingham and Shenandoah Counties included nutrient and sediment pollution, which reduced water quality in the Shenandoah River. Flooding problems existed in some parts of the watershed. In 1988, preliminary investigations indicated a need to gather more data and work with the Virginia Department of Environmental Quality to establish impaired uses. Sponsors: Shenandoah Valley Soil and Water Conservation District, Lord Fairfax Soil and Water Conservation District, Rockingham County Board of Supervisors, and Shenandoah County Board of Supervisors.

Blackwater River Hydrologic Unit Area – Final Report – This study in Franklin and Pittsylvania Counties evaluated the effects of accelerated land treatment in the Blackwater River watershed from 1990 to 1998. The study was completed in 1999 with publication of the final report.

Alternative Water Systems and Watershed Model for Non-point source Pollution and Assessment Demonstration. This study was conducted in conjunction with the Blackwater River HUA study and completed in 1998.

Port Republic Flood Study – Port Republic, in Rockingham County, experienced frequent flooding to residences, businesses, roads, and bridges in their historic community located at the confluence of the South River and North River. The report was completed in 1999. The analysis showed that it did not appear to be economically feasible to provide 100-year flood protection to the community. Sponsors: Community of Port Republic and Rockingham County Board of Supervisors.

South River Subwatershed (PL-534) – This study was prepared in 1999 to supplement the original South River Subwatershed Plan. There was frequent flooding to agricultural lands, businesses, bridges, roads, and residences. The local sponsors asked NRCS to look at possible alternative sites to substitute for the five floodwater retarding structures that were part of the original plan but not built for a variety of reasons. Sponsors: Headwaters Soil and Water Conservation District, Augusta County Board of Supervisors, and City of Waynesboro.

Dahlgren Shoreline Erosion Report – The Dahlgren Naval Base, located on the Potomac River, was experiencing excessive shoreline erosion. In FY99, the Navy contracted with NRCS to inventory the extent of the problem and to propose solutions.

Upper Reed Creek – The water quality in the Upper Reed Creek watershed (Wythe County) was negatively impacted by agricultural activities. The stream served as a public drinking water supply for parts of Wythe County and the Town of Wytheville. Tests showed high levels of turbidity and high fecal coliform counts in the water. The request for assistance was approved in 2000 and the public meeting was held in 2001. A land use layer for the watershed was developed and classified using GIS analysis. Due to other priorities, the NRCS Planning Team was unable to continue planning. Sponsors: Big Walker Soil and Water Conservation District, Wythe County Board of Supervisors, and Town of Wytheville. This project was withdrawn by the sponsors.

Elk Creek – Elk Creek, in Grayson County, was on the TMDL list as an impaired stream. It was negatively impacted by sedimentation and fecal coliform bacteria. Local citizens identified the sources as streambank and pastureland erosion and logging operations. The request for assistance was approved in 2000 and the public meeting was held in 2001. A land use layer for the watershed was developed and classified using GIS analysis. Due to other priorities, the NRCS Planning Team

was unable to continue planning. Sponsors: New River Soil and Water Conservation District and Grayson County Board of Supervisors.

Quantico Creek Stream Assessment – The Town of Dumfries requested assistance from NRCS to inventory the condition of Quantico Creek. The creek had experienced significant erosion since the Town straightened a reach downstream of the town. The 2002 report described the change to the stream configuration and why. This information was later used by a consultant to design solutions.

Big Moccasin Creek Watershed, Natural Resources Report – This report was a compilation of the planning efforts in this watershed. The watershed is located in Russell and Scott Counties. The sponsors had determined that the level and extent of pasture, cropland, forestland, and streambank erosion are greater than can be solved by available District and State Programs. The study was completed in 2004. Sponsors: Scott County Soil and Water Conservation District, Clinch Valley Soil and Water Conservation District, Russell County Board of Supervisors, Scott County Board of Supervisors, the Town of Weber City, and the Town of Gate City.

South Fork Shenandoah River Rapid Watershed Assessment – This study was prepared by the Virginia Department of Conservation and Recreation under a grant from NRCS. The results of the study were used to facilitate the timely implementation of the Chesapeake Bay Tributary Strategies, promote basin-wide watershed planning, and integrate the TMDL program with Tributary Strategy implementation. This study was completed in 2008.

North Fork of the Shenandoah Watershed Assessment – The watershed study involved the collection of data and information for the purpose of developing a watershed profile, including a description of the natural resource conditions and trends, issues, concerns and problems along with recommendations for local action. This study was completed in 2008. Sponsors: Potomac Valley Soil Conservation District, WV; Lord Fairfax Soil and Water Conservation District, VA; and Shenandoah Valley Soil and Water Conservation District, VA; and Shenandoah Resource Conservation and Development Council, VA.

Lower Shenandoah River Watershed Assessment (Virginia and West Virginia) – This rapid watershed assessment was prepared to provide initial estimates of where conservation investments would best address the concerns of landowners, conservation districts, and other community organizations and stakeholders. This study was completed in 2009. Sponsors: Eastern Panhandle Conservation District, WV; Potomac Headwaters Resource Conservation and Development Council, WV; Lord Fairfax Soil and Water Conservation District, VA; and Shenandoah Resource Conservation and Development Council, VA.

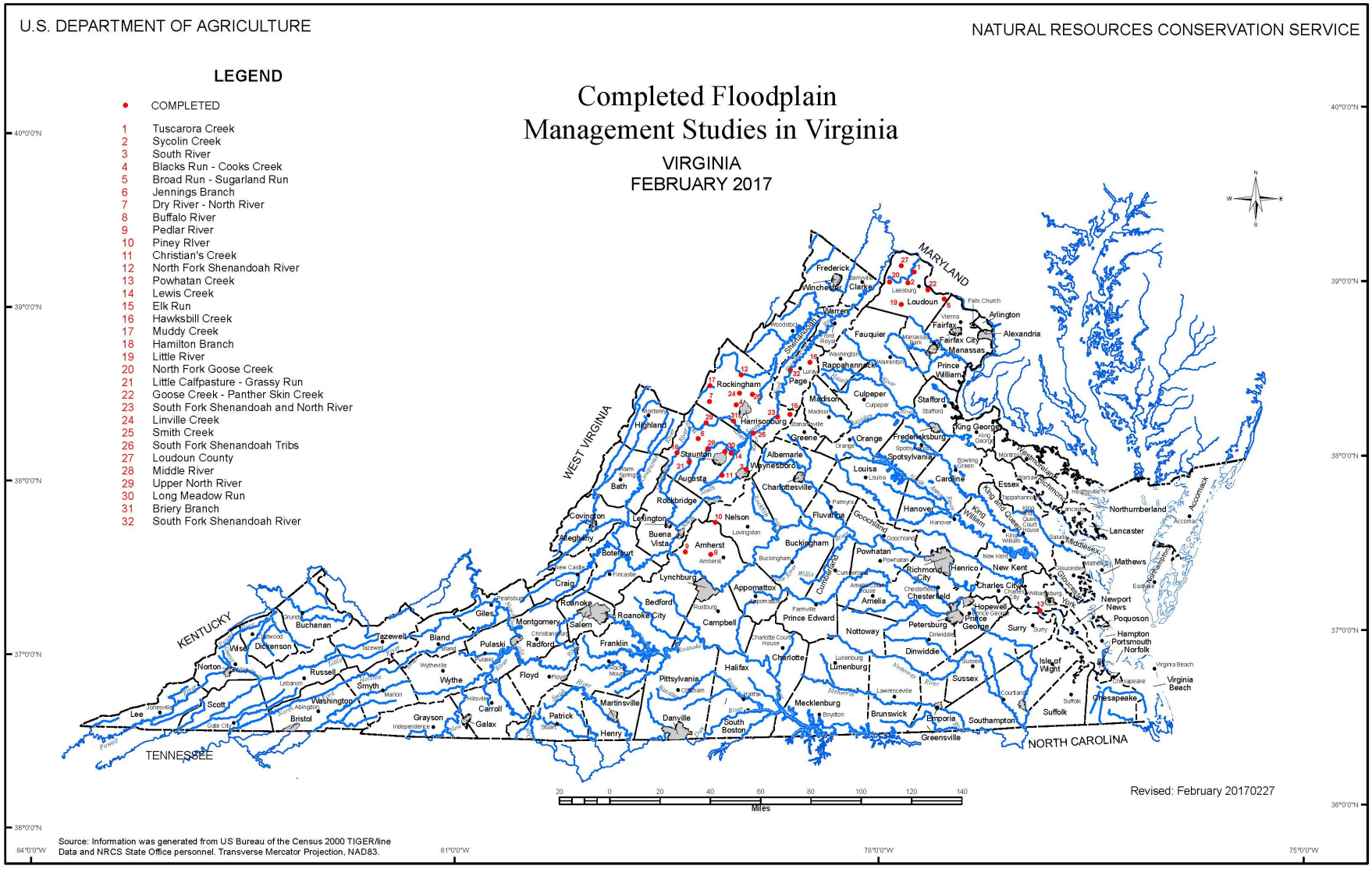
APPENDIX B: FLOODPLAIN STUDIES

Table B-1. Flood Plain Management Studies.

Stream	Year completed	Community	Size of Study Area, acres	Miles of Channel
Town of Haysi Flood Insurance Study (FIS)	1971	Town of Haysi (Dickenson County)	183,040	-
Town of Glasgow FIS	1973	Town of Glasgow (Rockbridge County)	1,957,120	-
Tuscarora Creek and tributaries Flood Hazard Analysis (FHA)	1974	Town of Leesburg and Loudoun County	354	7
Sycolin Creek and tributaries FHA	1974	Loudoun County	439	8
South River and tributaries FHA	1974	City of Waynesboro and Augusta County	6,055	45
Dry River and North River FHA	1974	Town of Bridgewater and Rockingham County	2,796	17
Blacks Run and Cooks Creek FHA	1974	City of Harrisonburg and Rockingham County	1,146	18.5
Broad Run and Sugarland Run FHA	1974	Town of Sterling and Loudoun County	3,278	24
Jennings Branch FHA	1974	Town of Churchville and Augusta County	581	7
Buffalo River FHA	1974	Amherst County	993	18
Pedlar River and tributaries FHA	1975	Amherst County	620	17
Piney River FHA	1975	Amherst and Nelson Counties	1,210	11
Christians Creek FHA	1976	Augusta County	1,121	22.9
Town of Grottoes FIS	1977	(Town of Grottoes (Rockingham County)	81,280+	-
North Fork of the Shenandoah River and tributaries FHA	1977	Rockingham County	5,000	62
Powhatan Creek and tributaries FHA	1976	City of Williamsburg and James City County	1,700	16
Lewis Creek and tributaries FHA	1977	City of Staunton and Augusta County	741	17
Elk Run and tributaries FHA	1977	Town of Elkton and Rockingham County	330	8
Hawksbill Creek and tributaries FHA	1977	Town of Luray and Page County	1,803	17.2
Muddy Creek and tributaries FHA	1978	Rockingham County	561	14.3

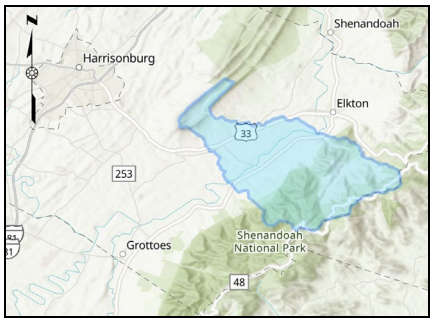
Stream	Year completed	Community	Size of Study Area, acres	Miles of Channel
Hamilton Branch FHA	1978	Town of Deerfield and Augusta County	5,760	4.3
Little River and Hungry Run FHA	1978	Loudoun County	32,000	13.6
North Fork Goose Creek and Beaver Dam Creek Flood Hazard Study (FHS)	1978	Loudoun County	1,289	12.8
Little Calfpasture River and Grassy Run FHS	1979	Town of Craigsville and Augusta County	35,072	12.2
Goose Creek and Pantherskin Creek FHS	1979	Loudoun County	284,160	36
South Fork of the Shenandoah and North River FHA	1979	Rockingham County	820,160	43
South Fork of the Shenandoah River and tributaries Flood Plan Management (FPMS)	1983	Rockingham County	2,863	62
Linville Creek FPMS	1982	Rockingham County	517	12
Smith Creek FPMS	1982	Rockingham County	1,066	27
Loudoun County FPMS	1983	Loudoun County – 13 stream segments throughout county	2,444	57
Middle River FPMS	1983	Augusta County	4,530	50.2
Long Meadow Run FPMS	1983	Augusta County	327	8.6
Upper North River FPMS	1984	Augusta County	1,148	7.5
Briery Branch, portions of North River and Mossy Creek FPMS	1984	Rockingham County	1,828	15.9
South Fork of the Shenandoah River FPMS	1987	Page County	173,376	48.1

Figure B-1. Completed Flood Plain Studies in Virginia.



APPENDIX C: WATERSHED DESCRIPTIONS

CHANNEL IMPROVEMENTS



PL-534 Gap Run

Location:	Rockingham County
Watershed Size:	5,103 acres
Operations Date:	March 1962
Status:	Completed
Completion Date:	June 1962

Sponsor: Shenandoah Valley Soil and Water Conservation District

Background: Gap Run is a tributary of the South Fork, Shenandoah River. It is approximately 3.7 miles southwest of Elkton, Virginia, in Rockingham County.

Project Purpose: This channel improvement was designed to prevent swamping and flooding in the small rural community of Yancey (locally called Berrytown).

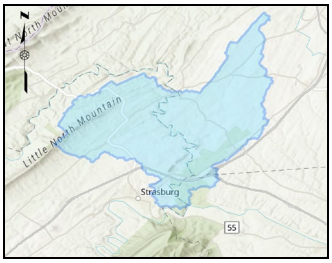
Progress: A total of 0.24 miles of channel improvement was completed.

Current Status: The project was closed in 1962.

Sources: Design Report dated March 1960; 1985 Water Resources Progress Report.

PL-534 Tumbling Run

Location:	Shenandoah County
Watershed Size:	9,514 acres
Operations Date:	December 1960
Status:	Completed
Completion Date:	May 1961



Sponsor: Lord Fairfax Soil and Water Conservation District

Background: On July 18, 1960, the Tumbling Run watershed experienced an isolated, severe storm that, by two accounts, produced approximately 4.5 inches of rain in 1.5 hours. The lower 2.62 miles of the channel had a significantly diminished capacity when this event passed.

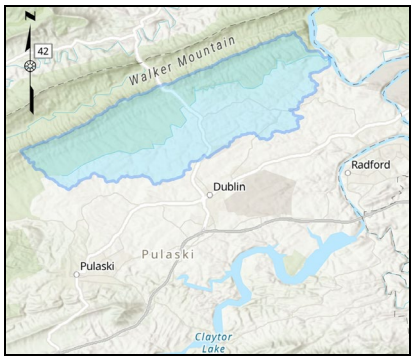
Project Purpose: Restore the capacity of the channel.

Progress: About 2.25 miles of channel was restored to the original capacity.

Current Status: The project was closed in 1961.

Source: 1985 Water Resources Report; Watershed Plan.

PL-566 Back Creek (Pulaski Co.)



Location:	Pulaski County
Watershed Size:	22,340 acres
Application Date:	February 1955
Plan Date:	March 1955
Operations Date:	June 1957
Status:	Completed
Completion Date:	September 1964

Sponsor: Skyline Soil and Water Conservation District*

Background: Significant problems in the watershed were: 1) poor channel conditions which did not allow adequate removal of floodwater and adequate drainage and 2) lack of certain land treatment measures in the watershed. The plan was for improvement of the present channel to allow for more rapid runoff of flood water and to give drainage outlets to remove seepage water and to lower the water table.

Project Purpose: Channel improvement for flood protection and drainage and an acceleration of land treatment measures for watershed protection. Planned treatment was for 11.14 miles of channel improvement with a limited amount of straightening, backfilling of portions of the old channel, and tree removal, brushing and snagging of the remainder. Planned land treatment measures included contour strip cropping, waterways, pasture planting, pasture improvement, wildlife border strips, open drains, and stock water ponds.

Progress: Eleven miles of channel improvement were installed.

Current Status: The project was closed in 1964.

Follow-up: There was a letter, dated May 30, 1979, in the file that explained the purpose of the project and the consequences. "The intended purpose of the channel improvement has been accomplished; which was to increase the velocity so that the channel would degrade thus providing a quick exit for flood water. It was also intended to keep the banks clear of trees or bushes to prevent meander. Channel improvement for flood control is always done at the expense of an increase in erosion. Back in the late 1950's, however, the sponsors apparently felt that the faster velocities (and thus erosion) was the lesser of the two evils and elected to go for the flood control."

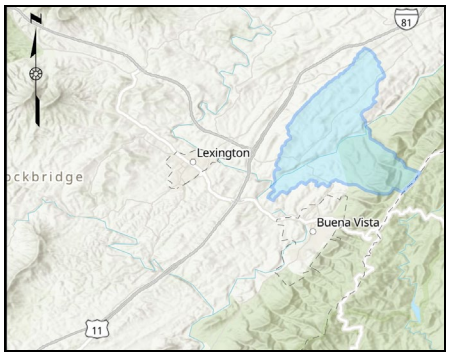
The Back Creek Watershed Association wanted the erosion problems corrected. The District Conservationist described the needed action and the likely consequences of reversing the channel work.

Source: Original Watershed Workplan; 1985 Water Resources Report; 1979 letter.

*Responsible for O&M.

PL-566 Buena Vista

Location:	City of Buena Vista Rockbridge County
Watershed Size:	11,850 acres
Application Date:	May 1993
Plan Date:	May 1999
Operations Date:	January 2003
Status:	Active



Sponsors: City of Buena Vista*
Natural Bridge Soil and Water Conservation District

Background: This flood control project was planned to prevent flood damage to the City of Buena Vista from four interior streams. Flooding problems consist of economic losses to streets, bridges, gas lines, waterlines, homes, businesses and industries. Detailed studies indicate that a 100-year storm without project protection would flood 245 residences, 70 commercial properties, and many bridges, streets, roads and utilities, resulting in $9.5 million of urban damages. An additional $1.9 million in losses would result from costs related to infrastructure repairs and the clean-up of debris.

Project Purpose: Flood prevention.

Progress: Two debris basins were constructed in 2006 on Washer Hollow and Chalk Mine Run. Two bridges were upgraded and replaced in 2008 on Ridge Road and on Rockbridge Avenue. In 2009, a frequently flooded house on Catalpa Avenue was acquired and demolished and a permanent easement was placed on the property. A design for channel improvements on Chalk Mine Run was completed in 2011 and provided to the City. In 2000, the City used the NRCS Watershed Work Plan to obtain a FEMA Hazard Mitigation Grant with the intention to acquire and demolish 10 residential structures and elevate 16 residential structures.

Current Status: The City has not moved forward with the channel improvements to Chalk Mine Run and have not requested funding to continue the project. No federal funds for implementation have been received since 2011. Flooding problems continue in Buena Vista that are caused by the interior streams. The additional structural measures that are planned for this project will be deleted from the watershed plan when this project is closed.

Works of improvement on this project not yet completed include:

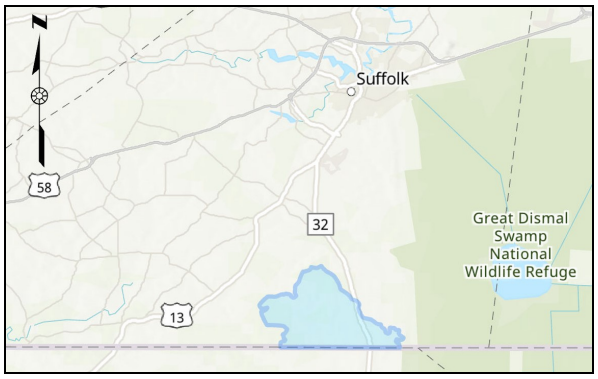
- Construct 6 debris basins
- Replace/enlarge/remove five culverts and/or bridges
- Construct 500 feet of concrete floodwall
- Improve 5,538 feet of stream channel and realign and improve 120 feet of stream channel
- Replace 2 railroad bridges and one railroad culvert

Sources: 2017 Water Resources Report; newsletter on FEMA Grant

*Responsible for O&M.

PL-566 Hobbsville-Sunbury

Location:	Gates County, NC Nansemond County, VA (now City of Suffolk)
Watershed Size:	85,500 acres
Application Date:	June 1963
Plan Date:	August 1966
Operations Date:	February 1967
Status:	Completed
Completion Date:	September 1981



Sponsors: Gates Soil and Water Conservation District, North Carolina
Gates County, NC, County Commissioners
Peanut Soil and Water Conservation District, Virginia
Gates County Drainage Districts No. 2 and No. 3

Background: Works of improvement planned in the watershed were expected to benefit 11,480 acres of cropland and pasture on 250 farms. The works of improvement included land treatment measures for watershed protection, 317,245 feet (60.0 miles) of multiple-purpose channel improvement, and about 200 acres of wildlife wetland areas. Only 1,850 acres of the watershed are in Virginia.

Project Purpose: Reduce frequent flooding of cropland and pasture and provide outlets for on-farm drainage.

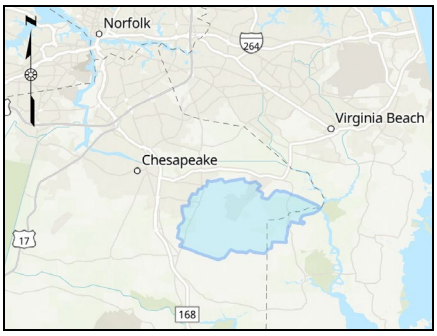
Progress: The project was completed in 1981 and encompassed 60 miles of channel improvement, land treatment, and wildlife wetland areas.

Current Status: The project was closed in 1981.

Sources: 1985 Water Resources Report; Hobbsville-Sunbury Watershed Work Plan and supplements.

PL-566 Indian Creek

Location:	City of Chesapeake
Watershed Size:	6,750 acres
Application Date:	June 1968
Plan Date:	December 1973
Operations Date:	February 1974
Status:	Completed
Completion Date:	June 1976



Sponsors: Virginia Dare Soil and Water Conservation District
City of Chesapeake

Background: Indian Creek drains about 6,750 acres in the southeastern part of the City of Chesapeake, formerly Norfolk County. The three major problems were: the need to improve land treatment practices and measures on individual farms, inadequate outlets for farms and small group drainage systems; and flood damages to crops and pasture.

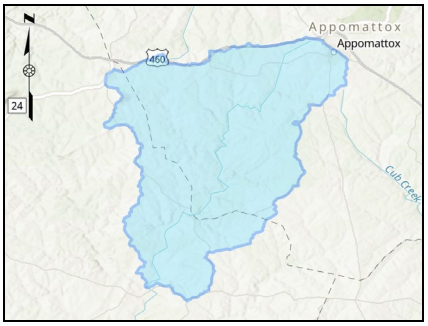
Project Purpose: The land treatment measures for this project were designed to increase moisture absorption and improve internal drainage in areas having a high water table. Structural measures consisted of approximately 2.25 miles of multiple-purpose channel for flood prevention and drainage in the upper one-third of the watershed.

Progress: Installation of the structural works of improvement benefitted about 2,375 acres on 40 farms. There were 2.25 miles of channel improvement installed. This work included channel excavation, land clearing, spoil spreading, and stacking, shaping, and seeding of the construction area. Channel improvement cost was $45,520. Land treatment measures included crop residue management, drainage main or lateral, conservation cropping systems, pasture and hayland management, tree planting, and hydrologic cultural operations.

Current Status: The project was closed in 1976.

Sources: Indian Creek Watershed Work Plan signed 12/19/1973; Construction Completion Report; 1985 Water Resources Progress Report

DAMS



Pilot East Fork Falling River

Location:	Appomattox County Campbell County
Watershed Size:	42,706 acres
Operations Date:	November 1954
Status:	Completed
Completion Date	November 1958

Sponsor: Robert E. Lee Soil and Water Conservation District*

Background: The plan for this project was prepared under the authority of the Soil Conservation Act of 1935, Public Law No. 46, and as provided for under the Watershed Protection item in the Agricultural Appropriation Bill No. 1954. The major problems in the watershed were flooding and erosion. There were 158 out-of-bank events in the 20 years before the plan was written.

Project Purpose: This Pilot watershed program was intended to provide experience in developing sound procedures for Local-State-Federal cooperation in achieving the watershed objectives of local people and to demonstrate the actual physical and economical results of a planned watershed program by determining increased productivity, decreased erosion, decreased floodwater and sediment damage, and other benefits resulting from the watershed improvement.

Planned actions included installation of three single purpose flood control dams, 15.15 miles of channel clearing, stabilization of 4.4 miles of streambanks by providing adequate vegetative cover, and stabilization of critical runoff and sediment producing areas. Planned land treatment measures included conservation crop rotation, diversions, terraces, waterways, stripcropping, pasture improvements, and establishment of alfalfa and perennial grasses.

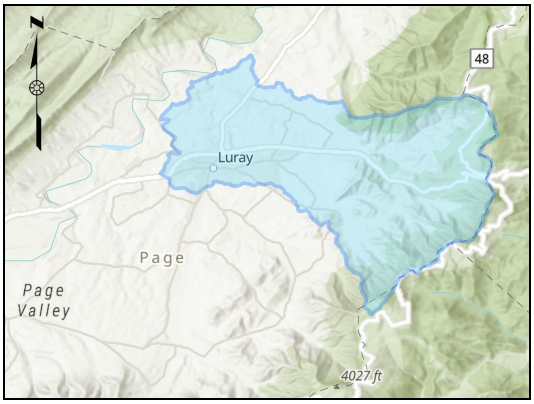
Progress: One single purpose floodwater retarding dam (No. 15) was built in 1956 and two multipurpose (floodwater and recreation) dams (No. 7 and No. 21) were built in 1958 and 1957, respectively. Other measures included 18 miles of channel work, 49 miles of road bank stabilization, 114 acres of stabilization of silt-producing areas, 1,041 acres of tree planting, 46 sod waterways, 1,731 acres of stripcropping, 1,058 acres of pasture seeding, and 2,967 acres of pasture improvement.

Current Status: All three dams were built as Low hazard structures and now have a hazard class of Significant.

Sources: Watershed plan, 1985 Water Resources Report; Pilot Watershed Tour fact sheet, August 27, 1958; Construction Archive; DamWatch; DCR Dam Safety Inventory.

*Responsible for O&M.

PL-534 Dry Run



Location:	Page County
Watershed Size:	9,000 acres
Plan Date:	June 1965
Status:	Completed
Completion Date:	July 1972

Sponsors: Shenandoah Valley Soil and Water Conservation District*
Town of Luray*

Background: This agricultural watershed had a history of frequent, damaging floods that damaged crops and pastures, fences, roads and bridges, homes, and other works of improvement. The use, management, and development of some of the most productive and valuable land in the watershed was severely limited by these floods. There was also a problem with erosion of the uplands and scouring and deposition on the bottomlands. The water supply for the Town of Luray was inadequate for the needs at that time.

Project Purpose: Planned works of improvement included one single purpose floodwater retarding structure, one multi-purpose structure for floodwater and water supply (450 acre-feet) for the Town of Luray, 0.77 miles of channel improvement, and land treatment for crop, pasture, and forestland on approximately 50 farms.

Progress: Arrowhead Lake (No. 101) was built in 1971 as a High hazard dam for flood control and future water supply. It is currently used for recreation and the VDWR stocks the lake. Morningstar Lake (No. 102) is a single purpose dam built in 1969 as a High hazard flood control structure. The planned land treatment included 1,249 acres of cropland, 883 acres of grassland, 10 acres of miscellaneous land, and 18 acres of critical area planting. The channel improvement was removed from the project in 1972 because the cost to conform to the design criteria greatly exceeded the work plan estimate of cost.

Current Status: The two sponsors are jointly responsible for the operation and maintenance of the dams.

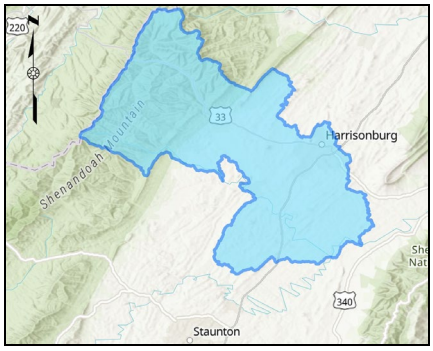
Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-534 Lower North River

Location: Augusta County
Rockingham County
Watershed Size: 204,588 acres

Operations Date: September 1964
Status: Completed
Completion Date: April 2018



Sponsors: Shenandoah Valley Soil and Water Conservation District* (Dam Nos. 22B, 78, 80, 82, and 83)
Headwaters Soil and Water Conservation District
Rockingham County Board of Supervisors
Augusta County Board of Supervisors
City of Harrisonburg* (Dam No. 81C)

Background and Problems: The watershed was primarily agriculture with a history of frequent flooding. There were also urban, rural non-farm, and public recreation areas which, in the past, had sustained severe damages. The Town of Bridgewater is the largest urban development in the watershed. Floodplain scour has been a problem in the past from hurricanes and severe storm events. Erosion and sediment control were identified in the original work plan as a problem.

Project Purpose: Provide flood prevention and watershed protection for erosion and sediment control. The project, as supplemented, called for 16 floodwater retarding structures, 9.98 miles of channel improvements, 8,400 feet of dikes, and land treatment. One single purpose dam was changed to a multipurpose dam to provide water supply to the City of Harrisonburg.

Progress: Five single purpose dams and one multipurpose dam were built. Together, these dams provide 165 surface acres of water which can be used for recreation, 4,500 acre-feet of water supply storage, 9,829 acre-feet of floodwater retarding capacity, and 1,331 acre-feet of sediment storage. These impoundments also provide downstream water quality benefits to the Shenandoah Valley, the Potomac River, and the Chesapeake Bay. Two sections of dike/channel improvement were installed. The planned land treatment was accomplished. All of the dams but one were constructed with hazard class of High. Dam No. 22B was constructed with a hazard class of Significant.

Current Status: The project was closed in April 2018. Eleven dams from the original watershed plan were not installed for various reasons and were removed from the plan at closeout. Over 38,300 acres of land treatment were applied. All of the dams now have a hazard class of High.

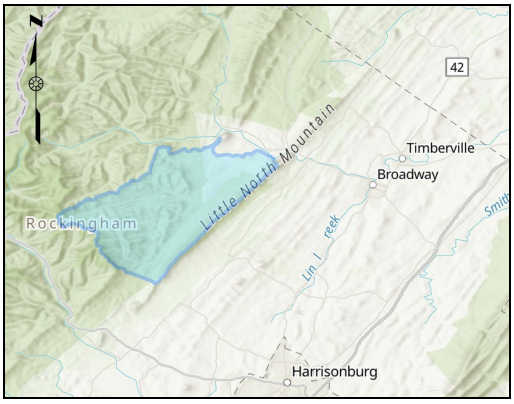
Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-534 Shoemaker River

Location: Rockingham County
Watershed Size: 23,110 acres
Operations Date: October 1972
Status: Completed
Completion Date: November 1988

Sponsor: Shenandoah Valley Soil and Water Conservation District*



Background: The major floodwater problems in the watershed were damage to crops, pasture, roads, and bridges. Frequent overflow restricted floodplain uses and development. About 1,040 acres were inundated by the 100-year frequency flood. In 1972, there were 150 permanent residents living in the floodplain and an estimated 300 temporary residents and visitors during the peak recreation season. Approximately 64% of the watershed in the George Washington and Jefferson National Forest and 36% is in private ownership.

Project Purpose: Watershed protection for soil erosion and sediment control and flood control. Planned activities included four floodwater retarding structures and an accelerated land treatment program on 1,077 acres of land.

Progress: Three single purpose dams were built from 1980-1986 with a hazard class of High. Slate Lick Lake (Dam 4C) is located in the National Forest and the fishery is managed by the Virginia Department of Wildlife Resources. Hog Pen Lake (Dam 3B) is also located in the National Forest and has a 4.9 mile trail used for hiking, horseback riding, and birdwatching. Shoemaker Lake (Dam 1A) is on private property. Conservation practices were installed on 125 acres of cropland, 320 acres of grassland, and 15 acres of miscellaneous land.

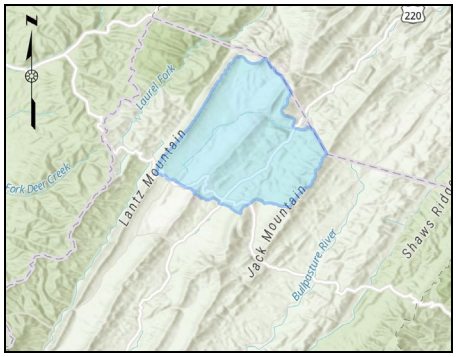
Current Status: The project was closed in 1988. The fourth dam was not built.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

Hog Pen Lake. Photo from AllTrails website (https://www.alltrails.com/trail/us/virginia/hogpen-lake-via-fdr-230)

PL-534 South Branch Potomac River Subwatershed



Location:	Highland County, VA Pendleton County, WV Grant County, WV
Watershed Size:	187,300 acres
Operations Date:	March 1971
Status:	Deauthorized
Completion Date:	April 2019

Sponsors: Pendleton County Commission, WV
Potomac Valley Soil and Water Conservation District, WV
Mountain Soil and Water Conservation District, VA

Background and Problems: The agricultural lands and improvements, businesses, residences, camps, roads, bridges, and utilities were subject to frequent flooding and sediment damage. Water-based recreation was also a need. In 1970, the estimated average floodwater damages totaled $550,600. The project would reduce these damages by about 50 percent. Eighty percent of the watershed is in West Virginia. The Virginia portion of the watershed is shown in the map.

Project Purpose: Flood prevention and watershed protection for erosion and sediment control. Seven single purpose and one multipurpose dam were planned for flood prevention and recreation.

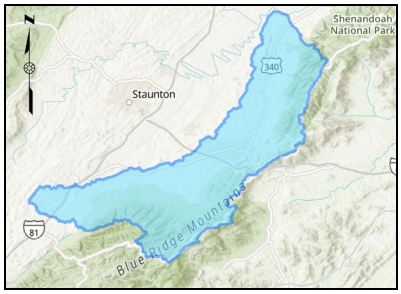
Progress: About 19,739 acres of cropland, pastureland and forestland were adequately treated for erosion and sediment control. A re-evaluation of the project to update the benefits and cost of installing the dams was made due to a loss of recreation as a project purpose of the multipurpose structure. This resulted in an unfavorable benefit to cost ratio. None of the dams were built.

Current Status: This project was deauthorized in 2018.

Sources: Watershed Plan and supplements, Status of Projects report (May 18, 2017); 2017 Water Resources Progress Report.

PL-534 South River

Location: Augusta County
Watershed Size: 156,700 acres
Operations Date: January 1955
Status: Completed
Completion Date: April 2018



Sponsors: Headwaters Soil and Water Conservation District (after 1976)* (Dam Nos. 4, 6, 7, 11, 19, and 24 solely; Dam Nos. 23, 25, and 26 jointly with Augusta County and City of Waynesboro; Dam No. 8 jointly with City of Waynesboro; Dam No. 3 jointly with Virginia Department of Corrections)
Shenandoah Valley Soil and Water Conservation District (before 1976)
Augusta County Board of Supervisors* (Dam Nos. 23, 25, 26, and 10A)
City of Waynesboro *(Dam Nos. 23, 25, 26, and 8)

Background and Problems: Frequent floods caused water and sediment damages to agricultural lands, businesses, roads, bridges, and residences in Augusta County and urban land in the City of Waynesboro.

Project Purpose: Flood prevention and watershed protection for erosion and sediment control. Seventeen flood prevention structures were planned originally. The plan was later supplemented to add one multipurpose structure for flood control and water supply. The planned channel work included approximately 17 miles of channel clearing and snagging, 13 miles of channel enlargement, and 31 miles of streambank stabilization. Nearly 33,000 acres of land treatment were planned.

Progress: One mile of channel enlargement and 26 miles of channel clearing and snagging were completed. Conservation practices have been applied in excess of those identified in Table 1 of the original Watershed Plan. The multipurpose structure (No. 10A) and twelve single purpose structures were built between 1954 and 1980. When constructed, six of the dams had a hazard class of Low, one dam had a hazard class of Significant, and six dams had a hazard class of High.

Current Status: The project was closed out in 2018. Of the planned 18 dams, five of the single purpose dams were not built for a variety of reasons. Approximately 61 miles of channel work were not implemented. The last five dams and channel work were deleted from the project as part of the closeout. Two dams have a current hazard class of Significant and 11 dams are now classified as High hazard.

The U.S. Forest Service is solely responsible for the O&M on Dam No. 27, Upper Sherando Lake. The Virginia Department of Corrections and Headwaters SWCD are jointly responsible for the O&M on Dam No. 3, Poor Creek.

Dam rehabilitation has been completed on four dams in this watershed to bring them into compliance with the criteria for a High hazard dam (No. 10A – Mills Creek; No. 23 – Robinson Hollow; No. 25 – Toms Branch; and No. 26 – Inch Branch).

The rehabilitation of Dam No. 23, Robinson Hollow, was completed in 2007 for a cost of $1,418,718. The dam was raised 4 feet by the installation of a concrete parapet wall. The north auxiliary spillway was widened, and new training walls were installed. The training walls and two auxiliary spillways were armored with articulated concrete blocks (ACBs). The hazard class had changed from Low to High due to changes in the land use in the floodplain of the dam.

Inch Branch (No. 26) was rehabilitated in 2008 for a cost of $658,325. Work consisted of widening the auxiliary spillway, adding a new training dike, armoring the auxiliary spillway and training dikes with ACBs, and replacement of the riser structure. The crest of the auxiliary spillway was lowered by 1 foot and the top of the dam was raised 0.5 feet. The hazard class had changed from Low to High due to changes in the land use in the floodplain of the dam.

No. 25, Toms Branch, was rehabilitated in 2010 for a cost of $1,617,342. The principal spillway riser was replaced, the top of the dam was raised 2 feet, and the auxiliary spillway was widened by 150 feet and armored with Turf Reinforcement Matting (TRM). The hazard class had changed from Low to High due to changes in the land use in the floodplain of the dam. The auxiliary spillway of this dam charged in 2019.

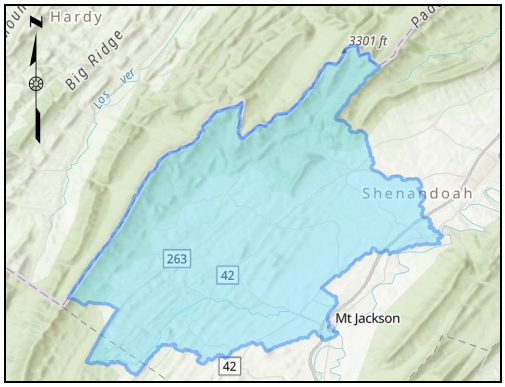
When Mills Creek (No. 10A) was built, the hazard class was Significant. The dam was rehabilitated in 2013 to meet the required criteria for a High hazard dam for a cost of $1,350,187. The water supply purpose was removed from the dam because the water quality was considered poor. The auxiliary spillway was lowered by 3 feet and armored with ACBs. The old principal spillway riser, which was embedded in the embankment, was closed and replaced with a new riser in the pool. At the outlet end, the distribution box was replaced with a riprap-lined plunge pool.

The sponsors have requested NRCS assistance for dam rehabilitation for four other sites in this watershed (No. 6 – Stoney Creek; No. 7 – Lake Wilda; No. 11 – Canada Run; and No. 19 – Waynesboro Nursery). Federal funding for NRCS planning assistance has not yet been approved for these dams.

Sources: South River Watershed Plan and Supplements; Construction Completion Reports for the rehabilitated dams; Rehab Status Report; DamWatch.

*Responsible for O&M.

PL-534 Stony Creek



Location:	Shenandoah County
Watershed Size:	72,148 acres
Operations Date:	March 1969
Status:	Completed
Completion Date:	September 1988

Sponsor: Lord Fairfax Soil and Water Conservation District*

Background: In 1969, this was primarily an agricultural watershed with a long history of frequent damaging floods. In the preceding years, there was considerable development of recreational facilities in the mountainous areas adjoining the George Washington National Forest. The frequent flooding in this watershed caused physical damage to agricultural interests, roads, bridges, homes, and commercial interests, and substantial loss of visitor use of the recreational development and sales losses to businesses. There was also a problem of erosion of the uplands and scour and deposition on the bottomlands.

This plan called for installation of land treatment measures, which were designed to increase moisture absorption and reduce runoff, three floodwater retarding structures, one multiple purpose structure for flood prevention and recreation, and approximately 0.66 miles of floodway.

Project Purpose: Reduce damage from flood waters and sedimentation.

Progress: Dam No. 10 (single purpose), Lake Birdhaven, was completed on August 1, 1972 for a cost of $250,098. Multipurpose Dam No. 9, Lake Laura, was completed on December 21, 1971 for a cost of $382,491. Lake Laura is used for water-based recreation and fishing, irrigation of the golf course, and snow-making at the ski resort. Installation of the other two dams and the floodway was delayed due to lack of land rights, and these elements were removed from the project in 1988.

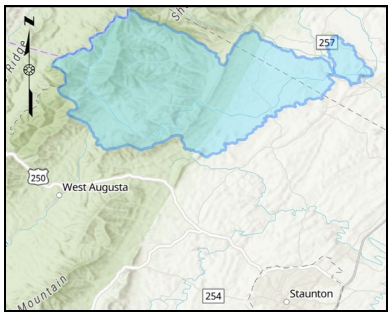
NRCS completed land treatment on 4,300 acres of cropland; 5,370 acres of grassland; and 225 acres of miscellaneous land; and critical area treatment for roadside erosion control on 74 acres. The US Forest Service completed 55 acres of land stabilization; 4,860 acres of forestland treatment; and 73.1 miles of road, trail, and streambank stabilization. Total land treatment cost was $577,280 (1968 basis).

Current Status: In 2016, the State modified the two dams to meet current State criteria for High hazard dams.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-534 Upper North River



Location:	Augusta County Rockingham County
Watershed Size:	67,961 acres
Operations Date:	August 1960
Status:	Completed
Completion Date:	April 2000

Sponsors: Shenandoah Valley Soil and Water Conservation District
Headwaters Soil and Water Conservation District* (Dam No. 77 solely; Dam No. 10 jointly with Augusta County)
Augusta County Board of Supervisors* (Dam No. 77)
City of Staunton* (Dam No. 76)

Background: From 1932 to 1955, there were at least ten floods which covered more than half the floodplain and 41 smaller floods. In 1949, a record flood occurred in the watershed which resulted in the death of three people in the Town of Bridgewater. Two highway bridges and approximately seven miles of road had to be rebuilt. About 100 farmsteads were damaged and 20 houses were destroyed. Sediment deposition in the watershed reduced the stream capacity and impaired use of the agricultural land. Floodplain scour in the bottomland damaged approximately 1,800 acres of agricultural land and streambank erosion damaged an additional 65 acres.

Project Purpose: Flood control and land treatment. Planned land treatment measures included conservation crop rotation systems, contour farming, contour stripcropping, pasture and hayland planting, pasture renovation, grassed waterways, and wildlife food plantings. Three single purpose floodwater retarding structures and 12 miles of channel improvement were planned.

Progress: In 1961, Elkhorn Lake (Dam No. 76) was converted to a multipurpose structure to provide water supply to the City of Staunton. The dam was constructed in 1965 as a High hazard structure. The single purpose structure, Todd Lake (Dam No. 10), was constructed in 1963 as a Significant hazard structure. Hearthstone Lake (Dam No. 77), was completed 1966 as a single purpose, High hazard structure. Over 4,200 acres of cropland, pastureland, and forestland practices were installed. The channel improvements were not installed. The fisheries at Elkhorn Lake and Hearthstone Lake are managed by the Virginia Department of Wildlife Resources (VDWR). The US Forest Service manages the campground and recreation facilities at Todd Lake.

Current Status: The watershed project was closed out in 2000. Since then, the hazard class at Todd Lake has changed to High. Both of these dams serve as multiple purpose structures for recreation and flood control. The VDWR stocks Elkhorn Lake and Hearthstone Lake. Todd Lake is not stocked because the US Forest Service regularly drains the lake for maintenance of the beach at the campground.

Todd Lake was rehabilitated in 2016 after changes in the downstream watershed required a change in classification from Significant hazard to High hazard. The dam was raised 2.7 feet with earthfill, a new training dike was installed, the riser was replaced, and a new rock toe drain was installed. The auxiliary spillway was widened and realigned. A concrete cutoff wall was installed at the

downstream end of the spillway and the surface was armored with ACBs. The Forest Service road to the campground was relocated to accommodate the new spillway configuration.

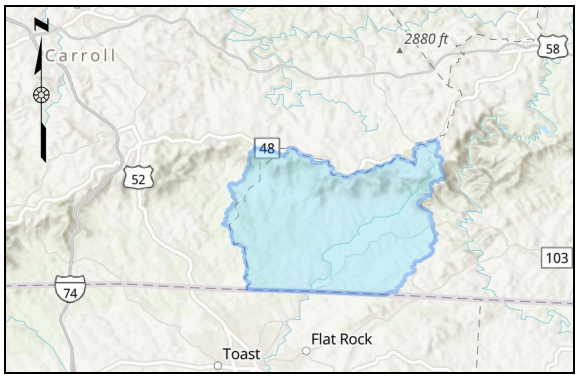
Hearthstone Lake was built as a High hazard dam in 1966. It was rehabilitated in 2020 to bring the dam into compliance with the new evaluation criteria. The footer of the principal spillway riser was upgraded to meet seismic criteria. A new mid-level gate was installed in the riser and the drain gate and metal components of the riser were replaced. The rockfill toe was replaced with toe drains and a seepage collection system with piezometers. The training dike was modified, the diversion dike/ditch was reconstructed to address erosion, a graded filter drain was installed near the right abutment, the access road to the ramp was improved, and stage gauges were installed to monitor pool elevations.

Sources: Watershed Plan and supplements; DamWatch; Construction Completion Report; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Ararat River

Location:	Patrick County Carroll County
Watershed Size:	37,960 acres
Application Date:	November 1989
Plan Date:	August 1991
Operations Date:	March 1993
Status:	Completed
Completion Date:	January 2007



Sponsors: Patrick Soil and Water Conservation District*
Patrick County Board of Supervisors*

Background: Due to the steeply sloping uplands, the farmable land in this watershed was primarily located in the floodplain. Frequent overbank flooding of the crop fields resulted in the complete loss of high value crops, such as tobacco, cabbage, staked tomatoes, and peppers. Land scour and sediment deposition contributed to the problem.

Project Purpose: Flood control and land treatment. The purpose of the flood control project was to protect high value agricultural crops, loss of cropland to floodplain scour, and damage to roads and bridges. The watershed plan called for the installation of 57 small floodwater retarding structures with both wet and dry sediment pools.

Progress: Seven single purpose flood control dams (sites 2, 17, 28, 32, 63, 64 and 69) were constructed from 1995 to 2001. Six of the seven had a hazard class of Low. Dam No. 28 has a hazard class of Significant. Best management practices were applied throughout the watershed and especially above the small floodwater retarding structures. The construction costs of the dams were much higher than was originally planned.

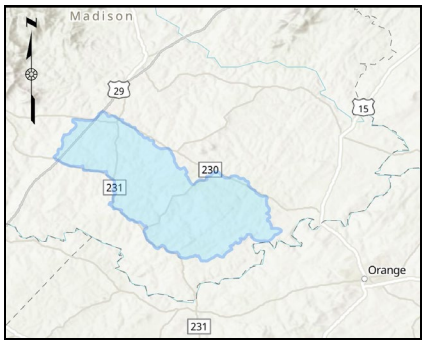
Current Status: This project was closed in 2007. NRCS did not receive adequate funding for the project in the years before the closeout and the local sponsors did not have the resources to contribute their share of the increased construction cost. Fifty sites were removed from the project. Patrick County and the Patrick SWCD are jointly responsible for maintenance of the dams.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Beautiful Run

Location:	Madison County
Watershed Size:	13,800 acres
Application Date:	April 1955
Plan Date:	July 1955
Operations Date:	September 1962
Status:	Completed
Completion Date:	September 1977



Sponsor: Culpeper Soil and Water Conservation District*

Background: From 1923 to 1947, 42 damaging floods were recorded in the Beautiful Run watershed. Six of these floods were very large, inundating about 90% of the bottomland acreage. Cropland damages included scour erosion and sediment deposition. Loss of the crops, fences, and access to the land also occurred. Since 1941, soil conservation practices, such as conversion from cropland to permanent grass, have reduced the erosion damage. Over 50 percent of the approximately 100 farms in the watershed had conservation plans as of 1962. Flooding caused frequent inundation of the roads and bridges.

Project Purpose: Flood control and land treatment. The land treatment goal for the watershed was to have conservation plans on 100 percent of the farms in the watershed. Cover crops, contour stripcropping, subsurface and surface drainage systems, hayland and pasture plantings and renovations, and critical area plantings were planned components of the conservation systems. Tree planting and control of erosion of logging roads was included. Nine floodwater retarding dams and 4.78 mile of stream channel improvement were planned.

Progress: Eight single purpose dams were constructed from 1964 to 1977 as Low hazard structures. One dam was removed from the project in 1969. The channel improvements were removed from the project in 1976. By 1977, nearly 21,000 acres of cropland, pasture, and woodland were treated with conservation practices.

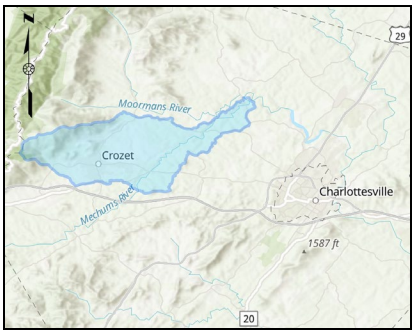
Current Status: The project was completed in 1977. The hazard class of one dam has been upgraded to High and the hazard class on two dams has been upgraded to Significant.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Beaver Creek

Location:	Albemarle County
Watershed Size:	7,010 acres
Application Date:	September 1958
Plan Date:	June 1959
Operations Date:	August 1960
Status:	Completed
Completion Date:	June 1965



Sponsors: Thomas Jefferson Soil and Water Conservation District
Albemarle County Board of Supervisors*

Background: There were 126 acres of highly productive bottomland in the watershed that flooded an average of twice per year. The steep slopes in the upper part of the watershed contributed large amounts of sediment from sheet and gully erosion. Ninety acres of the floodplain land had erosion and sediment damage. In addition, the existing water supply in the county was inadequate for the needs during drought and could not support the anticipated residential or industrial growth in the region.

Project Purpose: Flood control, water supply, and land treatment. The plan provided for an acceleration of the land treatment program for watershed protection and one multiple purpose structure of flood reduction and municipal water supply.

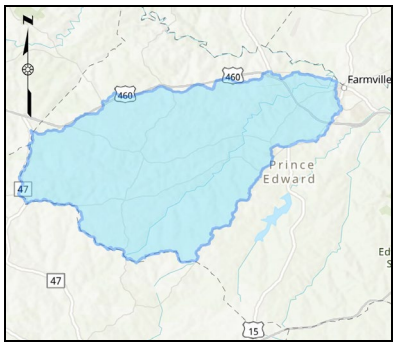
Progress: The dam was constructed in 1964 as a Significant hazard class structure and the planned land treatment was implemented. The hazard class has since been upgraded to High. The Virginia Department of Wildlife Resources has stocked the lake as a warmwater fishery.

Current Status: The Watershed Project was closed in June 1965. In 2020, the Sponsors initiated planning for rehabilitation of the structure to meet current NRCS and State dam safety criteria for a High hazard class structure.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Buffalo Creek



Location:	Prince Edward County
Watershed Size:	74,700 acres
Application Date:	August 1955
Plan Date:	April 1958
Operations Date:	April 1960
Status:	Completed
Completion Date:	June 1971

Sponsor: Piedmont Soil and Water Conservation District*

Background: The land in this watershed has been in production since the 1800's. The bottomland was used for tobacco, corn, small grain, and hay. Frequent flooding led to abandonment of the fields and a return to woods and pasture. When the bottomlands were abandoned, the uplands were cleared, and the subsequent erosion filled the drainage ditches and stream channels. In 1958, there were 52,290 acres of woodland; 13,070 acres in crop rotations; 4,105 acres of grassland; 4,485 acres of idle land; and 750 acres in miscellaneous, including roads, homesteads, towns, and streams. Conservation farm plans had been prepared for over 50 percent of the farms in the watershed.

Project Purpose: Watershed protection and flood control. The plan called for 39.34 miles of roadside erosion control, land treatment measures for flood prevention, nine floodwater retarding structures, and 25.48 miles of channel improvement.

Progress: Land treatment occurred on 3,822 acres of cropland, 6,759 acres of pastureland, and 784 acres of other land. Treatment also included tree planting (252 acres) and critical area planting (398 acres). There were 25.68 miles of stream channel improvement. From 1962 to 1967, eight single purpose floodwater retarding structures were built as Low hazard structures and one was constructed as a Significant hazard structure.

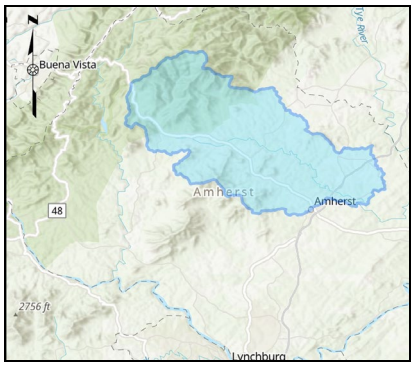
Current Status: The project was closed in June 1971. At the present time, the hazard class of one structure has been upgraded to High and the hazard class of eight structures has been changed to Significant.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Buffalo River

Location:	Amherst County
Watershed Size:	60,500 acres
Application Date:	October 1965
Plan Date:	December 1967
Operations Date:	October 1974
Status:	Completed
Completion Date:	May 1996



Sponsors: Robert E. Lee Soil and Water Conservation District
Amherst County Board of Supervisors*

Background: In 1974, most of the watershed land was in farm ownership. About 600 of the 793 acres of floodplain lands were used for crops and pasture. Due to the flood hazard, large areas were used for pasture with limited management practices. Other problems in this watershed included damage to highways and transportation systems, water systems, and other public utilities, erosion of upland, and sedimentation of the bottomlands and downstream channel areas. Economic growth and development of the area was being retarded due to lack of an adequate supply of municipal water.

Project Purpose: Flood control, water supply, recreation, and land treatment. Reduce flooding of farmland, highways, and other improvements; add water supply and recreation. Two floodwater retarding structures and two multiple purpose structures for floodwater and municipal and industrial water supply were planned to control the runoff from about 46.5% of the watershed. An accelerated land treatment program would reduce sedimentation.

Progress: The two single purpose structures (Dam No. 2 – Thrasher Lake and Dam No. 3 – Stonehouse Lake) were actually constructed as multipurpose structures. Dam No. 4A (Mill Creek Lake) was planned and installed as a multi-purpose structure. Dam Nos. 2 and 4A were constructed with a hazard class of Significant. Dam No. 3 was built as a High hazard structure. These three structures provide 152 surface acres of water which are used for recreation; 4,282 acre-feet of floodwater retarding capacity and 2,049 acre-feet of water supply storage. Amherst County installed recreational facilities at each dam, including parking, boat ramps, picnicking areas, and restrooms. The VDWR stocks all three lakes. In 1995, the number of visitor days for the three sites was estimated to be 27,375 per year. All planned land treatment is considered to be complete.

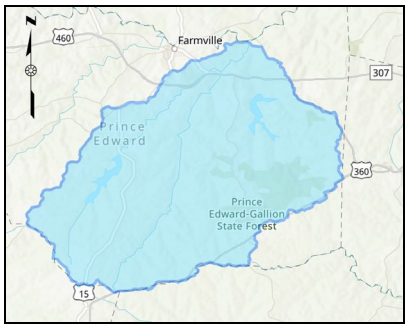
Current Status: The project was closed in 1996. At that time, the fourth multi-purpose structure was removed from the project because there were concerns about the impacts to threatened and endangered species, trout water, wetlands, cultural resources, and a State highway. The current hazard class of Dam Nos. 2 and 3 is High and the hazard class of Dam No. 4A is Significant.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Bush River

Location:	Prince Edward County
Watershed Size:	98,722 acres
Application Date:	June 1967
Plan Date:	July 1970
Operations Date:	October 1978
Status:	Completed
Completion Date:	April 2006



Sponsors: Piedmont Soil and Water Conservation District* (Dam Nos. 2, 4B, 5, 6, and 7 in conjunction with Prince Edward County)
Prince Edward County Board of Supervisors* (Dam No. 12; Dam Nos. 2, 4B, 5, 6, and 7 in conjunction with Piedmont SWCD)
Virginia Department of Wildlife Resources (VDWR) (formerly Department of Game and Inland Fisheries)* (Dam No. 1E)

Background: The use and management of large areas of the flood plain lands of Bush River were severely limited because of the flood hazard. When not subject to flooding, these lands produced high yields of corn, hay, and small grains.

Project Purpose: Flood prevention and watershed protection for erosion and sediment control. Two multipurpose structures and six single purpose floodwater retarding structures were planned. Opportunities for urban development were expected to increase with the establishment of an adequate public water supply and distribution system. Recreation at the two multipurpose structures was expected to draw 159,100 visits annually. Land treatment was proposed for 2,811 acres of cropland, 3,714 acres of pastureland, 12,450 acres of forestland, and 835 acres of land in other uses.

Progress: Five single purpose floodwater retarding structures were installed as Significant hazard structures. One multipurpose structure (Dam No. 12 – Sandy River Reservoir) was constructed for flood control, water supply, and recreation. The VDWR stocks this reservoir and there is public access for boating and fishing. The second multipurpose structure (Dam No. 1E – Briery Lake) was installed for flood control, recreation, and fish and wildlife. Briery Lake is owned and managed by the VDWR within the Briery Creek Wildlife Management Area. Both of the multipurpose structures were constructed with a hazard class of High. Land treatment measures were installed on approximately 2,800 acres of cropland, 3,700 acres of grassland, 12,500 acres of forestland, and 175 acres of upland wildlife habitat development.

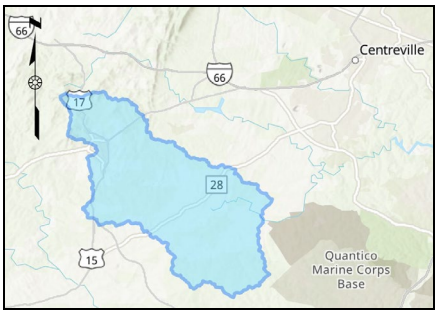
Current Status: The project was closed in 2006. Site 3 was deleted from the planned works of improvement. The hazard class of Dam Nos. 2, 7, and 4B has been upgraded to High. The hazard class of Dam No. 6 has been upgraded to Significant and the hazard class of Dam No. 5 has been changed to Low.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Cedar Run

Location:	Fauquier County
Watershed Size:	65,517 acres
Application Date:	January 1968
Plan Date:	October 1970
Operations Date:	October 1978
Status:	Active



Sponsors: John Marshall Soil and Water Conservation District* (Dam No. 4, jointly)
Fauquier County Board of Supervisors* (Dam No. 4, jointly)
Town of Warrenton* (Dam No. 3)

Background: The plan was developed because Fauquier County experienced frequent flood and sediment damages to agricultural lands, roads, bridges, and residences. The potential for urban growth and planned development in the area outside of the flood plain was restricted by the lack of an adequate municipal water supply system.

Project Purpose: Flood prevention and watershed protection. Planned work included an accelerated land treatment program and installation of three multipurpose (floodwater retarding and water supply) and four single purpose floodwater retarding structures.

Progress: Multipurpose Dam Nos. 4 and 3 were constructed in 1985 and 1992, respectively, as High hazard class structures. Dam No. 4 (Germantown Lake) was constructed for the purposes of flood control, water supply and recreation. This reservoir is the focal point of the 100-acre C.M. Crockett Park. Dam No. 3 (Airlie) was built for flood control and water supply.

The flood control portion of Dam No. 7 was incorporated into multipurpose Dam No. 6. The water supply storage in Dam No. 6 was increased from 1,000 acre-feet to 1,845 acre-feet. An environmental assessment was completed in 1994 which addressed the changes associated with this site. A design for the dam has been completed. The sponsors have deleted Sites 1, 2, 5, and 7 from the watershed plan. Soil conservation practices have been applied in excess of those identified in Table 1 of the Watershed Plan.

Current Status: Due to local opposition on Site 6, the project sponsors are not moving forward with this project at this time. If no activity is forthcoming, the structural measures that are planned for this project need to be deleted from the watershed plan and the project closed out.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Cherrystone Creek

Location:	Pittsylvania County
Watershed Size:	29,400 acres
Application Date:	December 1961
Plan Date:	August 1964
Operations Date:	July 1965
Status:	Completed
Completion Date:	June 1976

Sponsors: Town of Chatham*
Pittsylvania County Board of Supervisors
Pittsylvania Soil and Water Conservation District

Background: The Cherrystone Creek watershed had a history of frequent, damaging floods. This frequent flooding damaged business properties, crops and pastures, fences, farm roads and bridges, public highways, railroads, and other improvements in the flood plain. A portion of the Town of Chatham is also located in the flood plain. The use, management, and development of some of the most productive and valuable land was severely limited by these floods. There was also erosion of the uplands and scouring, deposition, and swamping in the bottomlands. The water supply for the Town of Chatham was inadequate for the planned expansion.

Project Purpose: Land treatment, water supply, and flood control. Approximately 25 percent of the farms in the watershed had conservation plans when the Watershed Plan was written. Planned practices included contour stripcropping, grassed waterways, diversions, row arrangement, and the use of cover and green manure crops. A multipurpose structure (flood water control and municipal water supply) and two single purpose floodwater retarding structures were planned. A short dike and 5.55 miles of stream channel improvement were also planned.

Progress: Dam No. 1, Cherrystone Lake, was constructed in 1965 for flood control and water supply. Dam No. 2A, Roaring Fork Lake, was constructed in 1969 as a single purpose structure but was modified to add water supply as a purpose in 2019. The remaining single purpose dam, the dike, and the channel improvements were removed from the project in 1976 because the major project objectives were met by the first two dams and because the estimated implementation costs were much greater than the estimate in the original plan. Land treatment included 4,130 acres of cropland, 4,101 acres of pastureland, and 5,160 acres of forest land.

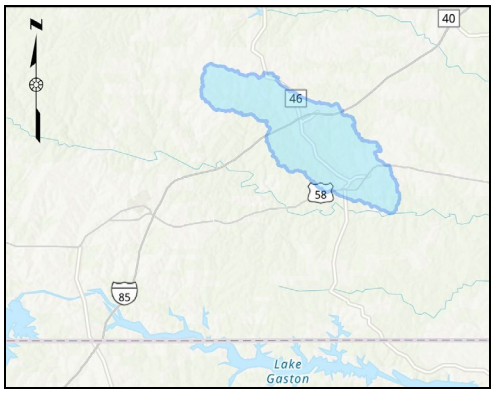
Current Status: The original project was closed in 1976. Due to development in the watershed downstream of the dams, the hazard class of both dams changed to High in 2008. The rehabilitation plans for both dams were completed in 2019. At that time, NRCS had insufficient staffing to request funding for design and construction.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Great Creek

Location:	Brunswick County Lunenburg County
Watershed Size:	29,754 acres
Application Date:	February 1955
Plan Date:	May 1971
Operations Date:	October 1978
Status:	Completed
Completion Date:	November 1994



Sponsors: Southside Soil and Water Conservation District
Brunswick County Board of Supervisors*
Town of Lawrenceville

Background: Due to the flood hazard, the use and management of large areas of the flood plain land for agricultural production were severely limited. Other problems caused by flooding included damage to urban areas of Lawrenceville, highways, public utilities, and farm improvements; erosion of the uplands; and sedimentation in the bottom lands. Economic growth and personal income in the area was restricted by an inadequate municipal water supply system.

Project Purpose: Flood control, water supply, recreation, and land treatment. Planned land treatment included 800 acres of cropland, 625 acres of pastureland, 33 acres of other open land, 6,980 acres of forestland, and 15 acres of wildlife habitat management. A multipurpose dam would be built for flood control, water supply, and recreation. Brunswick County planned to provide sanitary facilities, access roads, and parking for recreational purposes at the structure site.

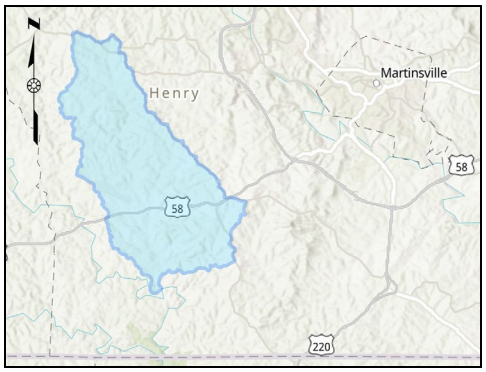
Progress: The multipurpose dam was constructed in 1989 and has 950 ac-ft of municipal and industrial water supply. The dam had a hazard class of High. The VDWR stocks the lake as a warmwater fishery. and has constructed a boat ramp and boarding pier. Brunswick County created a park around the reservoir with shelters, walking trails, and a playground. Land treatment measures were installed as planned.

Current Status: The project was closed in November 1994.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Horse Pasture Creek



Location:	Henry County
Watershed Size:	17,380 acres
Application Date:	January 1960
Plan Date:	September 1961
Plan Signed:	September 1963
Status:	Completed
Completion Date:	May 1980

Sponsors: Blue Ridge Soil and Water Conservation District*
Henry County Board of Supervisors

Background: The agricultural watershed had a history of frequent damaging floods. Portions of the flood plain were inundated two to four times each year. Frequent flooding damaged crops and pastures, fences, roads, and bridges. There was also a problem with erosion of the uplands and scouring and deposition on the bottomlands.

Project Purpose: Flood control and land treatment. Planned improvements included four floodwater retarding structures, 6.6 miles of channel improvement, and accelerated land treatment on cropland, pastureland, and woodland.

Progress: Two floodwater retarding structures were constructed in 1972 (Site No. 2 - Seale) and 1973 (Site 1C - Stanley). The other two dams and the channel work were removed due to difficulties with land rights. Approximately 1,850 acres of cropland, 2,100 acres of pastureland, 1,800 acres of forestland, 90 acres of critical area treatment, and 50 acres of other land were treated.

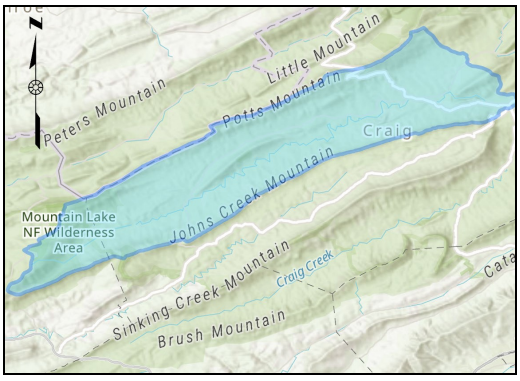
Current Status: The project was closed in May 1980. The sponsors have submitted applications for rehabilitation of both dams due the change from a hazard class of Low to High. Federal funding for NRCS planning assistance has not yet been approved for these dams.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Johns Creek

Location:	Craig County Giles County
Watershed Size:	65,000 acres
Application Date:	June 1960
Plan Date:	March 1961
Operations Date:	July 1963
Status:	Completed
Completion Date:	June 1976



Sponsors: Mountain Castles Soil and Water Conservation District* (after 1987)
Natural Bridge Soil and Water Conservation District (before 1987)
Craig County Board of Supervisors*

Background: The watershed is in the middle section of the Ridge and Valley Province of western Virginia and is characterized by mountain ridges and wide valleys. In 1963, 55,410 acres of the 65,000 acres in the watershed were wooded. Frequent flooding, two or three times per year, damaged crops, pasture, fences, and other fixed improvements. The majority of the roads were in or near the flood plain, resulting in substantial damage to roads and bridges, both public and private. Erosion on the uplands and scour and deposition on the bottomlands was a problem.

Project Purpose: Flood control and land treatment. Approximately 60 percent of the farms in the watershed had conservation plans when the watershed plan was written. The goal was to complete conservation plans on 100 percent of the farms. Four floodwater retarding structures and 17.8 miles of stream channel improvement were planned in the headwaters of Johns Creek.

Progress: Four flood control dams were built in 1966 and 1967. The 17.8 miles of channel improvement were deleted from the project because the estimated cost of the work greatly exceeded the cost estimated in planning. Land treatment measures were applied on 838 acres of cropland, 671 acres of pasture, 59,680 acres of forest, 25 acres of other land, and 71 acres of critical area planting.

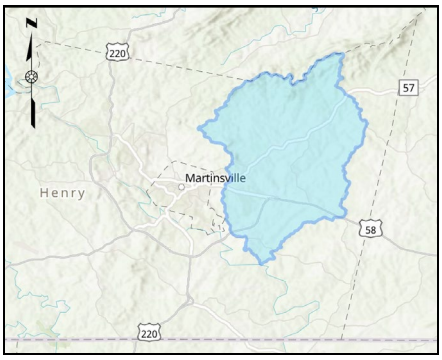
Current Status: All four of the Johns Creek dams have changed hazard class from Significant to High hazard due to development in the watershed. Applications for rehabilitation assistance have been submitted for all four dams. A rehabilitation plan for the dam at Johns Creek No. 1, McDaniel's Lake, was completed in 2019. The sponsors have not requested assistance with design and construction. Federal funding for NRCS planning assistance has not yet been approved for the remaining three dams. Craig County and the Mountain Castles SWCD are jointly responsible for operation and maintenance of the dams.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Leatherwood Creek

Location:	Henry County Franklin County
Watershed Size:	43,800 acres
Application Date:	September 1958
Plan Date:	January 1959
Operations Date:	July 1961
Status:	Completed
Completion Date:	January 1978



Sponsors: Blue Ridge Soil and Water Conservation District*
Henry County Board of Supervisors*

Background: During the early part of the 20th century, the more gently sloping part of this watershed was farmed by cultivating clean tilled crops year after year with little or no thought for, or knowledge of, conservation farming. As the uplands were cleared of timber and used for the production of small grain and other crops, the frequency of flooding increased. Approximately 80 floods occurred in the 22-year period evaluated in the historical series of storm events. The major problems in the watershed were the erosion of the uplands with resultant sediment damages, and the flood problems on the floodplain.

Project Purpose: Flood control and land treatment. Five floodwater retarding structures and 16.18 miles of channel improvement were planned. Accelerated land treatment included a plan for securing agreements from owners to carry out recommended soil and water conservation practices on not less than 50 percent of lands situated in the drainage area above each retention structure.

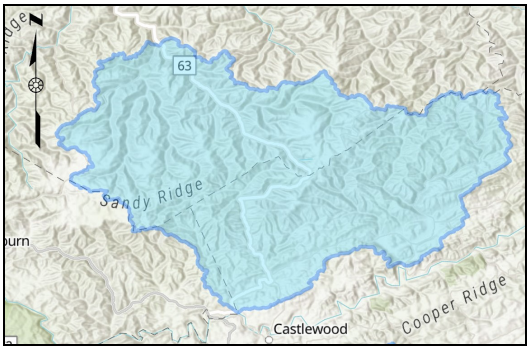
Progress: Five floodwater retarding dams were installed and 10.84 miles of channel improvement. The remaining 5.34 miles of channel improvement were removed due to excessive cost. Land treatment measures were installed on 1,177 acres of cropland, 3,255 acres of pastureland, 10,616 acres of forestland, 337 acres of other land, and 138 acres of critical area planting.

Current Status: The sponsors have submitted rehabilitation applications for all five dams due to hazard class changes from Low to High. Federal funding for NRCS planning assistance has not yet been approved for these dams. Henry County and the Blue Ridge SWCD are jointly responsible for maintenance of the dams.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Lick Creek



Location:	Dickenson County Russell County Wise County
Watershed Size:	5,650 acres
Application Date:	December 1988
Plan Date:	December 1989
Operations Date:	November 1991
Status:	Deauthorized
Deauthorization Date:	December 2018

Sponsors: Russell County Board of Supervisors
Clinch Valley Soil and Water Conservation District

Background: The Lick Creek Watershed was identified as a potential PL-566 flood control project in the Southern Virginia River Basin Study completed in 1994. This study included the Clinch River Basin. Flood damage to homes, businesses, roads, and bridges was frequent. Extensive damage occurred in the floods in 1943 and 1977 to residential properties and transportation routes in and near the Town of Dante, Virginia. As of 1991, 143 commercial and residential properties were affected by the 500-year frequency event and 118 properties were affected by the 100-year frequency event.

Project Purpose: Flood prevention. Two roller compacted concrete floodwater retarding structures, 4,000 feet of clearing and snagging, and 0.5 acres of critical area treatment were planned.

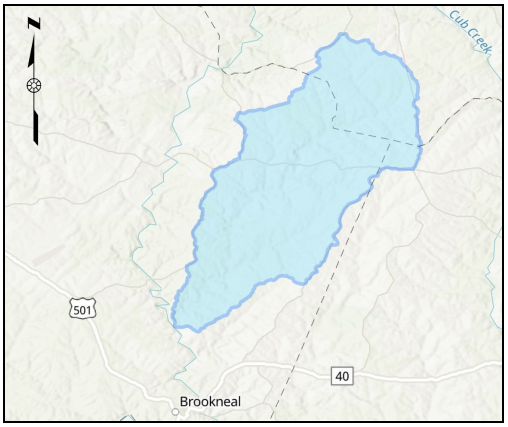
Progress: There has been no construction in this watershed due to land rights issues related to underground mineral rights.

Current Status: Deauthorized.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017); 2004 Water Resources Progress Report

PL-566 Little Falling River

Location:	Appomattox County Campbell County Charlotte County
Watershed Size:	27,700 acres
Application Date:	September 1960
Plan Date:	September 1963
Operations Date:	June 1964
Status:	Completed
Completion Date:	June 1969



Sponsors: Robert E. Lee Soil and Water Conservation District*
Appomattox County Board of Supervisors
Campbell County Board of Supervisors

Background: The agricultural watershed had a history of frequent, damaging floods. Portions of the floodplain were inundated two to three times per year. This frequent flooding damaged crops and pasture, fences, roads and bridges, and other improvements located in the floodplain. Public highways and bridges were frequently blocked and damaged by floodwater, causing lengthy detours and excessive maintenance to these improvements. There was also a problem with erosion of the uplands and scouring and deposition on the bottomlands.

Project Purpose: Flood control and land treatment. Approximately 60 percent of the farms in the watershed had conservation plans. The accelerated land treatment plan included an effort to complete farm plans for all lands in the watershed. Land treatment measures were proposed for 2,185 acres of cropland, 1,005 acres of grassland, 61 acres of miscellaneous land, and 20 acres of roadside erosion control. Three floodwater retarding structures were planned.

Progress: Three Low hazard floodwater retarding structures were constructed in 1966. Land treatment measures were applied on 1,336 acres of cropland, 396 acres of grassland, 167 acres of miscellaneous land, 55 acres of roadside erosion control (critical area planting), and 50 acres of wildlife land. The US Forest Service completed treatment on 4,500 acres.

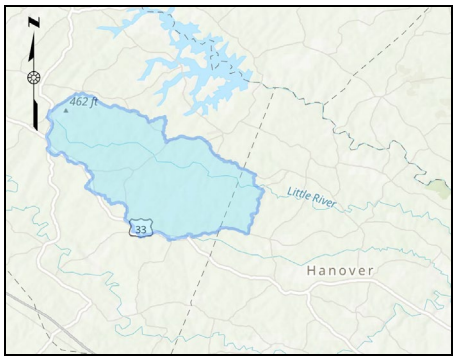
Current Status: The hazard class of all three dams has changed from Low to Significant.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Little River

Location:	Louisa County
Watershed Size:	30,500 acres
Application Date:	September 1958
Plan Date:	October 1959
Operations Date:	December 1961
Status:	Completed
Completion Date:	October 1990



Sponsors: Thomas Jefferson Soil and Water Conservation District*
Louisa County Board of Supervisors*

Background: The majority of the problems in the watershed were caused by improper use and management of the uplands, resulting in downstream flood and sediment problems. Increased economic and population pressure caused the clearing and intensive cropping of more and more of the uplands. Sediment resulting from erosion hastened the clogging of the streams, and increased flooding and swamping to the point that the bottomland was abandoned.

Project Purpose: Flood control and land treatment. Four flood control structures and 8.8 miles of channel improvement were planned. Over 50 percent of the farms in the watershed had conservation plans. The plan called for a concerted effort to plan all the farms in the watershed. Treatment was planned for 5,000 acres of cropland, 4,534 acres of grassland, 158 acres of miscellaneous land, and 8,723 acres of forestland.

Progress: One multipurpose dam (flood control and recreation) was installed in 1966. The second multipurpose structure (flood control and recreation) was installed in 1976. Both dams were constructed as Low hazard structures. Only 2.84 miles of channel improvement were completed. Nearly six miles (5.96 miles) of channel improvements were deleted because the project objective could be achieved with the installation of the dams. The last two dams were not built because NRCS determined that major land use changes in the watershed took away potential project benefits. Louisa County did not sign the Closeout supplement, prepared in 1990, because they felt that the need for additional rural flood protection still existed. Land treatment measures were installed on 5,000 acres of cropland, 4,534 acres of grassland, 8,723 acres of forestland, 693 acres of other land, and 10 acres of critical area planting. Louisa County and the Thomas Jefferson SWCD are jointly responsible for maintenance of the dams.

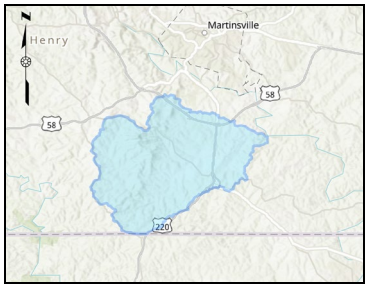
Current Status: The current hazard class of both dams is Significant.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Marrowbone Creek

Location:	Henry County
Watershed Size:	19,300 acres
Operations Date:	January 1960
Status:	Completed
Completion Date:	June 1968



Sponsors: Blue Ridge Soil and Water Conservation District*
Henry County Board of Supervisors

Background: This watershed has been in agricultural production since the early 1800's. Extensive erosion and sediment deposition resulted from the farming practices. Frequent flooding restricted use of the bottomlands for farming. Highways and farm fences were intermittently damaged by floods and some of the bridges were occasionally made impassable. Basic conservation plans have been developed and applied on 30 farms in the watersheds. Each farmer with a conservation plan seems to feel that erosion on his farm has been reduced.

Project Purpose: Flood control and land treatment. One floodwater retarding structure, 4.65 miles of channel improvement, 17.77 miles of roadside erosion control, and an accelerated land treatment program were planned. The original channel improvement work consisted of brushing and snagging and channel realignment immediately below the dam. Supplement 1 added an additional 4.66 miles of stream channel excavation. The proposed channel capacity was increased to provide the level of flood protection promised to the sponsors.

Progress: One Low hazard flood control dam was built in 1961. Land treatment measures were installed on 1,204 acres of cropland, 1,540 acres of grassland, 15 acres of wildlife land, 4,973 acres of woodland, and 117 acres of miscellaneous land. Fifty-one acres were treated for roadside erosion control. There was a total of 5.02 miles of channel improvement.

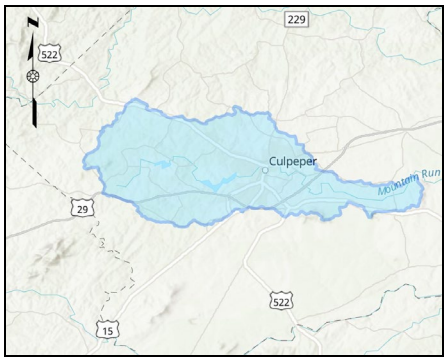
Current Status: In 1988, the dam was reclassified as a High hazard structure due to development in the downstream watershed. The sponsors applied for federal assistance in 2002 and the rehabilitation plan was completed in 2004. The existing vegetated earth auxiliary spillway was replaced with a roller-compacted concrete chute, the top of the dam was raised with a concrete parapet wall, and the riser was replaced. This work was completed in 2005 for a cost of $2,522,376.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017); VA Dam Rehab Summary as of 6/15/2020

*Responsible for O&M.

PL-566 Mountain Run

Location:	Culpeper County
Watershed Size:	28,700 acres
Application Date:	February 1955
Plan Date:	October 1955
Operations Date:	April 1958
Status:	Completed
Completion Date:	September 1979



Sponsors: Town of Culpeper* (Dam Nos. 11 and 50)
Culpeper Soil and Water Conservation District* (Dam Nos. 13, 18, and 8A)

Background: Flooding in the watershed caused significant damage in the Town of Culpeper. Six major floods occurred from 1935 to 1955. The primary damages occurred to facilities crossing the floodplain, such as railroad fills, highways and bridges, water mains, and the sewage disposal plant.

Project Purpose: Flood control and land treatment. The original plan was for an accelerated land treatment program; two floodwater retarding structures; one multipurpose structure for floodwater retarding and municipal water storage; and 6.1 miles of channel improvement. The planned channel improvements consisted of brushing, snagging, and debris removal. Roadside erosion was determined to be the main source of sediment in the watershed. Supplement No. 1, in 1967, added one floodwater retarding structure, one multipurpose structure for floodwater control and municipal water supply, and 3.45 miles of stream channel improvement. This change was needed because the Town of Culpeper experienced unanticipated residential, business, and industrial growth in the years after the original plan was written. The existing water supply was no longer adequate and there was a marked increase in urban floodwater damage potential. Supplement No. 2, in 1972, converted Dam No. 18 from a single purpose structure to multipurpose to add water supply. Land treatment was planned for 2,500 acres of cropland, 8,275 acres of pastureland, 3,075 acres of forestland, and 90 acres of other land.

Progress: When the project was closed in 1979, there were three structures for floodwater retarding and water supply; two floodwater retarding structures, and 4.7 miles of channel improvement. The two single purpose dams were originally classified as Low hazard structures. Dam No. 8A has been upgraded to a Significant hazard class and Dam No. 13 has been upgraded to High hazard. Dam Nos. 50 and 18 were constructed as High hazard structures. Dam No. 11 was originally classified as Low hazard.

Current Status: In 2012, NRCS received applications for the rehabilitation of Dam No. 11 – Mountain Run Lake and Dam No. 50 – Lake Pelham. Dam No. 11 was reclassified as a High hazard dam and required rehabilitation to meet NRCS and Virginia Dam Safety requirements for the integrity, capacity, and stability of the auxiliary spillway. Dam No. 50 was built as a High hazard structure, but due to changes in the evaluation criteria, the vegetated earth auxiliary spillway did not meet NRCS and Virginia Dam Safety requirements for the integrity, capacity, and stability.

Rehabilitation of Dam No. 11 was completed in 2019 for a cost of $5,694,574. The existing vegetated earth spillway was closed off with an earthen berm and replaced with a 150-foot-wide, 6

cycle concrete labyrinth spillway over the embankment. The riser was stabilized to meet current seismic criteria and the old 30" riser drain gate was replaced with a new 24" discharge gate.

Mountain Run Dam No. 50 was also rehabilitated in 2019. The vegetated earth auxiliary spillway was replaced with a 192-foot-wide, 5 cycle concrete labyrinth weir over the dam. The old auxiliary spillway was closed with an earthen dam across the entrance. The raw water intake building was removed, the drain gate was replaced, and a concrete divider wall was constructed in the riser to allow installation of a secondary 42" drain gate.

Sources: Original watershed plan and supplements; Supplemental rehabilitation plans; DamWatch; Construction Completion Reports; and the VA Dam Rehab Project Summary (as of (6/15/2020); Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Muddy Creek

Location:	Buckingham County
Watershed Size:	7,450 acres
Application Date:	June 1959
Plan Date:	January 1960
Operations Date:	October 1960
Status:	Completed
Completion Date:	October 1969

Sponsors: Robert E. Lee Soil and Water Conservation District (before 1973)
Peter Francisco Soil and Water Conservation District* (after 1973)
Buckingham County Board of Supervisors

Background: The problems in Muddy Creek were caused by improper use and management of the uplands, resulting in downstream flood and sediment problems. Sediment resulting from erosion hastened the clogging of the streams and increased flooding and swamping to the point that the bottomland was abandoned. Flood waters damaged farm roads, fences, and similar fixed improvements. When the plan was written, over 50 percent of the farms in the watershed had a conservation plan.

Project Purpose: Flood control and land treatment. The overall land treatment goal was to have all the farms in the watershed in a conservation plan. The flood prevention plan included 13.6 miles of roadside erosion treatment, 5.9 miles of stream channel clearing and snagging, and two floodwater retarding structures. An additional 2.4 miles of stream channel improvement were added with Supplement No. 2.

Progress: Two Low hazard floodwater retarding structures were constructed in 1962. A total of 8.3 miles of channel improvement was installed. Land treatment measures were installed on 150 acres of cropland, 1,015 acres of grassland, 5 acres of wildlife areas, 2,160 acres of forestland, and 35 acres of critical area planting.

Current Status: The hazard class of both dams has been changed to High.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Ni River

Location:	Spotsylvania County
Watershed Size:	33,707 acres
Application Date:	April 1966
Plan Date:	December 1967
Operations Date:	June 1971
Status:	Completed
Completion Date:	September 1976

Sponsors: Tri-County Soil and Water Conservation District
Spotsylvania County Board of Supervisors*

Background: The Ni River had a long history of damaging floods. From 1942 to 1970, the Ni River watershed had only four years which were flood-free. Much of the floodplain was abandoned for farming. In the area benefitted by this project, major fixed improvements included the Spotsylvania Water Authority treatment plant and raw water intake, a sewage treatment lagoon, five bridges and about a mile of highway. Erosion and sedimentation from road banks contributed to the problems in the watershed. Spotsylvania County was rapidly urbanizing due to proximity to Washington, D.C., and the available water supply was insufficient to meet the anticipated needs. Almost 45 percent of the farms in the watershed had implemented some conservation measures.

Project Purpose: Flood control, water supply, and land treatment. The plan called for an acceleration in the enlistment of cooperators, farm planning, and installation of land treatment measures. A multipurpose structure would be built for flood control and municipal water supply.

Progress: The 417-acre Ni River Reservoir was completed in 1974 as a High hazard class structure and is used for flood control, water supply, and recreation. The reservoir is stocked by the VDWR. The Ni River Recreational Area is open from March to October and offers boat rental, a boat launch, and picnic areas. Land treatment was completed on 2,510 acres of cropland, 3,660 acres of pastureland, 3,950 acres of forestland, 138 acres of other land, and 18 acres of critical area treatment.

Current Status: Completed.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Nibbs Creek

Location:	Amelia County
Watershed Size:	16,530 acres
Application Date:	June 1959
Plan Date:	July 1969
Operations Date:	September 1978
Status:	Deauthorized
Completion Date:	April 1986

Sponsors: Piedmont Soil and Water Conservation District
Amelia County Board of Supervisors

Background: This project was planned as a 313-acre multipurpose flood control, water supply and recreation structure. Land treatment on agricultural lands was also included in the plan.

Project Purpose: Flood prevention, water supply, recreation and watershed protection.

Progress: Following a lawsuit by some organized citizens in 1979, a judge ruled in October 1980 that the Environmental Impact Statement was inadequate for the project. Upon further evaluation, NRCS found that the project's benefit/cost ratio was not defensible or supportable. Federal funding on this project has been deauthorized. No implementation can occur in this watershed unless a new plan is developed that meets the National Environmental Policy Act (NEPA).

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

PL-566 Pohick Creek

Location:	Fairfax County
Watershed Size:	22,690 acres
Application Date:	September 1965
Plan Date:	May 1966
Operations Date:	April 1969
Status:	Completed
Completion Date:	January 1994

Sponsors: Northern Virginia Soil and Water Conservation District
Fairfax County Board of Supervisors*

Background: In the 1960's, Fairfax County was rapidly changing from an agricultural watershed to an urban watershed. The removal of natural cover was expected to result in greatly increased flooding and sediment damages in the downstream area. The Pohick Creek floodplains, planned for parks and recreation, would have become useless if the flooding were not managed. In addition, the roads and bridges would be subject to extensive damages. As one phase of the overall development plan, the Sponsors requested assistance under PL-566.

Project Purpose: Flood control, recreation, and land treatment. The plan included land treatment, seven floodwater retarding structures, one multiple purpose structure for flood control and recreation, and 6.28 miles of stream channel improvement. Land treatment measures were planned for 49 acres of cropland, 145 acres of grassland, 11,171 acres of miscellaneous land, and 76 acres of critical area planting. The first Watershed Plan Supplement, dated September 1970, added 6,000 acres of forest land treatment.

Progress: One multipurpose structure and five single purpose structures were constructed from 1970 to 1985. The six dams had a hazard classification of High. Two of the planned single purpose structures were not constructed. No channel work or land treatment measures were undertaken as part of the project. The six reservoirs have become vital resources in the Pohick Creek watershed and are used for recreation daily. In 2006, Dam No. 4, Lake Royal, was estimated to have over 15,000 user days per year. The total construction cost for the six dams was $5,698,313.

Current Status: The project was closed in 1994. In 2003, Fairfax County requested assistance for the rehabilitation of four of the dams. A reevaluation of the auxiliary spillway characteristics for each dam showed that the soils lacked sufficient integrity to meet current NRCS criteria for a vegetated earth auxiliary spillway.

Dam No. 4, Lake Royal, was rehabilitated in 2009 for a cost of $1,610,956. The work included realigning, widening, and adding Articulated Concrete Block (ACB) armor to the auxiliary spillway, and raising the training dikes. This work was complicated by the discovery of the remains of an archaic American Indian village in the floodplain below the dam.

Rehabilitation of Dam No. 3, Woodglen Lake, was completed in 2010 for a cost of $1,136,272. New training dikes were built to accommodate the realignment of the auxiliary spillway. The auxiliary spillway and training dikes were armored with ACBs.

The auxiliary spillway at Dam No. 2, Lake Barton, was rehabilitated in 2011 by the installation of two concrete cutoff walls. The upstream wall was a cast-in-place structure at the control section. The downstream wall was constructed of 79 36" diameter secant piles.at the end of the constructed outlet section. Turf Reinforcement Matting was installed on the ground between the two walls. The training dike was lengthened and raised, and the end of the dam was raised slightly to the design elevation. Fairfax County dredged the lake to remove sediment and lengthen the life of the sediment pool. The total cost of construction was $2,808,715.

The fourth dam, Huntsman Lake (Dam No. 8), was rehabilitated in 2014 for a cost of $2,475,179. The open top principal spillway riser was replaced with a closed top, baffle-type riser, the training dikes were extended and realigned, and the auxiliary spillway was armored with ACBs. The asphalt walking trail and access road were replaced.

Fairfax County assumed the responsibility of upgrading Dam No. 7 – Lake Braddock.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Potomac Creek

Location:	Stafford County
Watershed Size:	32,160 acres
Application Date:	September 1962
Plan Date:	March 1965
Operations Date:	August 1966
Status:	Completed
Completion Date:	September 1977

Sponsors: Tri-County Soil and Water Conservation District
Stafford County Board of Supervisors*

Background: The Potomac Creek watershed had a long history of frequent flooding with severe flooding at 5 to 10 year intervals. Public highways in the floodplains were frequently blocked and damaged by floodwaters causing excessive maintenance and prolonged traffic detours. Many of the floodplains were unusable for farming due to repeated flood events. More erosive, less productive uplands were farmed, which added to the erosion and sedimentation issues. Rural, non-farm uses expanded greatly due to proximity to major metropolitan areas. The lack of an adequate water supply and delivery system restricted growth. Approximately 35 percent of the farms in the watershed had conservation plans.

Project Purpose: Flood control, water supply, and land treatment. The proposed land treatment included a diligent effort to complete conservation plans for all the farms in the watershed and an accelerated program for implementing conservation measures. The plan proposed treatment on 2,528 acres of cropland, 2,628 acres of grassland, 57 acres of miscellaneous land, 3,557 acres of forestland, and 65 acres of critical area planting. One multipurpose structure for flood control and water supply, one single purpose floodwater retarding structure, and 5.81 miles of channel improvement were planned.

Progress: The multipurpose dam, Potomac Creek Dam No. 1, was built in 1970. In addition to water supply, the reservoir is used for recreation. The VDWR stocks the lake with warmwater fish. Boating, hiking, and picnicking are available. The single purpose dam, Potomac Creek Dam No. 2, was completed in 1972. The planned channel work was removed by Supplement 1 of the Watershed Plan. The land treatment was completed as planned. Both dams were built with a classification of High hazard.

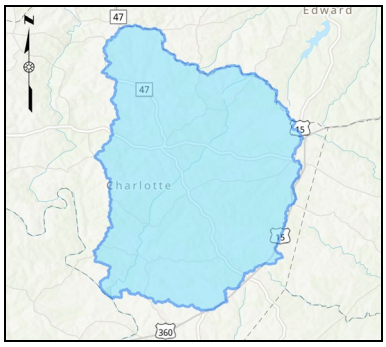
Current Status: The sponsors are in the process of planning modifications to Potomac Creek Dam No. 1 to meet State dam safety criteria. NRCS is requiring the sponsors to either bring the dam into compliance with all NRCS criteria or pursue a release of federal interest for the structure. NRCS is proceeding with a report detailing the completion of federal interest.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Roanoke Creek

Location:	Charlotte County
Watershed Size:	141,900
Application Date:	June 1955
Plan Date:	October 1955
Operations Date:	September 1959
Status:	Completed
Completion Date:	September 1979



Sponsors: Southside Soil and Water Conservation District* (Dam Nos. 4A, 5B, 6A, 31B, 35A, 43A, 49A, 54, 61A, 62, 67, and 68)
Charlotte County Board of Supervisors
Town of Keysville* (Dam No. 70A)
Town of Drakes Branch* (Dam No. 72A)

Background: The principal flood problem in the watershed was the frequent and prolonged inundation of the floodplains adjacent to the larger streams. Floods caused damages to highways, railroads, buildings, bridges, farm roads, and similar fixed improvements. Soil erosion from "clean tilled" land contributed to the sedimentation on the fields and streams. The lack of a consistent source of municipal and industrial water supply limited opportunities for expansion in the towns of Keysville and Drakes Branch.

Project Purpose: Flood control, municipal water supply, irrigation, and land treatment. The plan called for accelerated land treatment; 14 floodwater retarding structures; two multipurpose structures for flood control and municipal water supply; one multiple purpose structure for flood control and irrigation; and 57 miles of channel improvement. Conservation plans would be prepared for 7,500 acres and 500 landowners would have Forest Management Plans.

Progress: Three multipurpose structures and 11 floodwater retarding structure were installed. Three single purpose structures and 11.9 miles of channel work were removed when the project was closed. Channel work was completed on 47.8 miles of stream. Land treatment measures were installed on 23,619 acres of cropland, 8,835 acres of pastureland, 91 acres of critical area planting, 13,800 acres of forestland, and 270 acres of other land.

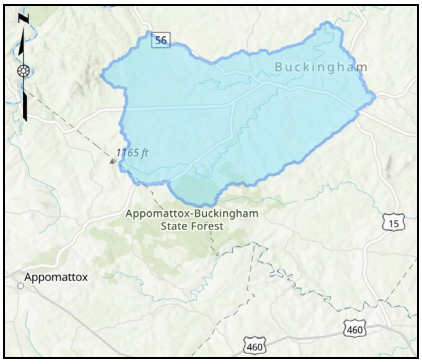
Current Status: The 11 single purpose structures were designed and constructed as Low hazard. The hazard class has been upgraded to High for all of them. The multipurpose structure for floodwater retarding and irrigation was built as a Low hazard structure and there has been no change. The design hazard class for Multipurpose Dam No. 70A, which provides water supply for the Town of Keysville, was Significant and there has been no change. Multipurpose Dam No. 72A, which provides water supply to the Town of Drakes Branch, was originally classified as Significant hazard but now is classified as High hazard.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Slate River

Location:	Buckingham County
Watershed Size:	98,730 acres
Application Date:	September 1962
Plan Date:	November 1965
Operations Date:	April 1969
Status:	Completed
Completion Date:	September 1994



Sponsors: Peter Francisco Soil and Water Conservation District (after 1973)* (Dam Nos. 7, 8, 13, and 14)
Robert E. Lee Soil and Water Conservation District (before 1973)
Buckingham County Board of Supervisors* (Dam No. 2)

Background: The floodplain areas of Slate River had a long history of damaging floods. Flood events in 1935, 1940, 1944, and 1955 resulted in major damages to cropland and the roadways. There were 18 locations where damages occurred to the road system, including one section of U.S. Route 60. There were traffic disruptions and loss of access to emergency services. Erosion on the uplands resulted in sediment deposition in the stream channel and floodplains. The municipal water supply for the town of Dillwyn was provided by a spring and several private wells. There was insufficient water supply to provide fire protection for the area around the town. Economic growth was limited by the lack of adequate municipal water.

Project Purpose: Flood control, municipal water supply, and land treatment. The proposed plan included six floodwater retarding structures, one multiple purpose structure for flood control and municipal water supply, 9.35 miles of stream channel improvement, and an accelerated land treatment program. Land treatment measures were planned for 5,019 acres of cropland, 2,159 acres of grassland, 84 acres of miscellaneous land, 190 acres of critical area planting, 15 acres of wildlife habitat development, and 9,540 acres of forestland.

Progress: One multipurpose structure for flood control and water supply, one multipurpose structure for flood control and recreation, and three single purpose dams were completed. Land treatment was applied as planned. The proposed channel improvements were removed by Supplement No. 2 due to objections raised by fish and wildlife interests and land rights complications. Two of the single purpose structures were deleted from the plan.

Current Status: The two multipurpose dams and one of the single purpose dams had an original hazard class of Significant but now are classified as High hazard. The other floodwater retarding structures were originally classified as Low hazard structures but now have a hazard classification of Significant.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 South Anna River

Location:	Albemarle County Hanover County Louisa County
Watershed Size:	234,000 acres
Application Date:	April 1958
Plan Date:	November 1958
Operations Date:	April 1965
Status:	Completed
Completion Date:	October 1990

Sponsors: Thomas Jefferson Soil and Water Conservation District* (Dam Nos. 3, 4, 5, 6B, 7, and 23)
Hanover-Caroline Soil and Water Conservation District* (Dam No. 52B)
Louisa County Board of Supervisors* (Dam No. 2)

Background: When the Watershed Plan was written in 1965, the South Anna River watershed was primarily agricultural. Frequent flooding damaged the floodplain fields three or more times in most years. Other problems included erosion in the uplands and scouring and deposition in the bottom lands. There were 46 different locations where primary and secondary roads which crossed the main stem and tributaries of the South Anna River were damaged by flooding. In some cases, the roads were closed for hours, and some sections of the watershed were isolated until the water receded. Major flooding was recorded in 1928, 1935, 1937, 1948, 1955, 1956, and 1962. The existing water supplies for the Towns of Louisa and Mineral were of poor quality and insufficient to meet the growing needs of the communities. There was a need for irrigation water to supply crop needs, particularly for vegetable crops. There was also the potential for water-based public recreation due to the proximity of the watershed to the Richmond metropolitan area.

Project Purpose: Flood control, municipal water supply, recreation, irrigation, and land treatment. Twenty-six floodwater retarding structures were planned. Three multipurpose structures were planned for flood control, each with a different secondary purpose: municipal water, recreation, or irrigation. Planning included channel improvements on 108.26 miles of stream. Land treatment measures were proposed for 13,443 acres of cropland, 12,560 acres of grassland, 7,719 acres of miscellaneous land, 33,500 acres of woodland, and 306 acres of critical area planting.

Progress: Two multipurpose dams for flood control, water supply, and recreation were constructed (Dam No. 2 – Bowlers Mill Lake and Dam No. 22 – Northeast Creek Reservoir). Louisa County is responsible for the O&M for Dam No. 2 and the Louisa County Water Authority is responsible for the O&M on Dam No. 22. Both reservoirs are stocked by the VDWR. Recreation was added as a purpose for Dam No. 7 – Lain Lake. Dam No. 39, originally with a secondary purpose of recreation, was never built. The purpose of irrigation was removed from Dam No. 3, Fishers Lake, and the dam was built as a single purpose structure. Five additional single purpose structures were constructed. Nineteen single purpose dams were removed. All channel work was removed. The land treatment measures were installed as planned.

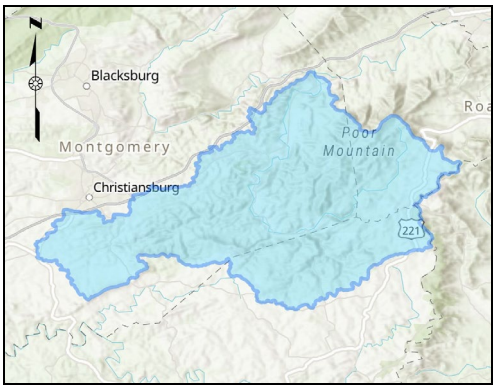
Current Status: The Towns of Louisa, Mineral, and Gordonsville were removed as project sponsors by Supplement No. 4. A rehabilitation request for Bowlers Mill Lake (Dam No. 2) was received in 2016 as a result of a hazard class change from Significant to High. Federal funding for NRCS planning assistance has not yet been approved.

Dam Nos. 3, 6B, 4, and 22 were all constructed with a hazard class of Significant, which has since been upgraded to High. Dam Nos. 7, 52B, and 23 were constructed as Low hazard structures; each has been upgraded to Significant. Dam No. 5 was constructed as a Low hazard structure but now has a classification of High.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 South Fork of Roanoke River



Location:	Floyd County Montgomery County Roanoke County
Watershed Size:	88,480 acres
Application Date:	November 1960
Plan Date:	January 1965
Operations Date:	August 1966
Status:	Deauthorized
Completion Date:	June 1986

Sponsors: Blue Ridge Soil and Water Conservation District
Skyline Soil and Water Conservation District
Floyd County Board of Supervisors
Montgomery County Board of Supervisors

Background: This is a PL-566 project for the protection of agricultural lands, roads, bridges, and residences that are subject to frequent flood and sediment damages.

Project Purpose: Flood prevention and land treatment.

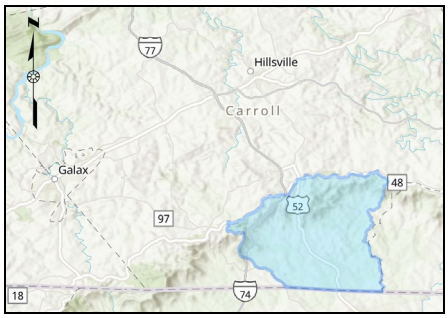
Progress: Four single purpose structures were planned for installation in the original Watershed Plan. At the sponsors' request, a supplement was prepared to include municipal water in two of the structures. No action was taken by the sponsors after this supplement was prepared. No landrights have been acquired and this project has been inactive since 1974. A Federal Register Notice in June 1986 announced the intention to deauthorize any federal funding for this project. No implementation can occur in this watershed unless a new plan is developed that meets the National Environmental Policy Act (NEPA).

Status: Deauthorized.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

PL-566 Stewarts Creek-Lovills Creek

Location:	Carroll County, VA Surry County, NC
Watershed Size:	72,000 acres
Application Date:	April 1962
Operations Date:	September 1965
Status:	Active



Sponsors: New River Soil and Water Conservation District, VA
Carroll County, VA, Board of Supervisors* (Dam No. 9B)
Town of Mount Airy, NC* (Dam No. 9B)
Surry Soil and Water Conservation District, NC
Surry County Watershed Improvement Commission, NC* (Dam No. 1A)
Surry County Board of Commissioners* (Dam No. 9B)

Background: In the 20 years prior to 1965, there were 44 storms that caused flooding in the watershed. One event, in 1947, flooded over 3.7 square miles. Extensive damage to homes, roads, bridges, fences, and buildings occurred annually. As farming activities moved to the uplands to avoid the floods, erosion of the uplands increased, and scouring and deposition occurred in the bottomlands. The Town of Mt. Airy, NC, was getting water from Lovills Creek but the supply was not sufficient to support future growth. There was also interest in water-based recreation.

Project Purpose: Flood prevention, water supply, and watershed protection for soil erosion and sediment control. When the watershed plan was written, there were approximately 750 farms within the watershed. Of these, 242 had conservation plans. The goal was to develop watershed plans on 306 farms and revise the plans on 122 farms. Land treatment measures were proposed for 6,574 acres of cropland, 5,150 acres of grassland, and 1,146 acres of miscellaneous land. Three single purpose structures for flood control and one multipurpose structure (flood control and water supply) were planned. About 118,800 feet of channel improvement, including 58,200 feet of stream channel enlargement and 60,600 feet of clearing and snagging, were planned.

Progress: Multipurpose Dam No. 1A, built for flood water control, water supply, recreation, and fish and wildlife, is located in North Carolina, and was completed in 1972. The watershed plan was supplemented to combine Sites 9 and 10 into one site, Site 9B, in Carroll County, Virginia, for flood control and recreation. Construction was completed in 1990. The dam was built as a High hazard structure. The reservoir is the centerpiece of the Lovills Creek Lake Recreation Area. The 55-acre reservoir is stocked by VDWR, and fishing, boating, picnicking, and hiking are available year round. The operation and maintenance of Dam No. 9B, Lovills Creek Lake, is the joint responsibility of Virginia and North Carolina sponsors because the dam is located in the upstream watershed and could directly affect North Carolina residents. The enlargement of 3.9 miles of channel through Mount Airy, NC has been completed. The remaining 7.1 miles of stream channel enlargement and 11.5 miles of clearing and snagging were removed from the project in 1995.

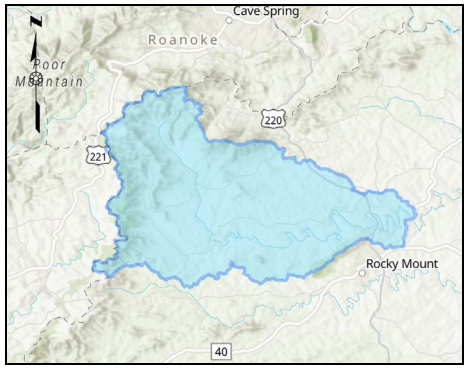
Current Status: NRCS in North Carolina is responsible for administration of this watershed plan. There are no remaining components to be implemented in the Virginia portion of the watershed.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Upper Blackwater River

Location:	Franklin County
Watershed Size:	73,905 acres
Application Date:	May 1961
Plan Date:	October 1965
Operations Date:	May 1970
Status:	Completed
Completion Date:	September 1979



Sponsors: Blue Ridge Soil and Water Conservation District*
Franklin County Board of Supervisors

Background: The Upper Blackwater River Watershed has a long history of frequent flooding. Cropland, farmsteads, fences, and farm roads were damaged during these events. Major events occurred in 1937, 1940, 1949, 1954, and 1962. The public highways, which cross the floodplain, were frequently blocked and damaged by floodwater, resulting in excessive maintenance, traffic detours, and loss of income to residents not able to get to work. Backwater from flooding repeatedly damaged the sewage and drain system for a local school. Erosion from the upland fields resulted in deposition on the bottomland fields.

Project Purpose: Flood control and land treatment. When the plan was written, about 54 percent of the farmers in the watershed had cooperative agreements with the Blue Ridge SWCD. The plan called for an acceleration in the enlistment of cooperators, farm planning, and the installation of land treatment measures. Land treatment measures were planned for over 6,700 acres of cropland, 6,085 acres of grassland, 360 acres of miscellaneous land, 6,210 acres of forest land, 150 acres of critical area planting, and 20 acres of wildlife habitat. Six floodwater retarding structures and 1.67 miles of channel improvement were planned.

Progress: Dam No. 6, Bowman, and Dam No. 4, Dillon, were installed in 1972 and 1974, respectively. The remaining dams and the channel improvement were not completed due to excessive costs in obtaining land rights. Land treatments was installed on 6,760 acres of cropland, 6,085 acres of grassland, 6,210 acres of forestland, and 530 acres of other land.

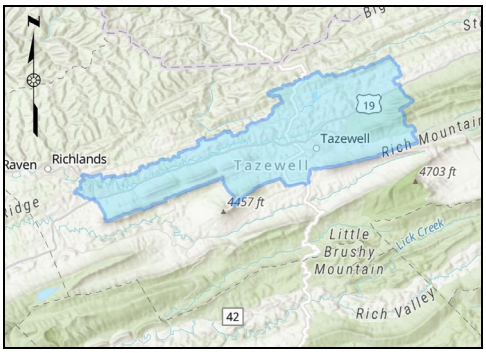
Current Status: These two dams were constructed as Significant hazard structures, which have both since been upgraded to High hazard structures. Applications for rehabilitation of these two dams were received in 2017. Federal funding for NRCS planning assistance has not yet been approved for these dams.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017); VA Dam Rehab Project Summary (as of 6/15/2020)

*Responsible for O&M.

PL-566 Upper Clinch Valley

Location:	Tazewell County
Watershed Size:	36,846 acres
Application Date:	March 1961
Plan Date:	January 1965
Operations Date:	April 1969
Status:	Completed
Completion Date:	September 1995



Sponsors: Tazewell Soil and Water Conservation District
Tazewell County Board of Supervisors* (Dam No. 1B)
Town of Tazewell* (Dam No. 8)

Background: Due to the topography in the Upper Clinch River watershed, most of the fixed improvements are located in the floodplain. In 1965, there were more than 80 home, 21 mobile homes, 28 commercial properties, a church, a bank, and multiple farm buildings in the area susceptible to flooding. Damages also occurred to highways, streets, railroad tracks, and private roads. The flood of record occurred in 1901 with most of the town inundated. Other floods resulting in major losses occurred in 1944, 1955, and 1963. These floods were typically caused by high intensity, short duration storms giving little or no warnings for preparation. Lack of adequate supplies of municipal or industrial water limited opportunities for economic growth. There were also few opportunities for water-based recreation.

Project Purpose: Flood control, water supply, recreation, and land treatment. The planned structural improvements included two floodwater retarding structures, two multipurpose structures for flood control and water supply, and 8.42 miles of stream channel improvement. Accelerated land treatment measures were planned for 1,760 acres of cropland, 2,701 acres of grassland, and 27 acres of critical area planting. Forestland improvements were planned on 2,660 acres.

Progress: The two multipurpose dams were completed in 1973 and 1988 as High hazard structures. Supplement No. 3 closed out the project with the removal of the two floodwater retarding structures (Site Nos. 2 and 9) and all the channel improvement. There was local opposition to construction of Site 2 and Site 9 was displaced by construction on Highway 460.

Current Status: Dam No. 8, Lincolnshire Park, was built for flood control, water supply, recreation, and fish and wildlife. A large park was built around the lake. Dam No. 1B, known as Lake Witten or Cavitts Creek Park, was built for flood control and water supply and is also heavily used for recreation.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Watkins Branch

Location:	Buchanan County
Watershed Size:	2,202 acres
Application Date:	November 1984
Plan Date:	March 1985
Operations Date:	September 1988
Status:	Deauthorized
Completion Date:	August 2019

Sponsors: Big Sandy Soil and Water Conservation District
Buchanan County Board of Supervisors
Town of Grundy

Background: The major problem in this watershed was flood damages to residential and commercial properties and roads. Sediment from eroded streambanks, roads, and road banks was contributing to the problem by reducing the capacity of the stream system.

Project Purpose: Flood prevention.

Progress: One flood control structure was planned.

Current Status: This project was deauthorized in 2019 because the sponsors could not obtain land rights.

Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

PL-566 White Oak Run

Location:	Madison County
Watershed Size:	11,130 acres
Application Received:	September 1960
Plan Date:	January 1961
Operations Date:	September 1962
Status:	Completed
Completion Date:	June 1969

Sponsors: Culpeper Soil and Water Conservation District*
Town of Madison

Background: From 1923 to 1947, 44 damaging floods were recorded in the watershed. Seven events inundated 85 percent or more of the floodplain land. Roads and bridges were often flooded, resulting in traffic problems. Much of the bottomland was converted to low value crops while the higher value crops were farmed on the uplands. The erosion and resulting sedimentation further compound the scour and deposition problems. Local water sources were insufficient to provide fire protection and to provide services for new customers.

Project Purpose: Flood control, water supply, and land treatment. The structural measures consisted of a multipurpose dam for flood control and water supply, and 5.3 miles of channel improvements. Land treatment measures were planned for 4,150 acres of cropland, 3,937 acres of grassland, 12 acres of miscellaneous land, 1,160 acres of woodland, and 25 acres of critical area planting.

Progress: The multipurpose dam was completed in 1965. The dam was built as a Significant hazard structure and there has been no change to that status. The vegetated earth auxiliary spillway was severely damaged in the flood that occurred in June 1995. The auxiliary spillway was replaced by a roller-compacted concrete chute spillway in 1997. The land treatment and 5.30 miles of channel improvement were completed as planned.

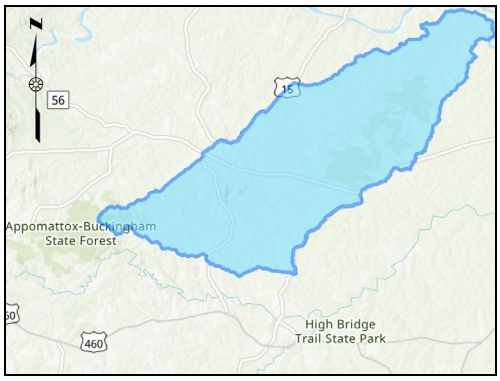
Current Status: The Rapidan Service Authority and the Culpeper SWCD together are responsible for the operation and maintenance of this dam.

Sources: Watershed Plan and supplements; DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

PL-566 Willis River

Location:	Buckingham County Cumberland County
Watershed Size:	176,700 acres
Application Received:	June 1960
Plan Date:	January 1961
Operations Date:	August 1965
Status:	Completed
Completion Date:	June 1976



Sponsors: Robert E. Lee Soil and Water Conservation District (until 1973)
Peter Francisco Soil and Water Conservation District* (after 1973)
Buckingham County Board of Supervisors
Cumberland County Board of Supervisors

Background: When the plan was written, the Willis River watershed was primarily agricultural. Frequent flooding precluded use of the productive bottomlands for crops. Erosion of the uplands and deposition and scour of the bottomlands was common. The flooding also damaged road crossings in 24 different locations, including U.S. Route 60. Inundation of the roads disrupted traffic and, in some cases, isolated sections of the county until the water receded.

Project Purpose: Flood control and land treatment. The planned structural improvements included 11 floodwater retarding structures and 14.91 miles of stream channel improvements. The accelerated land treatment program consisted of treatment of 14,852 acres of cropland, 20,397 acres of grassland, 2,644 acres of miscellaneous land, 10,900 acres of forest land, and 160 acres of critical area planting.

Progress: Installation of the 11 floodwater retarding structures began in 1968 and was completed in 1975. The planned land treatment measures were also completed. The channel improvements were removed from the project in 1972 due to objections raised by fish and wildlife interests and complications encountered in securing land rights.

Current Status: Eight of the dams constructed as Low hazard structures have been upgraded to High hazard structures. Dam No. 7 was constructed as a Low hazard structure and was upgraded to Significant hazard. Dam Nos. 6 and 6A are now High hazard structures after being constructed as Significant hazard.

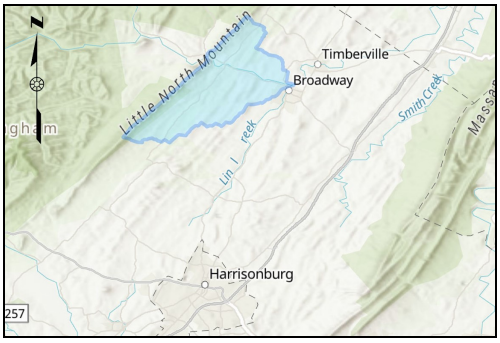
Sources: Watershed Plan and supplements, DamWatch database; Status of Projects report (May 18, 2017)

*Responsible for O&M.

LAND TREATMENT WATERSHEDS

PL-534 Linville Creek

Location: Rockingham County
Watershed Size: 29,487 acres
Operations Date: November 1985
Status: Completed
Completion Date: September 2007



Sponsors: Rockingham County Board of Supervisors
Shenandoah Valley Soil and Water Conservation District

Background: This was a PL-534 watershed protection project to treat erosion and the resulting sedimentation from 2,396 acres of cropland, 5,250 acres of pastureland, and 610 acres of forestland. Forty dairy farms, which produced 44,000 tons of animal waste annually, were identified as needing animal waste management systems.

Project Purpose: Watershed protection for soil erosion and sediment control, and improved water quality.

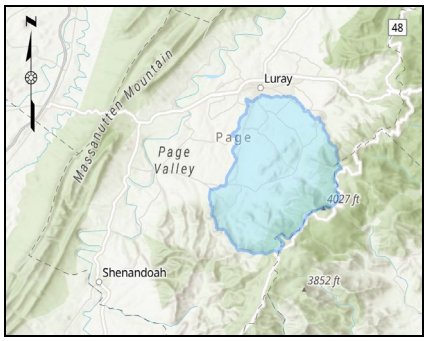
Progress: Forty-three long-term contracts were developed; of these, 35 were fully installed and eight were partially installed and subsequently terminated. Installation funding included $687,000 in Federal funds and an additional $448,830 in local funds. The total project cost, including practice installation, technical assistance, and project administration, was $1,614,380.

Twenty-two animal waste systems were installed, which resulted in the management of 6,000 tons/year of poultry waste, 12,600 tons/year of dairy waste, and 1,350 tons/year of beef manure. Nutrient management plans were written for 2,200 acres. Other practices installed included 123 acres of conservation tillage, 1,053 of pasture and hayland planting, over 101,400 feet of fence, and 38 watering troughs with associated practices.

Current Status: The project was closed in 2007.

Sources: 2004 Water Resources Progress Report; Virginia Water Resources Long Range Plan 2006-2008; Watershed Workplan and supplements.

PL-534 Mill Creek



Location:	Page County
Watershed Size:	8,200 acres
Operations Date:	May 1983
Status:	Completed
Completion Date:	May 1992

Sponsors: Page County Board of Supervisors
Shenandoah Valley Soil and Water Conservation District

Background: The Mill Creek Land Treatment Project was the first of its kind in Virginia. There were 2,870 acres of cropland, 3,280 acres of pastureland, 820 acres of woodland, and 1,230 acres of other uses. In 1982, there were 125 farms in the watershed.

Project Purpose: Soil erosion and water quality. Approximately 1,750 acres of cropland were experiencing excessive sheet and rill erosion, while 1,860 acres of pastureland were experiencing excessive sheet, rill, and gully erosion. Fertilization rates increased as the land productivity decreased. The high erosion rates resulted in the loss of surface soil, organic matter, natural fertility, 16,600 tons of animal wastes, 184,500 pounds of nitrogen, 74,050 pounds of phosphorus, and large quantities of farm chemicals each year.

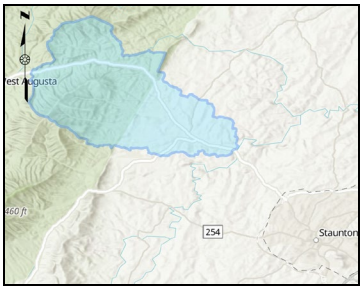
Progress: When the project was closed out in 1992, eleven different practices had been installed in the watershed. Agronomic practices included cover and green manure crops, pasture and hayland planting, and critical area stabilization. Other practices included diversions, grassed waterways, watering facilities, and fencing. Two waste storage structures and two animal waste management systems were installed. Total project cost, including technical assistance and project administration, was $395,169.

Current Status: The project was closed in 1992.

Sources: 1985 Water Resources Progress Report; Watershed Plan and supplements.

PL-534 Moffett Creek

Location:	Augusta County
Watershed Size:	17,434 acres
Operations Date:	January 1985
Status:	Completed
Completion Date:	August 1999



Sponsors: Headwaters Soil and Water Conservation District
Augusta County Board of Supervisors

Background: In 1985, land use in the watershed was 1,252 acres of cropland, 10,435 acres of pastureland, 5,224 acres of woodland, and 523 acres of other land. There were 85 farms in the watershed. Soil loss on pasture resulted in decreased grazing capacity. An estimated 172,683 tons per year of sheet and rill erosion were depleting the soil resource, decreasing productivity, increasing operating costs, and adversely affecting water quality. Approximately 36,547 tons of sediment were delivered to the streams annually.

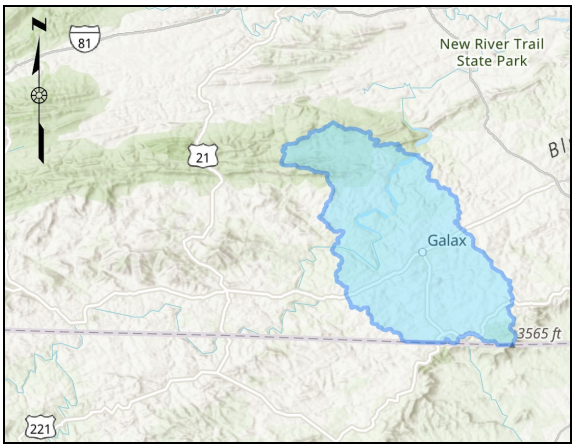
Project Purpose: Soil erosion and water quality. Based on the plan, 5,863 acres of cropland, woodland, and pastureland would be benefitted. Aquatic habitat would improve on 46 stream miles and in 10 ponds, to varying degrees.

Progress: When the project was closed out in 1999, 46 long-term contracts had been completed. Installed practices included 396 acres of conservation tillage, 160 acres of critical area planting, 19 acres of grasses and legumes in rotation, 2,100 acres of pasture and hayland planting, and 2,300 acres of pasture and hayland maintenance. Seventeen acres of grassed waterways and 69 acres of stripcropping were installed, and 145 acres of tree planting. Ten wells and 20,900 feet of pipeline were installed to supply 42 watering troughs. The total project cost, including technical assistance and project administration, was $1,480,460 of which $1,074,575 were federal funds and $405,885 were local funds.

Current Status: The project was closed in 1999.

Sources: 1985 Water Resources Progress Report; 1997 Water Resources Progress Report; Watershed Plan and supplements.

PL-566 Chestnut Creek



Location:	Carroll County, VA Grayson County, VA City of Galax, VA Surry County, NC Allegheny County, NC
Watershed Size:	91,594 acres
Application Received:	September 1993
Plan Date:	July 1996
Operations Date:	November 1996
Status:	Completed
Completion Date:	November 2015

Sponsors: Galax City Council
Fries Town Council
Carroll County Board of Supervisors
Grayson County Board of Supervisors
New River Soil and Water Conservation District

Background: This was a PL-566 watershed protection project that addressed downstream water quality problems that negatively affected recreation, water supply and treatment, power generation opportunities, and fish and wildlife habitat. Agricultural income was experiencing a reduction resulting from excessive soil erosion and the long-term deterioration of soil productivity.

Project Purposes: Improve water quality; improve fish and wildlife habitat; and reduce on-farm damages caused by excessive erosion and sedimentation resulting from poor pasture management and overgrazing. Planned projects included the installation of erosion and sediment control practices and systems on 12,883 acres. The installation of these practices, systems and conservation easements was projected to reduce erosion by 283,412 tons/year, sedimentation by 113,641 tons/year, and nutrient and fecal coliform loading the watershed. The project would improve riparian zone management, restore 28.6 miles of trout streams and improve water quality of 21.5 additional stream miles.

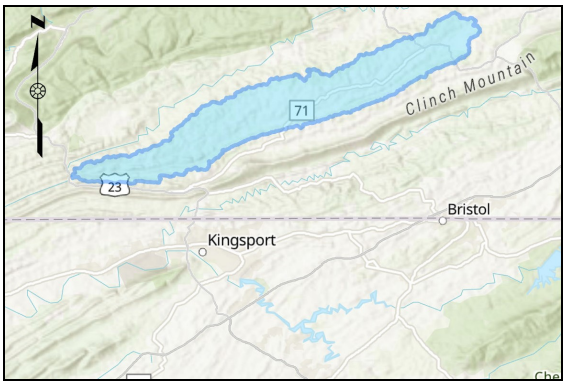
Progress: There were 63 long term contracts developed with landowners which obligated approximately $954,150 in federal money. These contracts were implemented through the installation of conservation practices in the watershed. The majority of the practices were related to improvements in pasture systems, which included installation of 235 watering facilities and 169,406 feet of fence.

Current Status: The project was closed in 2015.

Sources: Watershed Plan and supplements; 2004 Water Resources Progress Report

PL-566 Copper Creek

Location:	Scott County Russell County
Watershed Size:	85,300 acres
Application Received:	February 1983
Plan Date:	July 1983
Operations Date:	May 1985
Status:	Completed
Completion Date:	September 2012



Sponsors: Clinch Valley Soil and Water Conservation District
Scott County Soil and Water Conservation District (formerly Natural Tunnel SWCD)
Scott County Board of Supervisors
Russell County Board of Supervisors

Background: In 1985, land use in the watershed was 19,595 acres of cropland, 26,807 acres of pastureland, 37,118 acres of woodland, and 1,780 acres of other land. There was an estimated 1,127 farms. Soil loss on pasture resulted in decreased grazing capacity of about two animal unit months per acre. An animal unit month (AUM) is the amount of forage, in pounds, that a cow consumes in a month. An estimated 622,134 tons per year of sheet and rill erosion were depleting the soil resource, decreasing productivity, increasing operating costs, and adversely affecting water quality. Approximately 132,830 tons of sediment were delivered to the streams annually.

Project Purposes: Watershed protection for soil erosion and sediment control, and improved water quality. Planned treatment of 3,421 acres of cropland, 15,140 acres of pastureland, and 776 acres of critically eroding road banks, pastureland, and woodland was expected to reduce erosion by 296,158 tons annually. Sedimentation to streams was expected to be reduced by 69,775 tons annually.

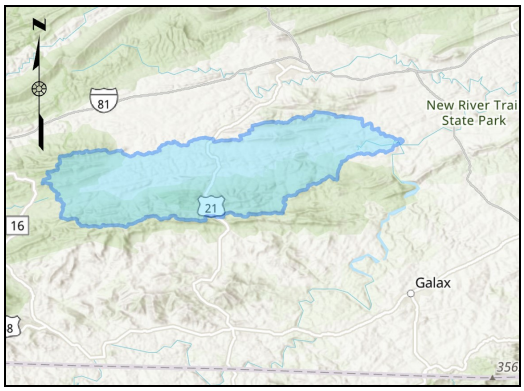
Progress: There were 104 long-term contracts completed with landowners. The majority of the practices were related to improvements in pasture systems, which included installation of 299 watering facilities and 413,125 feet of fence. Landowners applied about 2,500 acres of pasture and hayland planting. Practice installation cost $997,752 in federal funds and $504,434 in local funds for a total cost of $1,502,186.

Current Status: The project was closed in 2012.

Sources: Watershed Plan and supplements; 1985 Water Resources Progress Report.

PL-566 Cripple Creek

Location:	Wythe County Smyth County
Watershed Size:	79,500 acres
Application Received:	January 1985
Plan Date:	March 1985
Operations Date:	April 1987
Status:	Completed
Completion Date:	September 2012



Sponsors: Big Walker Soil and Water Conservation District
Evergreen Soil and Water Conservation District
Wythe County Board of Supervisors
Smyth County Board of Supervisors

Background: This was a PL-566 watershed protection project to address erosion and the resulting sedimentation from 5,210 acres of cropland, 13,252 acres of pastureland, and 150 acres of forestland. Over 1.3 million tons of sheet, rill, gully, and ephemeral gully erosion was occurring annually. Grazing capacity was reduced by about three animal unit months per acre on pastureland. Approximately 460,200 tons of sediment per year were delivered to streams and ponds. Water quality adversely affected the stream habitat of a native brook and stocked trout fishery.

Project Purposes: Watershed protection for soil erosion and sediment control, and improved water quality. The watershed plan called for installation of conservation practices on 18,612 acres of cropland, pastureland, and forest land. Wildlife habitat for rabbits and meadowlarks would be gained as a side effect of practice implementation. Aquatic habitat and water quality were expected to improve to various levels on 361 miles of stream and 124 ponds.

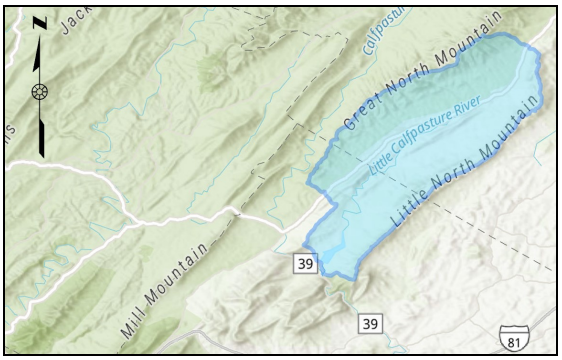
Progress: There were 126 long-term contracts developed with landowners obligating approximately $1,425,351 in federal funds. The predominant practices applied in the watershed were for improvements to the livestock systems. Practices included pasture and hayland planting on 4,646 acres, over 414,000 feet of fence, and 250 watering facilities.

Current Status: The project was closed in 2012.

Sources: Watershed Plan and supplements; 1985 Water Resources Progress Report.

PL-566 Hays Creek

Location:	Augusta County Rockbridge County
Watershed Size:	49,000 acres
Application Received:	December 1985
Plan Date:	April 1986
Operations Date:	June 1988
Status:	Completed
Completion Date:	August 2015



Sponsors: Headwaters Soil and Water Conservation District
Natural Bridge Soil and Water Conservation District
Augusta County Board of Supervisors
Rockbridge County Board of Supervisors

Background: This was a PL-566 watershed protection project to address soil erosion and the resulting sedimentation from 2,290 acres of cropland, 8,180 acres of pastureland, 4,445 acres of forestland, and 96 acres of other land.

Project Purposes: Watershed protection for soil erosion and sediment control, and improved water quality. The watershed plan anticipated completion of 50 long-term contracts. At project completion, soil erosion would be reduced by 289,903 tons/year and sedimentation would be reduced by 72,937 tons/year.

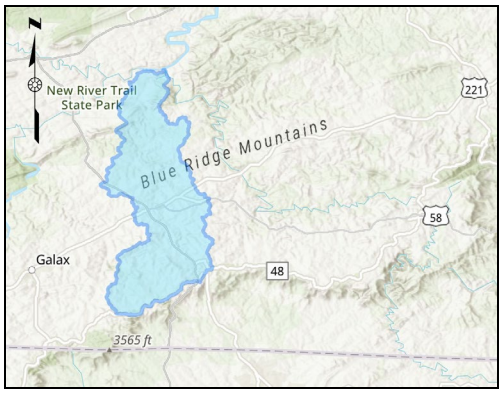
Progress: There were 52 long-term contracts developed with landowners that obligated approximately $1,038,000 in federal funds. Applied practices included 419 acres of crop rotation, 136 acres of stripcropping, and 71 acres of critical area planting. The majority of the practices addressed the needs of animal operations with installation of 108 watering facilities, 1,914 acres of pasture and hayland planting, and 23,292 feet of fence. Trees were planted on nearly 950 acres.

Current Status: The project was closed in 2015.

Sources: Watershed Plan and supplements; 1997 Water Resources Project Report.

PL-566 Little Reed Island Creek

Location:	Carroll, Pulaski and Wythe Counties
Watershed Size:	53,172 acres
Application Received:	November 1999
Plan Date:	October 2001
Operations Date:	January 2002
Status:	Completed
Completion Date:	November 2015



Sponsors: Town of Hillsville
Carroll County Board of Supervisors
New River Soil and Water Conservation District
Big Walker Soil and Water Conservation District
Skyline Soil and Water Conservation District

Background: This watershed protection project addressed downstream water quality problems due to nonpoint sources of pollution caused primarily by agricultural activities. Overgrazing of pastureland was common, and livestock had unlimited access to streams causing fecal coliform bacteria counts in the stream to be high. Approximately 74,273 tons of animal waste generated annually was largely unmanaged. Approximately 257,984 tons of soil erosion annually were depleting the soil resource base, decreasing productivity, and adversely impacting water quality. Sedimentation to lakes and streams was occurring at the rate of 86,044 tons per year. Trout streams were negatively impacted. The increased cost water treatment for public water supply was $3,369 annually.

Project Purposes: Improve water quality; improve fish and wildlife habitat; and reduce on-farm damages caused by excessive erosion and sedimentation resulting from poor pasture management and overgrazing. The plan called for installation of conservation practices on 15,659 acres of pasture, hayland, cropland, woodland, dairy lots, and riparian zones.

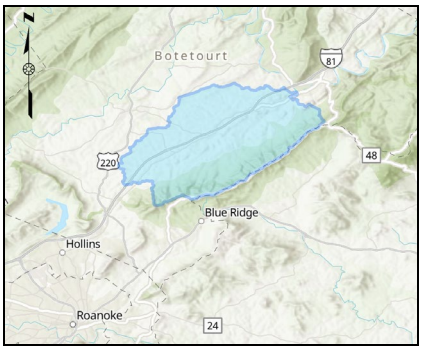
Progress: NRCS staff assisted with the development of ten long-term contracts with landowners have been developed for a total obligation of approximately $200,992 in federal funding. These contracts were implemented through the installation of ten different conservation practices in the watershed. Almost all of the installed practices were to support animal operations. Over 39,000 feet of fence, 133 acres of pasture improvement, and 37 watering facilities were installed.

Current Status: The project was closed in 2015.

Sources: Watershed Plan and supplements; 1997 Water Resources Progress Report

PL-566 Looney-Mill Creek

Location:	Botetourt County
Watershed Size:	19,500 acres
Application Received:	December 1983
Plan Date:	March 1984
Operations Date:	November 1985
Status:	Completed
Completion Date:	April 2000



Sponsors: Natural Bridge Soil and Water Conservation District (before 1987)
Mountain Castles Soil and Water Conservation District (after 1987)
Botetourt County Board of Supervisors

Background: This was a dominantly agricultural watershed with about 85 percent of the 19,500 acres in cropland, pasture, or woodland. There were 210 farms with an average size of 90 acres. Sheet, rill, gully, and ephemeral erosion was estimated to be 235,600 tons/year with 50,800 tons of sediment delivered to streams annually. The loss of grazing capacity was estimated to be four animal unit months per acre on pastureland.

Project Purpose: Reduce erosion and improve water quality. The plan called for installation of conservation practices on 7,070 acres of cropland, woodland, and pasture.

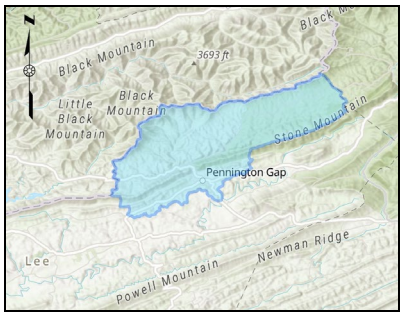
Progress: Thirty-three long-term contracts were completed with landowners. About 60 percent of the planned acres of conservation tillage were installed. Pasture and hayland planting occurred on 1,393 acres, pasture and hay management occurred on 4,625 acres, and planned grazing systems were applied on 1,725 acres. Nearly 104,150 feet of fence was installed. The majority of the other practices were installed to support livestock operations with 13 wells, 59 water troughs, three spring developments, and nine ponds. There were 497 acres of woodland improvement and 114 acres of upland wildlife habitat management.

Current Status: The project was closed in 2000.

Sources: Watershed Plan and supplements; 1997 Water Resources Progress Report.

PL-566 North Fork Powell River

Location:	Lee County
Watershed Size:	57,670 acres
Application Received:	July 2004
Plan Date:	February 2008
Operations Date:	March 2009
Status:	Active



Sponsors: Daniel Boone Soil and Water Conservation District
Virginia Department of Mines, Minerals and Energy (DMME)
Lee County Board of Supervisors

Background: This is a PL-566 watershed protection project that addresses acid mine drainage and erosion control on abandoned mine land. Many of the tributary streams in this watershed have poor water quality. This is due, in part, to the presence of abandoned coal mines that are emitting acid mine drainage and/or experiencing critical levels of soil erosion. Acid mine drainage is low pH water that flows from open mine portals, seeps in highwalls, or through mine spoil piles and contaminates streams. This water also contains dissolved metals that are toxic to fish and insects. Abandoned mine lands that are left bare cause excessive erosion and sedimentation. This sediment also has the same low pH values and metals that are produced by acid mine drainage. Sediment covers up insect habitat, suffocates fish eggs, and damages the gills of the fish.

Project Purpose: This plan calls for the installation of passive acid mine drainage treatment measures and/or erosion and sediment control practices on 39 sites that are located on private lands. The primary purpose is to improve water quality in streams, improve habitat for fish and other aquatic species and reduce erosion and sediment damage.

Progress: Five sites were completed using funds provided through the American Recovery and Reinvestment Act: two projects in the Upper Stone Creek tributary in 2010 and three projects in the Ely Creek tributary in 2011. The local sponsors have fixed a few sites with other funding. The Army Corps of Engineers also fixed some sites. As a result of the combined efforts, one stream has been delisted from the Impaired Streams List.

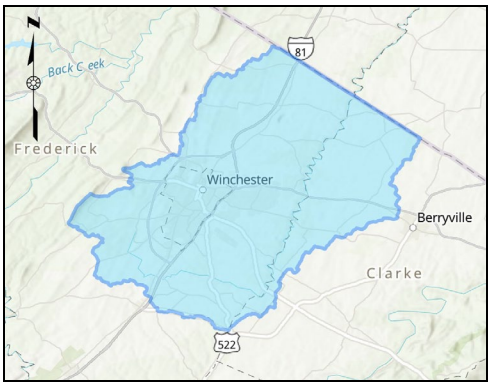
Current Status**:** The current outlook for future work in this watershed is uncertain. Since 2009, there has been no federal funding for implementation of PL-566 watershed protection projects. The local sponsors have continued to make some limited progress to implement some sites through other sources of funding. They are interested in continuing with the restoration work they have started.

Recent efforts by the Sponsors to include the Southwest Virginia drainage as part of the Mississippi River Basin Critical Conservation Area were unsuccessful. NRCS leadership in Washington DC decided not to include Virginia as part of the 12 states eligible for funding out of the entire 32 state watershed. As such, Virginia will not be able to compete for these watershed funds.

Source: 2017 Water Resources Progress Report.

See Appendix G for more information about this project.

PL-566 Opequon Creek



Location:	Clarke County, VA Frederick County, VA Berkeley County, WV Jefferson County, WV
Watershed Size:	215,680 acres (95,280 acres in VA)
Application Received:	February 1984
Operations Date:	October 1986
Status:	Completed
Completion Date:	October 2017

Sponsors: Lord Fairfax Soil and Water Conservation District, VA
Eastern Panhandle Soil and Water Conservation District, WV

Background: This was a PL-566 watershed protection project that addressed nonpoint agricultural pollution that was a major contributor to the degradation of ground water and stream water quality within this watershed. Animal waste pollution entering Opequon Creek was identified as the single largest treatable nonpoint agricultural water quality problem.

Project Purpose: Watershed protection to improve water quality. The project proposed installation of 34 agricultural waste management systems to handle the 102,100 tons of unmanaged animal wastes generated each year. The Eastern Panhandle SWCD (WV) was the lead sponsor.

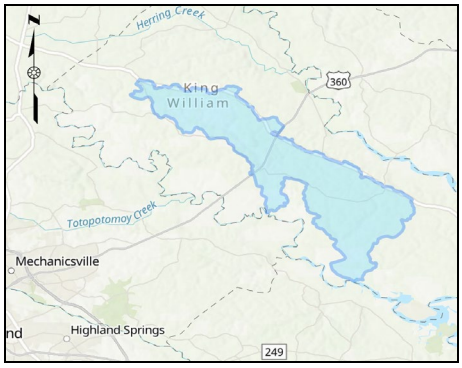
Progress: In Virginia, five long-term contracts with landowners, of the eight planned, were completed for a federal obligation of $159,610. The animal waste structures installed will store approximately 33,296 tons of manure annually. Nutrient management plans were written for 1,183 acres. Seventeen long-term contracts were completed in West Virginia on 19 systems.

Current Status: The project was closed in 2017.

Sources: Watershed Plan and supplements; 2017 Water Resources Progress Report.

PL-566 Pamunkey River

Location:	King William County
Watershed Size:	107,000 acres
Application Received:	December 1985
Plan Date:	April 1986
Operations Date:	December 1988
Status:	Completed
Completion Date:	February 2000



Sponsors: King William County Board of Supervisors
Three Rivers Soil and Water Conservation District

Background: When the project was planned, there were issues with soil erosion and the resulting sedimentation from 8,200 acres of cropland, 2,400 acres of pastureland, and 4,990 acres of forestland. Eight dairies and one feedlot operation needed waste management systems.

Project Purpose: Watershed protection for soil erosion and sediment control, and improved water quality. Measures were planned to treat cropland, pastureland, and forestland. Estimated results of proposed treatment were a reduction in soil erosion of 193,485 tons/year and a reduction in sedimentation of 42,567 tons/year. The plan proposed implementation of fifty long-term contracts.

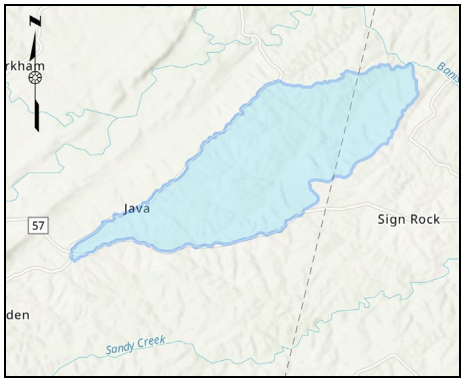
Progress: Technical and financial was provided to service five long-term contracts with landowners and to complete all the conservation practices in the contracts. Practice installation included conservation cropping systems, conservation tillage system, and crop residue management on 732 acres. Other cropland practices included contour farming (101 acres), cover crop (43 acres), and filter strips (20 acres). Practices installed to support livestock operations included three waste storage structures, 1,606 acres of nutrient management, 63 acres of planned grazing system, 8,189 acres of fencing, five watering facilities, 131 acres of pasture and hayland planting, and 260 acres of pasture and hayland management. The federal cost-share amount spent for this work was $157,053.

Current Status: The project was closed in 2000.

Sources: 1997 Water Resources Progress Report; Watershed Plan and Closeout Supplement.

PL-566 Sandy Creek

Location:	Pittsylvania and Halifax Counties
Watershed Size:	63,316 acres
Application Received:	July 1986
Plan Date:	February 1989
Operations Date:	November 1990
Status:	Completed
Completion Date:	August 2015



Sponsors: Halifax Soil and Water Conservation District
Pittsylvania Soil and Water Conservation District
Halifax County Board of Supervisors
Pittsylvania County Board of Supervisors
Town of Halifax

Background: This was a PL-566 watershed protection project to address excessive soil erosion and sedimentation that was depleting the soil resource, decreasing productivity, increasing operating costs, and adversely affecting water quality.

Project Purposes: Watershed protection to reduce on-farm damages and to improve adjacent and downstream water quality caused by erosion and sediment delivery. The plan called for 150 long-term contracts on 9,749 acres. Anticipated improvements included a reduction in the average annual erosion rate from 33 tons/acre to 3 tons/acre. The total estimated erosion reduction from the problem areas was projected to be 319,000 tons/year with a reduction of sediment deposition of 9,000 tons/year.

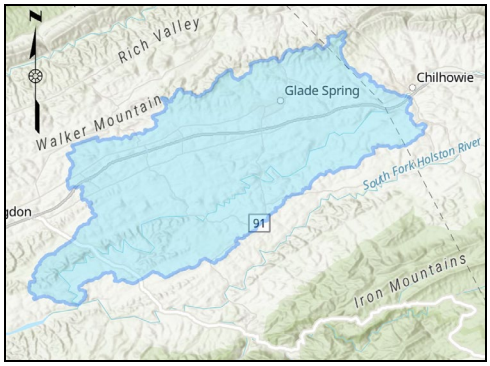
Progress: From 1991 to 2015, 127 long-term contracts were developed with landowners, obligating approximately $1,147,045 of federal dollars. Land treatment practices included 152 acres of field border, 102 acres of grassed waterway, 176 acres of buffer stripcropping, 207,803 linear feet of terrace, 598 acres of critical area planting, and 647 acres of tree/shrub establishment. Animal operations were assisted by the installation of 175,238 feet of fencing, 1,077 acres of pasture and hayland planting, ten spring developments, and eight watering facilities.

Current Status: The project was closed in 2015.

Sources: 2004 Water Resources Progress Report; Watershed Plan and Closeout Supplement.

PL-566 Three Creek

Location:	Washington County
Watershed Size:	26,374 acres
Application Received:	March 1987
Plan Date:	November 1987
Operations Date:	November 1990
Status:	Completed
Completion Date:	September 2015



Sponsors: Holston River Soil and Water Conservation District
Washington County Board of Supervisors

Background: This was a PL-566 watershed protection project that addressed excessive soil erosion and sedimentation that was depleting the soil resource, decreasing productivity, increasing operating costs, and adversely affecting water quality. Slightly over 50 percent of the watershed was in pasture. An estimated 492,000 tons of sheet, rill, gully, and ephemeral gully erosion was occurring annually. Nearly 129,000 tons of sediment were estimated to be delivered to the Middle Fork of the Holsten River per year.

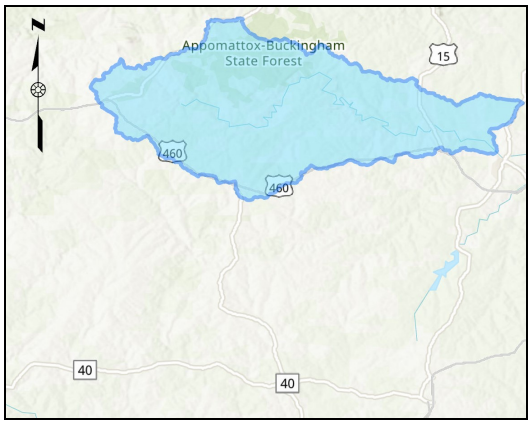
Project Purposes: To reduce on-farm damages caused by erosion and to improve downstream water quality resulting from watershed sediment delivery. Measures to treat cropland, pastureland, forestland and other land with 150 long-term contracts were planned. Soil erosion was projected be reduced by 84,222 tons/year. The average annual project benefits were estimated to be $131,722.

Progress: During the life of the project, 54 long-term contracts were developed with landowners in this watershed which obligated approximately $769,745 in federal funds. These contracts were implemented through the installation of conservation practices which primarily benefitted livestock operations. There were 276 watering facilities and supporting practices, 342,890 feet of fencing, 695 acres of pasture and hayland planting, and 13 acres of livestock exclusion.

Current Status: The project was closed in 2015.

Sources: Virginia Water Resources Long Range Plan 2006-2008; Watershed Plan and Project Completion Report

PL-566 Upper Appomattox River



Location:	Appomattox County Buckingham County Cumberland County Prince Edward County
Watershed Size:	200,826 acres
Application Received:	July 1972
Plan Date:	September 1977
Operations Date:	August 1984
Status:	Completed
Completion Date:	August 1999

Sponsors: Peter Francisco Soil and Water Conservation District
Robert E. Lee Soil and Water Conservation District
Appomattox County Board of Supervisors
Buckingham County Board of Supervisors
Cumberland County Board of Supervisors
Prince Edward County Board of Supervisors
Town of Appomattox
Town of Farmville

Background: Soil erosion was occurring on 8,998 acres of cropland, 5,666 acres of pastureland, 1,489 acres of forestland, and 932 acres of other land, producing sedimentation. An estimated 390,950 tons/year of sheet and rill erosion and 39,100 tons/year of sediment deposition contributed to resource degradation in the watershed. About 29,000 tons/year of animal waste required management.

Project Purpose: Watershed protection for soil erosion and sediment control, and improved water quality. Land treatment measures were proposed for 10,578 acres.

Progress: As of 1997, there were 102 long-term contracts written, obligating $333,646 to install soil and water conservation practices on 4,890 acres. Of these, 91 long-term contracts were completed. About 72 percent of the planned acres of conservation tillage systems (3,015 acres) and 119 percent of the planned acres of pasture and hayland planting (3,540 acres) were implemented. About $287,000 in federal funds were obligated.

Current Status: The project was closed in 1999.

Sources: Watershed Plan and supplements; 1997 Water Resources Progress Report.

APPENDIX D: INVENTORY OF DAMS IN VIRGINIA

Table D-1. Dams in completed Pilot Watershed Project.

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
East Fork Falling River	15	Caldwell Lake	16	1956	$25,135
	21	Moses Lake	7	1957	$25,766
	7	Gala Lake	20	1958	$42,184

*Price base is year built.

Table D-2. Dams in completed PL-534 Watershed Projects.

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
Dry Run	102	Arrowhead Lake	34	1969	$467,757
	101	Morningstar Lake	7	1971	$284,664
Lower North River	80	Union Springs	7	1967	$178,633
	78	Briery Branch	10	1968	$485,825
	83	Hone Quarry	6	1968	$382,954
	22B	Dry Run	8	1970	$342,518
	81C	Switzer	119	1975	$3,200,000
	82	Dry River	15	1980	$591,880
Shoemaker River	1A	Shoemaker	8	1980	$599,193
	4C	Slate Lick	22	1984	$1,393,713
	3B	Hog Pen	7	1986	$1,513,000
South River	24	Happy Hollow	5	1954	$22,884
	23	Robinson Hollow	7	1956	$42,696
	26	Inch Branch	7	1956	$40,000
	19	Waynesboro Nursery	11	1957	$28,329
	25	Toms Branch	9	1957	$78,269
	11	Canada Run	5	1957	$30,202
	7	Lake Wilda	7	1957	$40,294
	3	Poor Creek	5	1958	$26,424
	27	Upper Sherando	9	1958	$78,269
	6	Stoney Creek	12	1959	$76,948
	4	Lofton Lake	8	1959	$48,396
	10A	Mills Creek	6	1963	$317,620
	8	Jones Hollow	9	1980	-
Stony Creek	9	Lake Laura	44	1971	$382,491
	10	Lake Birdhaven	16	1972	$250,098
Upper North River	10	Todd Lake	7	1963	$127,694
	76	Elkhorn Lake	54	1965	$611,974
	77	Hearthstone Lake	14	1966	$558,526

*Price base is year built.

Table D-3. Dams in completed PL-566 Watershed Projects.

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
Ararat River	2	Dellenback #2	2	1995	-
	63	Dellenback #63	2	1995	
	32	Hill Lake	2	1999	$318,623
	17	Slate Lake	1	1999	$303,808
	28	Clements Lake	2	2000	$266,675
	64	Montgomery Lake	4	2001	$545,007
	69	Hoback Lake	3	2001	
Beautiful Run	2A	None	9	1964	$42,843
	4	None	4	1966	$53,878
	5	None	3	1966	$53,878
	11	None	10	1967	$24,861
	6	None	6	1967	$32,110
	7	None	5	1970	$42,681
	10	None	3	1970	$34,000
	1B	None	14	1977	$124,505
Beaver Creek	1	Garnett Dam	104	1964	$152,934
Buffalo Creek	2	Stockton Lake	23	1962	$54,261
	6	Bell Lake	19	1965	$76,826
	7	Lake Gayle	12	1965	$43,122
	5	Buffalo Lake	20	1965	$69,483
	1	Grandview Lake	34	1965	$71,166
	4	Spring Creek Lake	68	1967	$106,948
	3	Little Creek Lake	24	1967	$82,732
	8	Carey Creek Lake	14	1967	$47,492
	9	New Hope Lake	10	1967	$38,386
Buffalo River	2	Thrasher Lake	36	1977	$385,436
	3	Stonehouse Lake	41	1978	$255,595
	4A	Mill Creek Lake	194	1985	$1,544,000
Bush River	2	Rice Creek Lake	24	1985	-
	1E	Briery Lake	810	1985	$3,037,968
	12	Sandy River Reservoir	740	1988	$4,342,830
	7	Hobgood	52	1990	$865,687
	5	Camp Creek Lake	18	1994	$485,712
	6	Evans Creek Lake	21	1995	$819,836
	4B	Mountain Creek	101	2001	$881,426
Cherrystone Creek	1	Cherrystone Lake	105	1968	$176,208
	2A	Roaring Fork Lake	17	1969	$96,952

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
Great Creek	6A	Great Creek Lake	210	1989	$5,550,781
Horse Pasture Creek	2	Seale	13	1972	$62,637
	1C	Stanley	21	1973	$137,150
Johns Creek	2	Little Oregon Lake	11	1966	$117,634
	4	Dicks Creek Lake	12	1966	$162,705
	3	None	4	1967	$72,967
	1	McDaniel's Lake	28	1967	$284,246
Leatherwood Creek	5	Lawrence	31	1963	$104,834
	6	Laurel Park	12	1965	$59,871
	2A	Walker	21	1965	$56,998
	3	Finney	34	1965	$68,169
	4	Barrow Brothers	9	1965	$51,982
Little Falling River	3	Joy Lake	15	1966	$40,590
	2	Watts Lake	11	1966	$57,621
	1	Liberty Lake	43	1966	$76,055
Little River	4	Kemps Lake	22	1966	$54,565
	1	Bentley/Pleasant's	16	1976	$138,343
Marrowbone Creek	1	Clanton Lake	33	1961	$56,493
Mountain Run	11	Mountain Run Lake	75	1959	$41,893
	8A	Caynor Lake	22	1959	$38,864
	13	Merrimac Lake	15	1960	$29,999
	50	Lake Pelham	220	1972	$260,620
	18	Catalpa Lake	46	1973	$149,854
Muddy Creek	1	Nuckols	16	1962	$71,760
	2	Banton	7	1962	$71,760
Ni River	1	Ni River Reservoir	417	1974	$631,411
Pohick Creek	7	Lake Braddock	18	1970	$174,722
	8	Huntsman Lake	29	1973	$176,364
	4	Lake Royal	38	1977	$323,007
	2	Lake Barton	9	1978	-
	3	Woodglen Lake	15	1981	-
	1	Lake Mercer	43	1985	$2,580,000
Potomac Creek	1	Abel Lake	185	1970	$415,930
	2	None	12	1972	$75,000

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
Roanoke Creek	35A	Jack Daniel's Lake	18	1960	$35,418
	67	Crab Orchard Lake	33	1960	$44,517
	68	Elders Lake	30	1961	$42,688
	4A	Pugh Lake	9	1962	$44,846
	5B	Cooter Lake	27	1962	$65,367
	70A	Keysville Town Lake	42	1962	$47,582
	6A	Dixon Lake	31	1962	$58,846
	49A	Royster Lake	36	1963	$41,653
	61A	Lacks Lake	12	1963	$48,179
	62	Horseshoe Lake	36	1964	$65,473
	72A	Drakes Lake (Town)	86	1967	$124,229
	31B	Scott Pond	37	1967	$50,952
	54	Anderson Lake	43	1968	$60,345
	43A	Ruritan Lake	36	1975	$174,252
Slate River	2	County	58	1973	$181,873
	14	Ripley Creek	26	1982	$278,035
	13	Slate Chesapeake	28	1983	$245,082
	8	Coffey	37	1984	$513,600
	7	State	38	1991	$796,869
South Anna River	2	Bowlers Mill Lake	75	1969	$171,652
	7	Lain Lake	35	1971	$52,498
	5	Eli Lake	24	1973	$55,485
	52B	Springfield Lake	68	1973	$165,239
	3	Fishers Lake	25	1980	-
	6B	Reynolds Lake	21	1980	$369,394
	4	Javor Lake	20	1981	-
	22	Northeast Creek Res.	182	1982	-
	23	Waldrop Lake	11	1983	-
Upper Blackwater River	6	Bowman	15	1972	$114,457
	4	Dillon	10	1974	$151,477
Upper Clinch Valley	8	Lincolnshire Park	21	1972	$236,710
	1B	Cavitts Creek Park	52	1988	$2,300,147
White Oak Run	1	White Oak Lake	49	1965	$144,892
Willis River	9	Spencer	11	1968	$40,692
	6A	Elcan	20	1970	$84,933
	7	Ownby	38	1970	$83,936
	6	Johns	38	1972	$219,598
	5F	Kyanite	13	1973	$83,456
	5E	Hardiman	18	1973	$98,250

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
Willis River (cont.)	4	Seaman	16	1974	$102,412
	3	Tipton	16	1974	$102,333
	1A	Big Chesapeake	38	1975	$230,837
	1B	Little Chesapeake	16	1975	$230,837
	2	Booker	36	1975	$194,459

*Price base is year built.

Table D-4. Dams in Active PL-566 Watershed Projects.

Watershed	Site Number	Common Name	Surface Acres	Year Built	Construction Cost*
Cedar Run	4	Germantown Lake	108	1985	-
	3	Airlie	55	1992	$1,743,939
Stewarts-Lovills Creek	9B	Lovills Creek Lake	55	1990	-

*Price base is year built.

APPENDIX E: OPERATION AND MAINTENANCE EXPIRATION DATES

APPENDIX E

Table E-1 lists the O&M agreement expiration dates in chronological order for all 150 NRCS assisted watershed structures in Virginia.

Table E-1. O&M expiration date for each dam.

Dam Name	Owner Name (O&M Signatories)	O&M Agreement Expiration Date
South River No. 24	Headwaters SWCD	9/29/2004
East Fork Falling River No. 15	Robert E. Lee SWCD	8/20/2006
South River No. 19	Headwaters SWCD	6/1/2007
East Fork Falling River No. 21	Robert E. Lee SWCD	7/24/2007
South River No. 11	Headwaters SWCD	10/7/2007
South River No. 7	Headwaters SWCD	11/4/2007
East Fork Falling River No. 7	Robert E. Lee SWCD	7/26/2008
South River No. 3	Headwaters SWCD/VA Dept. of Corrections	9/18/2008
South River No. 27	US Forest Service	10/29/2008
South River No. 6	Headwaters SWCD	6/16/2009
South River No. 4	Headwaters SWCD	7/2/2009
Mountain Run 8A	Culpeper SWCD	11/20/2009
Mountain Run 13	Culpeper SWCD	7/26/2010
Roanoke Creek No. 35A	Southside SWCD	8/17/2010
Roanoke Creek No. 67	Southside SWCD	11/22/2010
Roanoke Creek No. 68	Southside SWCD	10/19/2011
Buffalo Creek No. 2	Piedmont SWCD	5/16/2012
Roanoke Creek No. 4A	Southside SWCD	6/25/2012
Roanoke Creek No. 70A	Town of Keysville	9/14/2012
Roanoke Creek No. 5B	Southside SWCD	9/15/2012
Muddy Creek No. 1	Peter Francisco SWCD	10/5/2012
Muddy Creek No. 2	Peter Francisco SWCD	10/5/2012
Roanoke Creek No. 6A	Southside SWCD	10/5/2012
Roanoke Creek No. 49A	Southside SWCD	4/2/2013
Roanoke Creek No. 61A	Southside SWCD	8/28/2013
Leatherwood Creek No. 5	Blue Ridge SWCD/ Henry County	11/7/2013
Roanoke Creek No. 62	Southside SWCD	6/8/2014
Beautiful Run 2A	Culpeper SWCD	7/17/2014
Buffalo Creek No. 1	Piedmont SWCD	1/30/2015
Leatherwood Creek No. 2A	Blue Ridge SWCD/ Henry County	5/10/2015
Buffalo Creek No. 6	Piedmont SWCD	7/1/2015
Leatherwood Creek No. 3	Blue Ridge SWCD/ Henry County	9/10/2015
Leatherwood Creek No. 4	Blue Ridge SWCD/ Henry County	9/10/2015
Buffalo Creek No. 7	Piedmont SWCD	9/28/2015
Leatherwood Creek No. 6	Blue Ridge SWCD/ Henry County	10/12/2015
Buffalo Creek No. 5	Piedmont SWCD	10/26/2015
Upper North River No. 76	City of Staunton	11/5/2015
Beautiful Run 4	Culpeper SWCD	6/9/2016
Beautiful Run 5	Culpeper SWCD	7/2/2016
Little River No. 4	Thomas Jefferson SWCD/Louisa County	8/24/2016
Buffalo Creek No. 4	Piedmont SWCD	1/13/2017
Roanoke Creek No. 72A	Town of Drakes Branch	1/13/2017

Dam Name	Owner Name (O&M Signatories)	O&M Agreement Expiration Date
Beautiful Run 11	Culpeper SWCD	5/5/2017
Buffalo Creek No. 3	Piedmont SWCD	5/9/2017
Beautiful Run 6	Culpeper SWCD	8/23/2017
Buffalo Creek No. 9	Piedmont SWCD	10/3/2017
Buffalo Creek No. 8	Piedmont SWCD	10/9/2017
Roanoke Creek No. 31B	Southside SWCD	11/22/2017
Roanoke Creek No. 54	Southside SWCD	12/23/2018
White Oak Run No. 1	Rapidan Service Authority/Culpeper SWCD	6/26/2019
Beautiful Run 7	Culpeper SWCD	6/19/2020
Beautiful Run 10	Culpeper SWCD	6/22/2020
Mountain Run 18	Culpeper SWCD	9/6/2023
Roanoke Creek No. 43A	Southside SWCD	8/21/2025
Little River No. 1	Thomas Jefferson SWCD/Louisa County	8/31/2026
Beautiful Run 1B	Culpeper SWCD	9/24/2027
South River No. 8	City of Waynesboro/Headwaters SWCD	10/27/2030
Ararat River No. 2	Patrick County/Patrick SWCD	3/23/2050
Ararat River No. 63	Patrick County/Patrick SWCD	3/23/2050
Ararat River No. 17	Patrick County/Patrick SWCD	12/13/2054
Ararat River No. 32	Patrick County/Patrick SWCD	12/13/2054
Ararat River No. 28	Patrick County/Patrick SWCD	12/8/2055
Ararat River No. 64	Patrick County/Patrick SWCD	10/1/2056
Ararat River No. 69	Patrick County/Patrick SWCD	10/1/2056
South River No. 23	Headwaters SWCD/Augusta County/City of Waynesboro	9/15/2057
South River No. 26	Headwaters SWCD/Augusta County/City of Waynesboro	7/30/2058
South River No. 25	Headwaters SWCD/Augusta County/City of Waynesboro	6/7/2060
Pohick Creek No. 2	Fairfax County	12/6/2061
Marrowbone Creek No. 1	Blue Ridge SWCD	10/28/2062
South River No. 10A	Augusta County	10/31/2063
Beaver Creek No. 1	Albemarle County	6/23/2065
Upper North River No. 10	Headwaters SWCD	3/25/2066
Little Falling River No. 3	Robert E. Lee SWCD	8/14/2066
Little Falling River No. 2	Robert E. Lee SWCD	10/27/2066
Little Falling River No. 1	Robert E. Lee SWCD	12/5/2066
Johns Creek No. 2	Mountain Castles SWCD/Craig County	12/9/2066
Johns Creek No. 4	Mountain Castles SWCD/Craig County	12/9/2066
Lower North River No. 80	Shenandoah Valley SWCD	6/17/2067
Johns Creek No. 3	Mountain Castles SWCD/Craig County	6/28/2067
Johns Creek No. 1	Mountain Castles SWCD/Craig County	7/25/2067
Cherrystone Creek No. 1	Town of Chatham	7/2/2068
Willis River No. 9	Peter Francisco SWCD	7/3/2068
Lower North River No. 78	Shenandoah Valley SWCD	9/20/2068
Lower North River No. 83	Shenandoah Valley SWCD	11/1/2068
Mountain Run 11	Town of Culpeper	7/1/2069
Mountain Run 50	Town of Culpeper	7/1/2069
Dry Run No. 102	Town of Luray/Shenandoah Valley SWCD	7/18/2069
Cherrystone Creek No. 2A	Town of Chatham	9/16/2069

Dam Name	Owner Name (O&M Signatories)	O&M Agreement Expiration Date
South Anna River No. 2	Louisa County	3/6/2070
Willis River No. 6A	Peter Francisco SWCD	5/18/2070
Willis River No. 7	Peter Francisco SWCD	6/16/2070
Lower North River No. 22B	Shenandoah Valley SWCD	9/28/2070
Pohick Creek No. 7	Fairfax County	10/13/2070
Potomac Creek No. 1	Stafford County	10/16/2070
Dry Run No. 101	Town of Luray/Shenandoah Valley SWCD	6/7/2071
South Anna River No. 7	Thomas Jefferson SWCD	9/29/2071
Stony Creek No. 9	Lord Fairfax SWCD	12/21/2071
Potomac Creek No. 2	Stafford County	7/17/2072
Stony Creek No. 10	Lord Fairfax SWCD	8/1/2072
Willis River No. 6	Peter Francisco SWCD	8/10/2072
Upper Blackwater No. 6	Blue Ridge SWCD	9/20/2072
Upper Clinch Valley No. 8	Town of Tazewell	9/27/2072
Horse Pasture Creek No. 2	Blue Ridge SWCD	10/26/2072
South Anna River No. 5	Thomas Jefferson SWCD	4/24/2073
Willis River No. 5F	Peter Francisco SWCD	5/15/2073
Willis River No. 5E	Peter Francisco SWCD	6/5/2073
South Anna River No. 52B	Hanover-Caroline SWCD	7/3/2073
Horse Pasture Creek No. 1C	Blue Ridge SWCD	11/20/2073
Slate River No. 2	Buckingham County	12/5/2073
Willis River No. 4	Peter Francisco SWCD	5/24/2074
Ni River No. 1	Spotsylvania County	7/10/2074
Upper Blackwater No. 4	Blue Ridge SWCD	7/30/2074
Willis River No. 3	Peter Francisco SWCD	11/13/2074
Willis River No. 1A	Peter Francisco SWCD	5/19/2075
Willis River No. 1B	Peter Francisco SWCD	5/19/2075
Willis River No. 2	Peter Francisco SWCD	9/15/2075
Lower North River No. 81C	City of Harrisonburg	10/1/2075
Buffalo River No. 2	Amherst County	8/30/2077
Buffalo River No. 3	Amherst County	4/6/2078
Pohick Creek No. 4	Fairfax County	5/18/2079
Shoemaker River No. 1A	Shenandoah Valley SWCD	6/6/2080
South Anna River No. 3	Thomas Jefferson SWCD	6/18/2080
South Anna River No. 6B	Thomas Jefferson SWCD	9/11/2080
Lower North River No. 82	Shenandoah Valley SWCD	9/25/2080
South Anna River No. 4	Thomas Jefferson SWCD	8/10/2081
South Anna River No. 22	Louisa County Water Authority	10/20/2082
Slate River No. 14	Peter Francisco SWCD	12/16/2082
Pohick Creek No. 3	Fairfax County	12/23/2082
Slate River No. 13	Peter Francisco SWCD	7/13/2083
South Anna River No. 23	Thomas Jefferson SWCD	8/11/2083
Shoemaker River No. 4C	Shenandoah Valley SWCD	6/25/2084
Slate River No. 8	Peter Francisco SWCD	10/31/2084
Buffalo River No. 4A	Amherst County	1/24/2085
Bush River No. 7	Piedmont SWCD/Prince Edward County	6/24/2085

Dam Name	Owner Name (O&M Signatories)	O&M Agreement Expiration Date
Bush River No. 2	Piedmont SWCD/Prince Edward County	7/16/2085
Pohick Creek No. 1	Fairfax County	12/2/2085
Cedar Run No. 4	Fauquier County/John Marshall SWCD	12/16/2085
Bush River No. 1E	Va. Dept. of Wildlife Resources (formerly DGIF)	12/20/2085
Shoemaker River No. 3B	Shenandoah Valley SWCD	11/7/2086
Bush River No. 12	Prince Edward County	6/25/2088
Upper Clinch Valley No. 1B	Tazewell County	10/13/2088
Great Creek No. 6A	Brunswick County	6/5/2089
Pohick Creek No. 8	Fairfax County	1/2/2090
Stewarts Cr.-Lovills Cr. No. 9B	Carroll County/City of Mt Airy NC/Surry County NC	4/18/2090
Slate River No. 7	Peter Francisco SWCD	8/13/2091
Cedar Run No. 3	Town of Warrenton	9/10/2092
Bush River No. 5	Piedmont SWCD/Prince Edward County	5/10/2094
Bush River No. 6	Piedmont SWCD/Prince Edward County	11/1/2095
Upper North River No. 77	Headwaters SWCD	5/16/2098
Bush River No. 4B	Piedmont SWCD/Prince Edward County	7/18/2101

APPENDIX F: PROFESSIONAL PAPERS ON WATERSHED DAMS IN VIRGINIA

APPENDIX F

The use of secant pile walls in the rehabilitation of the Pohick Creek Dam No. 2 (Lake Barton) auxiliary spillway

Alica J. Ketchem, Gerald W. Wright, Mathew J. Lyons
Presented at the 2012 ASABE Annual International Meeting

Abstract. Pohick Creek Dam No. 2, known as Lake Barton, was built in 1978 in Fairfax County, Virginia. This structure was built as a High hazard dam due to its location in an urban environment. In 2004, the Virginia Division of Dam Safety issued a conditional certificate for Operation and Maintenance because the vegetated earthen auxiliary spillway could not pass the Probable Maximum Flood without breaching the structure. Under the authority of the Small Watershed Amendments of 2000 (PL 106-472), the USDA Natural Resources Conservation Service prepared a rehabilitation plan for the dam. The plan provided for building a reinforced concrete wall at the end of the control section and a concrete secant pile wall at the end of the constructed outlet section. Construction was completed in 2010. The secant pile wall was constructed of 79 alternating reinforced and non-reinforced concrete piles drilled an average of 68 feet into the ground. Tieback anchors were utilized to prevent the secant wall from overturning in the event the downstream material was removed during the design event. A 6.6 foot deep reinforced concrete wall was installed across the 70-foot wide control section and up the side slopes to the elevation of the top of the dam. The footprint of the construction site was 0.7 acres, the construction time was 7 months, and the total construction cost was $2,808,715.

Introduction. In 1969, the USDA Soil Conservation Service (SCS), now the Natural Resources Conservation Service (NRCS), prepared a watershed protection and flood control plan for the Pohick Creek watershed in Fairfax County, Virginia. This work was done under the authority of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566), as amended. Under this plan, five flood control dams and one multi-purpose dam were built from 1970 to 1985. All of these structures were designed as High hazard dams with a life span of 100 years. Pohick Creek Dam No. 2, known locally as Lake Barton, was built in 1978 (Figure 1). This dam had a 44-foot high earthen embankment and a grass-lined auxiliary spillway designed to pass the flood waters from the Probable Maximum Precipitation (PMP) storm event. The dam is owned and maintained by Fairfax County.

In 2001, Fairfax County commissioned Gannett Fleming, Inc., to perform a study of the auxiliary spillway. The purpose of the study was to evaluate the integrity of the auxiliary spillway by assessing its potential for erosion and headcutting during storm events that would cause water to flow in the auxiliary spillway. The selected events were the 100-, 200-, 500-, 1,000-, 2,000-, and 5,000-year events, the ½ PMP and the PMP. This analysis showed that the auxiliary spillway would breach at events equal to or larger than the 5,000-year event.

In response to this information, the Virginia Department of Conservation and Recreation (DCR) - Division of Dam Safety issued a conditional certificate for Operation and Maintenance in 2004. A conditional certificate serves as notification to the Sponsors (Fairfax County and the Northern Virginia Soil and Water Conservation District) that the dam no longer meets State requirements and must be modified as soon as possible to meet State law. The Sponsors asked NRCS to help with the rehabilitation in accordance with the provisions of the PL-566 Small Watershed Rehabilitation Amendments of 2000 (Section 313 of Public Law 106-472). In 2009, NRCS completed a Supplemental Watershed Plan – Environmental Assessment for the rehabilitation of Lake Barton.

NRCS subsequently provided financial and technical assistance with the design and construction of the selected rehabilitation alternative.

Figure 1. Lake Barton dam and auxiliary spillway.

Watershed Description. Fairfax County is located in northern Virginia very close to Washington, D.C. In 1969, when the original plan was written, the area was rapidly beginning to change from a rural community to an urban one. By the time the rehabilitation was planned, over 62% of the drainage area of the Lake Barton Dam was Residential/Business. Fairfax County was well prepared for this occurrence. In the early 1960s, the County zoned the 100-year floodplain in the Pohick Creek watershed to prevent development. Of the 539 acres of the watershed upstream of the Lake Barton dam, 109 acres (20.2%) are in woodland. Most of this is adjacent to the stream. Almost 69% of the breach zone below the dam is in woodland with 25% in Residential/Business and 6% in other uses (Figure 2).

Description of the Dam. The dam at Lake Barton is a 698-foot long, 44-foot high earthen dam with a 14-foot wide top and 2.5:1 side slopes. The principal spillway is a 204-foot long, 30-inch diameter, reinforced concrete pipe with a covered reinforced concrete riser, and an impact basin outlet. As built, there was a 70-foot wide vegetated earthen channel auxiliary spillway in the right abutment with a 50-foot long control section approximately eight feet below the top of the dam. The inlet section was 200 feet long with a 0.2% slope. The constructed outlet section was 100 feet long with 50 feet at a 3% grade and 50 feet at a level grade. The spillway outlet was a wooded slope leading to a defined channel.

Figure 2. Wooded outlet channel below dam.

Problems with the Dam. When all of the studies were complete, there were five identified problems. The biggest one was that the soils in the auxiliary spillway did not have the integrity to pass the volume of the 5,000-year or greater storm event without breaching. The second problem was that the crest elevation of the auxiliary spillway was 0.1 feet too low to contain the volume of the 100-year, 10-day storm event. Third, the settled top of the dam was about 0.4 feet lower than the planned elevation for about 50 feet on the side of the embankment adjacent to the auxiliary spillway. Fourth, the training dike was shorter and lower than needed. These first four problems were all addressed in the rehabilitation of the auxiliary spillway.

The fifth problem had to do with the available sediment storage in the lake. The original design included sediment storage for 100 years. During construction, the planned amount of borrow was not removed from the pool area and there was only 72 years of sediment storage capacity. In addition, the actual sedimentation rate was slightly higher than the design rate. At the time of rehabilitation, the lake had a future sediment storage life of only 42 years. Under the rehabilitation legislation, there had to be a minimum of 50 years of sediment life when rehabilitation was complete. Fairfax County addressed this problem by dredging the lake at its own expense (Figure 3).

Figure 3. Barge dredging Lake Barton.

Figure 4. Aerial view of Lake Barton and surrounding homes.

Sideboards for Construction. The Lake Barton auxiliary spillway is located immediately adjacent to a townhouse community. These townhouses have an average market value of $527,000 each. One row of homes is less than 50 feet away from the edge of the auxiliary spillway (Figure 4). There was concern about the potential for damage from construction equipment. In addition, the local residents were strongly opposed to removing the trees from the wooded outlet slope. These concerns had to be addressed in the evaluation of potential solutions.

Solutions Considered. After much consideration, there were three viable ways to rehabilitate the auxiliary spillway. These solutions represented different combinations of armoring, cutoff walls, or both. There were also different combinations of materials that could be used.

Option 1 – Armor with Articulated Concrete Blocks (ACBs). Keep the auxiliary spillway in its original location and change the outlet section to a 400-foot long chute that would extend from the downstream end of the control section to the valley floor. Outlet the chute into a 37-foot long stilling basin. Armor the spillway with ACBs from the upstream edge of the control section to the end of the stilling basin. Cover the armor with topsoil and vegetate with grass. Install training dikes along the auxiliary spillway outlet to the valley floor on both sides. With this option, the

construction limits were about 30 feet from the nearest townhouse. The estimated construction cost was $2,470,000 and the total project footprint was 2.5 acres, including removal of 2.2 acres of trees.

Option 2 – Realign the Auxiliary Spillway and Armor with ACBs. Shift the auxiliary spillway toward the dam embankment to get the construction away from the townhouses. The chute spillway, stilling basin, and ACB armoring were essentially the same as Option 1. The estimated construction cost for this option was $2,590,000 and the total project footprint was 2.5 acres, including removal of 2.2 acres of trees.

Option 3 – Two Cutoff Walls. Place a cast-in-place, reinforced concrete cutoff wall at the downstream end of the control section. Place a second cutoff wall at the end of the existing constructed outlet section. This option would prevent a breach of the auxiliary spillway but would provide no erosion protection for the wooded outlet area downstream of the second wall. Construction of a berm near the residential area and extensive clearing of the wooded area downstream would be avoided. The downstream cutoff wall could be a concrete slurry wall or a concrete secant pile wall. With either one, there would be only minor differences in the visual appearance of the auxiliary spillway once construction was complete. The total project footprint was estimated to be 1.9 acres, including 0.4 acres of trees in the access road and along the end of the auxiliary spillway. The construction footprint was 0.7 acres. The construction cost estimated in the NRCS Watershed Plan was $2,730,000 for a reinforced concrete wall and a concrete slurry wall. For the reinforced concrete wall and a concrete secant pile wall, the estimated cost was $2,040,000.

Option 4 – One Cutoff Wall with ACB Armoring. Place a concrete slurry wall or a concrete secant pile wall at the end of the constructed outlet section and use ACBs to armor the auxiliary spillway from the upstream end of the control section to the wall. This option had the same construction footprint as Option 3 and there would no difference in the visual appearance of the site. For the concrete slurry wall variation, the estimated construction cost was $3,300,000. The concrete secant pile wall variation had an estimated cost of $2,600,000.

Selected Option. The selected option for the rehabilitation of the auxiliary spillway was to install two cutoff walls in the auxiliary spillway using reinforced concrete for the upstream wall and a concrete secant pile wall for the downstream cutoff. This was the least cost alternative.

Design. Fairfax County hired URS Corporation to prepare the design for the selected auxiliary spillway rehabilitation option. The design was prepared in accordance with NRCS technical design criteria, where appropriate. The majority of this guidance came from the NRCS National Engineering Handbook, Part 628, *Dams*, Chapter 50, "Earth Spillway Design" and NRCS Technical Release 60 (TR-60), *Earth Dams and Reservoirs*. Design features not addressed by NRCS design procedures were designed in accordance with state-of-the-practice methods. The components of the design included a small realignment of the auxiliary spillway, two below-grade cutoff walls, extension of the downstream training dike, and some turf reinforcement matting.

Auxiliary Spillway Elevation and Alignment. As part of the design process, the adequacy of all the components of the dam was evaluated. The contractor began with a review of the principal spillway and the required floodwater detention storage. The most recent precipitation data was used. Based on this information, the auxiliary spillway crest was found to be 0.1 feet too low. The elevation of the control section was raised to correct this.

To provide additional protection to the townhouses adjacent to the outlet area, the alignment of the auxiliary spillway was modified by moving the control section upstream of the centerline of the

dam and rotating it to direct flow away from the townhouses. The control section was shortened to 30 feet and the spillway width was maintained at 70 feet by reducing the width of the upstream training dike. Additional curvature was added to the inlet section of the auxiliary spillway to accommodate these changes.

Secant Pile Wall. The secant pile wall extended across the end of the constructed outlet section for approximately 120 feet and then bent approximately 64° upstream along the right abutment for another 90 feet. The secant pile wall was constructed with 79 overlapping drilled shafts filled with concrete. Every other shaft was reinforced with reinforcing steel. The wall extended from the ground surface to an average depth of 68 feet. This was approximately 40 feet below the valley floor. Earth anchor tiebacks were installed to support the top of the wall in case the wall is exposed by a PMP event. Based upon theory and NRCS experience, the projected depth of head cutting will be limited to the depth to the valley floor. Approximately 28 feet of wall would be exposed if the head cut fully developed during a design flow event.

Cast-in-place Concrete Wall. The upstream wall was placed along the downstream edge of the control section at the elevation needed to achieve the required flood storage. It extended for a length of about 128 feet across the auxiliary spillway and up the abutments. This cast-in-place wall was designed to be stable when the soil downstream of the wall has been removed by scour and headcutting. Three feet is the expected maximum depth that will be removed by headcutting because the top of the secant pile wall controls the depth of erosion at the downstream end of the constructed outlet. A concrete apron slab was placed along the downstream side of the wall about three feet below the finished grade of the auxiliary spillway to serve as an energy dissipater if flow through the spillway removes the overlying earthfill material.

Training Dike Extension. The existing downstream training dike was extended approximately 50 feet to guide auxiliary spillway flow to a point downstream of the toe of the dam. The training dike was widened from 12 feet to 60 feet so that the materials excavated from the cutoff walls could be utilized on-site.

Turf Reinforcing Mats (TRM). The effective stress on the grass-lined surface of the auxiliary spillway during the design storm was estimated to be higher than the amount allowable for the soil properties of the site. At the recommendation of the NRCS National Design, Construction, and Soil Mechanics Center, turf reinforcement matting was used to provide additional stability to the grass vegetation.

Responsibilities. The prime contractor for this job was Shirley Contracting from northern Virginia. Shirley Contracting was responsible for project administration and quality control, construction of the access road, all site preparation work, including installation of the guide wall for the secant piles, and construction of the cast-in-place wall.

The drilling work was subcontracted to Nicholson Construction Company from Bridgeville, Pennsylvania. This company is a subsidiary of Soletanchi Bachy from Great Britain. Nicholson was responsible for installation of the secant pile wall. This work included drilling and casing the holes and placing the steel and concrete. It also included installation of the tieback system, including drilling, anchoring, grouting, and post-tensioning.

The Fairfax County Public Works Department, Construction Management Division, provided project administration and quality assurance. Because this project was installed under the American

Recovery and Reinvestment Act (ARRA), it had to be a locally-led project. The Fairfax County Critical Structures Group also provided construction inspection.

Construction oversight was provided by URS Corporation. An NRCS Project Engineer served as the Government Representative in order to ensure that the Federal interest in this project was protected.

Construction Process. The Notice to Proceed was issued on December 6, 2010. The first priority was installation of the construction access. A temporary road was constructed through the woods below the dam and the alignment was chosen to minimize the removal of trees. There were some weather related delays in getting the equipment onto the site but once construction began, there were only minor delays in the process. The entire footprint of the construction site was only about 0.7 acres. This made construction sequencing a critical part of the operation because of the size of the drilling equipment.

After the initial site preparation was complete, Shirley constructed two reinforced concrete guide walls along the path of the secant pile wall (Figure 5). This wall was used to ensure that placement of the piles would be controlled in the lateral direction and that there would be the required amount of pile overlap.

Figure 5. Installation of guide wall.

Figure 6. Drill with auger and drive head.

Nicholson then began to drill the vertical holes for the piles (Figure 6). The drilling was done in multiple steps. A 36-inch steel casing was placed over the space in the guide wall. A telescoping 30-inch diameter auger attached to the center drive shaft was used to excavate and remove the majority of the material within the casing. Once this material was removed, the casing was fastened to a metal drive head that was used to cause the casing to rotate. The initial piece of casing used for every hole had teeth on the bottom. When rotated, the teeth excavated the material adjacent to the casing wall until the entire hole was empty. After the entire length of the casing piece was excavated, the auger unit swung out of the way so that the crane could put the next piece of casing in place. This process was repeated until the hole reached the desired depth.

The secant pile wall was constructed by overlapping completely reinforced concrete piles, called primary piles, with non-reinforced (secondary) concrete piles. The secondary piles were installed first by drilling every other hole. After the hole was cased, one piece of #11 rebar was set in the center of the hole and the concrete was poured using a tremie pipe to fill the hole from the bottom to the top. As the concrete was poured, a hydraulic machine pulled each section of casing out of the ground (Figure 7). After the concrete set, an overlapping hole was drilled between the secondary piles. The steel rebar cage used for reinforcement was assembled from 14 #11 bars. The crane placed the rebar cage into the hole and the concrete was again poured from the bottom to the top. This bottom-to-top placement avoided bridging and aggregate displacement and also displaced any water that had accumulated in the hole.

Figure 7. Machine for extracting casing.

Figure 8. Installation of earth anchor in waler wall.

Once the piles were complete, the guide wall was removed, leaving the top three feet of the piles exposed. A reinforced concrete waler wall was installed on the downstream side of the piles. This wall had precast holes in it to allow for installation of the tieback system. At each opening, a 6-inch diameter, 60-foot deep hole was drilled into the soil in the upstream direction. The lower 40 feet of the anchor was sleeved with corrugated PVC that formed a bonded section when the grout was placed. The upper 20 feet of the anchor was sleeved in smooth PVC to create an unbonded section that allows some movement. The end of the anchor was threaded to allow connection with the waler. After the grout was set, a heavy steel plate was set over the end of the rebar and tension was applied to a designed level (Figure 8). An 18-inch thick concrete pile cap was poured over the top of the piles to the design elevation of the spillway. This cap was left exposed for use as a sidewalk across the spillway. The original asphalt path across the spillway was replaced with a new path that met the requirements of the Americans with Disabilities Act (ADA). This path was located downstream of the secant pile wall (Figure 9).

Figure 9. Pile cap and asphalt walkway.

Figure 10. Installation of upper cutoff wall with downstream apron.

The upstream cutoff wall was built after completion of the secant pile wall (Figure 10). The reinforced concrete wall had a stem height of 6.6 feet and a width of 12 inches and a footer that was 7.5 feet wide and 18 inches thick. The 8-inch thick, 10-foot wide apron slab was installed along the entire length of the wall after some of the fill material was placed over the footer.

After the upstream cutoff wall was built, material excavated to install the cutoff walls was used to build the downstream training dike. The auxiliary spillway was finished by installing about 1980 square yards (0.4 acres) of turf reinforcement mat about six inches below the finished grade. The site grading and re-vegetation were completed, and the temporary construction access was removed. The job was considered to be substantially completed by June 10, 2011. Total construction time was seven months.

Conclusion. The total cost of the contract was $2,808,715. Since the construction followed the design very closely, there was little difference between the bid cost and the final price. Although this option was selected because it was identified as the least cost alternative during the planning process, the complexity of the final design accounted for the larger number. The rehabilitation of Lake Barton met the requirements of the Virginia Division of Dam Safety and a regular Operation and Maintenance Certificate has been issued.

With the rehabilitation of the Lake Barton dam, the threat to loss of life has been minimized for the people who live and work in the breach zone of the dam. The breach zone has about 535 people who live in 192 homes and over 1,050 people who work in 41 business properties. Approximately 73,800 people who use the roads downstream of the dam and 9,000 railway commuters have also been protected. In addition, Lake Barton will continue to be a central component of the recreation in the area. Overall, the quality of life of the residents of Fairfax County has been retained by this effort (Figure 11).

Figure 11. Lake Barton after rehabilitation of auxiliary spillway.

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Rehabilitation of the auxiliary and principal spillways on South River Dam 10A, Augusta County, Virginia

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Abstract. In 1963, the USDA Natural Resources Conservation Service (formerly Soil Conservation Service) built South River Dam 10A, known locally as Mills Creek Dam, in Augusta County, Virginia, as a Significant hazard dam. This multi-purpose structure included both flood control and municipal water supply. By 2005, the hazard classification of the dam changed to High because of the downstream development and the increased risk to public safety from a dam breach. The vegetated auxiliary spillway did not have the capacity, stability, or integrity to pass the probable maximum flood (PMF) event without breaching. There were also several problems with the principal spillway pipe outlet and riser. Rehabilitation of the auxiliary spillway included lowering the crest elevation to increase capacity and armoring the surface with articulated concrete blocks to achieve integrity and stability. Since poor water quality prevented use of the municipal water supply, the water supply component of the dam was removed. The original riser of the principal spillway was abandoned, and a new riser was installed. The principal spillway pipe was slip-lined, and the concrete outlet structure was replaced by a riprap plunge pool. Cooperation with multiple Federal, state, and local entities was an essential part of this project. The dam is located on USDA Forest Service administered land but is owned by Augusta County. A threatened plant species was found downstream of the site. The lake is a put-and-grow fishery; and there was a flood-monitoring gage in the dam embankment. NRCS completed rehabilitation of this dam in 2013.

INTRODUCTION

The USDA Natural Resources Conservation (NRCS), formerly Soil Conservation Service, has built 150 flood control dams in Virginia since 1954. NRCS built most of these dams in rural areas as low or Significant hazard structures. Because there were little or no restrictions on development in the breach zones of these dams, many of these dams are now High hazard. South River Dam 10A, known locally as Mills Creek Dam, was built in Augusta County, Virginia, in 1963 under the authority of the Flood Control Act of 1944 (Public Law 78-534) as a Significant hazard structure. In 2005, NRCS reclassified the dam as High hazard due to development in the downstream watershed and the risk to public safety from a dam breach. Under Virginia Department of Conservation and Recreation (DCR), Division of Dam Safety regulations, the auxiliary spillway of a High hazard dam must have the capacity to convey the volume of water associated with 90% of the Probable Maximum Precipitation (PMP) without overtopping or breaching. The NRCS criteria for a High hazard dam require safe passage of 100% of the volume of the PMP. At the time of the hazard class change, NRCS estimated the auxiliary spillway capacity to be 70% of the required volume.

In June 2004, the Sponsor, Augusta County Board of Supervisors, applied for assistance from NRCS in preparing a plan to bring this dam into compliance with State Law. Under the authority of the Watershed Protection and Flood Prevention Act (Public Law 83-566) as amended by the Small

Watershed Rehabilitation Amendments of 2000 (Section 313 for Public Law 106-472), NRCS prepared a supplement to the original watershed plan to address rehabilitation of South River Dam 10A. NRCS completed the supplement in 2010. In 2012, NRCS completed the design for this structure and construction began in the fall of that year.

SITE CONCERNS AND COOPERATION

NRCS built South River Dam 10A in the headwaters of the South River to provide flood protection and municipal water supply to Augusta County. It has a completely forested watershed drainage area of 2,459 acres (3.84 square miles). The dam is located on US Forest Service administered land but is owned and operated by Augusta County under a Special Use Permit with the US Forest Service. Under a cooperative agreement, the Headwaters Soil and Water Conservation District (SWCD) mows the dam annually. Because of water quality problems, the lake was only briefly used for water supply. However, it is used for fishing. The Virginia Department of Wildlife Resources (DGIF) annually stocks brook trout fingerlings to provide a put-and-grow fishery. This cold-water lake originally had a water depth of 50 feet.

The area around the lake contains a colony of Swamp Pink, a Federally Threatened and State Endangered plant species. The US Fish and Wildlife Service, the US Forest Service, and the Virginia DCR, Division of Natural Heritage, were concerned that construction activities associated with the dam rehabilitation could affect the hydrology of the habitat by drying up the water or by filling the area with sediment, thereby threatening the Swamp Pink. Protection of this plant was a priority during rehabilitation. These agencies assisted NRCS in the identification of erosion and sediment control measures needed during construction.

A small spring located immediately below the toe of the dam contributes water to the wetlands that support the Swamp Pink. There was some concern that activities at the dam could adversely affect this spring. NRCS coordinated with the US Forest Service, the US Army Corps of Engineers, and the Virginia DCR, Division of Natural Heritage (Karst Program) to evaluate the relationship between seeps along the toe of the dam and the spring. This evaluation showed that the dam and the spring were not hydrologically connected. NRCS took extra measures during design and construction to protect the spring.

Invasive species management, fisheries development, and future maintenance needs were included in the cooperative efforts during the design and construction process.

EVALUATION

As part of the watershed plan, NRCS examined all of the existing components of the dam.

Embankment. The vegetated earthen embankment was 96.5 feet high from settled top of the dam to the downstream toe of the embankment. The top was 24 feet wide. The upstream face had a slope of 3 feet horizontal to 1 foot vertical (3:1) from the toe to the permanent pool elevation. From there, the slope was 2.5:1 to the top of the embankment. The downstream face had a slope of 2.5:1 with a 10-foot wide stability berm located midway down the slope. The Augusta County Department of Emergency Services installed an Integrated Flood Observing and Warning System (IFLOWS) gage in the dam embankment to allow remote monitoring of water levels. The embankment was in excellent condition except for some very small trees growing at the waterline.

Principal Spillway. Because NRCS built this dam to include water supply, the principal spillway system was considerably different from the riser, pipe, and plunge pool system typically used on

dams constructed by NRCS. The original system had four gates numbered from #1 to #4 starting with Gate #1 at the pond drain (Figure 1). The pond drain consisted of a pond drain tower with a gate valve at the bottom and a valve operating system at the top and 114' of 24" steel-reinforced concrete pipe that extended horizontally 114 feet from the base of the pond drain tower to the principal spillway riser. A 2009 video camera survey indicated some deterioration of the concrete in this section of pipe. Maintenance personnel could only access the valve operating system when the reservoir elevation was at the level of Gate #2.

The 54-foot-tall principal spillway riser was embedded in the embankment with the uppermost 14 feet above ground. The riser was a multi-stage, covered top structure (concrete slab on top of riser) with inside dimensions of 2 feet wide by 6 feet long. The permanent pool of the lake was set to the weir of the riser. Gate #4 was located at the base of the exposed section about 10 feet below the elevation of the permanent pool. Gates #2 and #3 were used to access the water supply. Both water supply gates had inlet structures on the face of the dam with 24-inch cast iron pipes that led to the riser. The valve operators for these gates were located uphill from the main riser at an elevation above the permanent pool.

During the 2008 annual inspection, inspectors observed water entering the riser through the construction joints. Operators lowered the reservoir elevation to the elevation of the lowest water supply gate (Gate #2) to take hydrostatic pressure off the riser (Figure 2). The 2009 video inspection showed that the riser had deteriorated to a remove-and-replace condition.

From the riser, the principal spillway pipe continued through the dam to a concrete water distribution box that built for use with the water supply. The concrete inside the distribution box had deteriorated but there were no structural issues with the pipe in this section. However, the configuration of the distribution box caused hydraulic conditions that had broken the connection between the pipe and the distribution box. During high flow conditions, inspectors observed water spurting out of the junction to heights of over 6 feet above the ground surface (Figure 3).

Figure 1. Original riser and gate system.

Figure 2. Lake drained to level of Gate #2.

Figure 3. Water flowing from broken seal at distribution box.

Auxiliary spillway. NRCS used the NRCS SITES model to evaluate the capacity, stability, and integrity of the vegetated earth auxiliary spillway (Figure 4). This model confirmed the lack of capacity required for a High hazard dam. It also indicated a lack of stability in the spillway. Stability is the measure of vulnerability to surface erosion. This auxiliary spillway flowed seven times since original construction (Figure 5). Inspectors observed damage to the surface of the auxiliary spillway following every spillway flow event. The Sponsor repaired the damage at their expense. Future erosion was a key issue NRCS addressed during rehabilitation.

The SITES model indicated a lack of integrity in the auxiliary spillway. Integrity is the measure of the erosion-resistance of the material under the auxiliary spillway surface. NRCS engineers considered the underlying material in the control section and constructed outlet section erodible on the surface, but not erodible further down in the profile.

Flows through the constructed auxiliary spillway exited onto a rocky hillslope consisting of fractured bedrock of sandstone, conglomerate, and quartzite with little or no fine material. The hillslope was about 70' high with a 40% grade (Figure 6). Little damage occurred in the hillslope area during the flow events other than the removal of overburden. Most of the rock material eroded from the hillslope deposited at the toe of the slope. Three small outlet channels formed through the deposited material.

An earthen training dike constructed along the right side of the auxiliary spillway from the top of the dam to the point where the flow left the constructed outlet section protected the backslope of the embankment. One section of the training dike was at an elevation lower than the anticipated flow depth. During auxiliary spillway flow events, some water exiting the hillslope drained toward the downstream toe of the embankment with the potential for causing erosion.

Figure 4. Original vegetated earth auxiliary spillway, looking downstream.

Figure 5. Auxiliary spillway flow after Hurricane Isabel, September 2003.

Figure 6. Hillslope exit of auxiliary spillway, looking upstream.

DESIGN AND CONSTRUCTION

Since the sponsors no longer used the water supply component of the dam, NRCS and the sponsors agreed to eliminate the water supply when rehabilitating the dam. This decision provided a number of opportunities for changing the operational features of the dam.

Removal of the water supply component required reconsideration of the new normal pool elevation of the reservoir. Based upon the required sediment storage volume, the new pool required a minimum depth of 14 feet. However, the Virginia DGIF did not think this depth sufficient to support a cold-water fishery. The DGIF determined that a depth of 25 feet would be sufficient to maintain the fishery. This change was acceptable to the Sponsors and to NRCS because the additional ten feet of storage caused only minimal changes to the height of the new riser. With this depth, the computed available stormwater detention storage was sufficient to contain the 200-year, 24-hour storm event.

The new water level in the lake gave rise to another concern. When the Sponsor lowered the water level in 2008 to protect the riser, the forebay at the upper end of the lake was exposed to air and sunlight. Although this is a completely forested watershed, grass began to grow in this area. The

US Forest Service was concerned about the potential for introduction of invasive species. To address this concern, NRCS worked with the US Forest Service to implement a planting plan about two years before construction began. Under this plan, the Sponsor planted over 4,500 shrubs and bare-root trees in the forebay. Over time, this newly forested area will shade the stream and help to maintain the cold-water fishery.

Principal spillway. Without the water supply component, it was not necessary to keep the existing gate system parts. During planning, NRCS considered excavating the embankment to remove the damaged riser, all the gates, and about 120 feet of pond drainpipe. This excavation would have daylighted on the back slope of the dam (Figure 7). During the design phase, designers evaluated this proposal more thoroughly. NRCS determined that this option would compromise the integrity of the dam. Instead, they developed a plan to abandon the riser in place. The design required removal of the valve box and inlets for Gates #2 and #3 and the pipe from Gate #3. The contractor left the pipe from Gate #2 in place and filled it with concrete.

The pond drain tower, drain gate valve, and operating system were removed to obtain access to the 24" drainpipe. The drainpipe was slip-lined with a 22" HDPE pipe, which was grouted into place. Before the slip-lining began, the contractor welded a new 16-foot-long section of steel-reinforced concrete pipe to the upstream end of the existing pipe to allow the footer for the new riser to be located outside of the toe of the embankment. Slip-lining the principal spillway pipe also eliminated the concern about the leaky pipe joints in this section.

The HDPE pipe was extended through the riser base to a point about 5 feet downstream of the riser. To allow access to the slip-lined pipe on the downstream end, the riser was cut off at a point about 3 feet below the existing ground level. The riser had a 6" concrete step in the bottom between the upstream and downstream sections of principal spillway pipe. The designer overcame the hydraulic impediment of the step by installing the HDPE pipe through the riser into the downstream section of the pipe.

NRCS criteria stipulated a minimum 24" pipe for this dam. The HDPE pipe had an inside diameter of 20.6". Since the Manning's "n" of the new pipe was much lower than Manning's "n" for the existing concrete pipe, the designer demonstrated an equivalent capacity between the HDPE lined pipe and the existing concrete pipe. NRCS headquarters approved the HDPE lined pipe as equivalent to the existing concrete pipe.

After installing the HDPE pipe, the contractor sealed both ends of the annular space between the two pipes with a bulkhead made of 2'-3' of cellular spray foam. The annular space between the pipes was filled with a cement grout that was installed under pressure (Figure 9). Once the grouting was complete, the contractor performed a video camera survey of the pipe to ensure that the grout had not extruded through any pipe joints or past the end of the HDPE pipe. The contractor placed a 5-foot layer of concrete in the base of the riser to encapsulate the HDPE pipe and then filled the rest of the riser with ASTM size #57 stone. The contractor placed a concrete cap at the top.

To complete the upstream end of the principal spillway, the contractor placed the riser footing and the first two sections of the riser prior to winter shutdown in December of 2012. Work on the riser resumed in the spring, but several delays occurred when spring runoff frequently impounded behind the dam. The finished single-stage, baffle-top riser was 25 feet high with inside dimensions of 2 feet by 6 feet and 12-inch thick walls (Figure 10). The contractor installed a rectangular drain gate at the base of the riser.

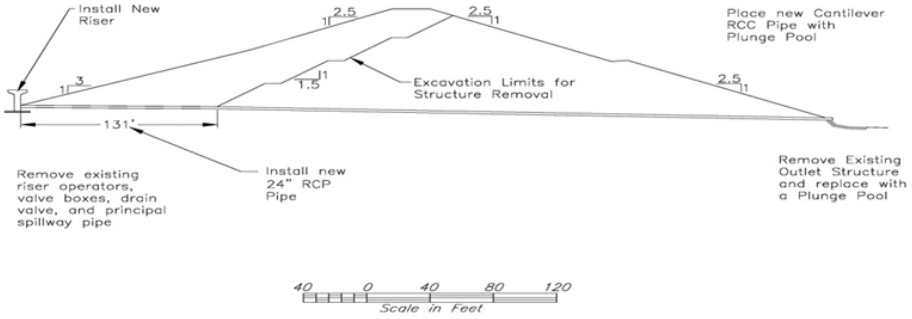

Figure 7. Proposed solution for removing the existing principal spillway system as identified in planning.

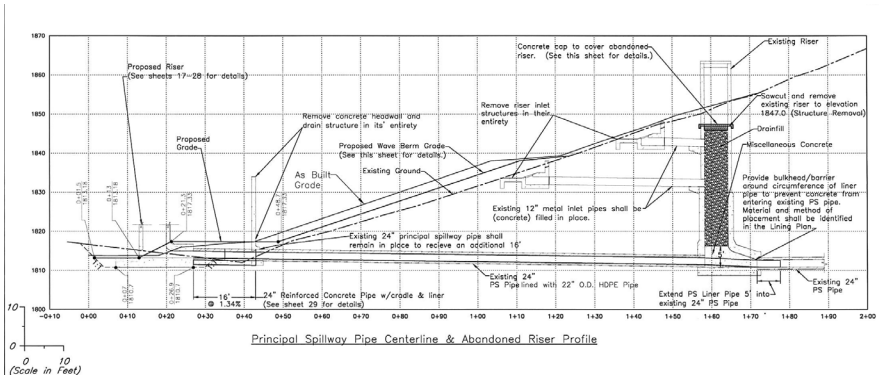

Figure 8. As-built drawing showing the final solution for removing the existing principal spillway system.

Figure 9. Grouting annular space between concrete pipe and HDPE.

Figure 10. New single-stage, baffle-top riser.

Figure 11. Cofferdam left in place around riser for ease of maintenance.

The contractor dewatered the area around the riser by installing an earth and rock cofferdam around the riser. The contractor placed a piece of PVC through the cofferdam and into the principal spillway pipe. During the workday, the contractor closed the pipe to prevent flow in the area. When the riser was complete, the contractor armored the cofferdam with riprap and left it in place (Figure 11) at the request of the Sponsor. By Virginia law, the owner of a dam has to activate the drain gate once a year. Many dam owners hesitate to do this because debris can clog the open gate and cause the lake to drain. With the cofferdam in place, the Sponsor can activate the gate without fear of completely draining the lake. The cofferdam will hold back the lake water and retain some portion of the fish population. The Sponsor will have easy access to the riser gate without dewatering the entire pool. For ease of annual maintenance, the contractor left the access road to the lake in place and installed a boat ramp armored with articulated concrete blocks (ACBs).

On the outlet end of the principal spillway pipe, the contractor removed the unneeded water distribution box (Figure 12) and installed a cantilever pipe outlet with a riprap plunge pool for energy dissipation (Figure 13). The contractor placed monitoring stations with collection pipes on each side of the principal spillway outlet to collect any water present in the rock toe filter of the dam (Figure 14). NRCS designed these monitoring stations to allow evaluation of both water quantity and quality.

Figure 12. Demolition of concrete distribution box.

Figure 13. New cantilever pipe with riprap plunge pool.

Figure 14. Outlet pipe and monitoring stations for toe drain.

Auxiliary spillway. Most of the work on the auxiliary spillway did not begin until the second construction season (Figure 15). With the water supply in place, the auxiliary spillway control section was set at an elevation that would allow detention of the water from the 100-year, 10-day storm event. With the water supply removed, the control section was lowered by 3.3 feet to achieve the necessary spillway capacity. Since the design lowered the new permanent pool level 25 feet below the original pool elevation, the detention storage of the lake increased to hold the 200-year storm event at the new control section elevation.

Lowering the auxiliary spillway crest also assisted with achievement of the needed integrity. The control section was lengthened from 20 feet to 50 feet and the constructed outlet section was shortened by about 55 feet. This allowed a flatter exit slope onto the rock hillslope. The auxiliary spillway was armored with ACBs from the control section downstream to the end of the controlled outlet section and on the inside of the downstream auxiliary spillway training dike (Figure 16 and Figure 17). As a cost-saving measure, the ACBs were left uncovered.

Training dikes were constructed both upstream and downstream of the control section using material excavated from the auxiliary spillway. The upstream training dike was constructed entirely of earth and was used to direct the water into the auxiliary spillway. The downstream dike was constructed of earthfill for 126 feet before transitioning to a vertical concrete wall. NRCS designed the wall because the steep hillslope did not provide sufficient room to continue the earthen dike. A second earthen training dike was installed at the bottom of the hillslope along the left abutment at the toe of the dam to keep auxiliary spillway flows from impacting the toe of the dam. The contractor used material from the plunge pool excavation to construct this dike.

The contractor used the remaining material from the auxiliary spillway excavation to construct a wave berm on the upstream face of the dam (Figure 18). This allowed construction of the project without hauling material off-site. The wave berm is 16 feet wide to accommodate the excess material. The slope below the waterline is 3:1. The Headwaters SWCD, who is responsible for mowing the dam, requested a wave berm because it makes it easier to control the vegetation that often grows at the waterline. It is also a safety feature. This dam has a 2.5:1 slope above the wave berm and is about 70 feet high. The wave berm will prevent the tractor and operator from falling into the lake in the event of a tractor rollover.

The IFLOWS gage was re-established and calibrated to the new permanent pool elevation after the lake was filled (Figure 19).

Figure 15. Auxiliary spillway at the beginning of construction.

Figure 16. Armoring the downstream training dike with ACBs.

Figure 17. ACB armor of auxiliary spillway control section, outlet section, and training dike.

Figure 18. Wave berm installed on upstream face of dam.

Figure 19. The pool area of the rehabilitated dam.

SUMMARY

NRCS rehabilitated South River Dam 10A in order to bring the dam into compliance with current NRCS and Virginia Dam Safety regulations. The dam rehabilitation consisted of lowering and armoring the auxiliary spillway and constructing training dikes for the auxiliary spillway. The principal spillway system was rehabilitated by abandonment or removal of the water supply components, installation of a new riser, slip-lining a portion of the principal spillway pipe, and replacing the concrete outlet structure with a rock-lined plunge pool.

Originally, the planners estimated a cost of $2,995,000 to rehabilitate South River Dam 10A. This plan included removal of the principal spillway system and lowering and armoring the auxiliary spillway. By abandoning the principal spillway system in place and slip-lining the upstream section of the principal spillway pipe, the final cost of rehabilitation was $1,350,187. This represented a considerable savings to both the Sponsor and to NRCS.

CONCLUSION

The small flood control dams constructed by NRCS are a valuable and integral part of the infrastructure of the communities they protect. Rehabilitation of these dams maintains the safety of the community and saves millions of dollars in flood damage. The rehabilitation of South River Dam 10A would not have been successful without the on-going collaboration between multiple Federal and State agencies and the local Sponsors. By their example, these participants serve as a role model for future successful rehabilitation projects.

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From 1954 to 2014 – 60 Years of NRCS Flood Control Dams in Virginia

By Alica J. Ketchem, P.E., and Mathew J. Lyons, P.E.
Presented at the 2015 ASABE Annual International Meeting

Abstract: From 1954 to 2001, the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS), built 150 flood control dams in Virginia. These structures were installed under the Pilot Watershed Program of 1953; Public Law 78-534 (PL-534), the Flood Control Act of 1944; and Public Law 83-566 (PL-566), the Watershed Protection and Flood Prevention Act of 1954. The cost of installing these structures was over $151 million. Over time, the benefits have far exceeded the initial investment. In many cases, the economic benefits of having the dams in place are greater now than when the dams were installed. However, these dams are aging. In 2000, Congress passed the Small Watershed Rehabilitation Amendments to the Watershed Protection and Flood Prevention Act. Since 2005, Virginia NRCS has rehabilitated nine dams and has seven additional dams in various stages of planning, design, and construction. NRCS has also received requests for Federal assistance on ten more dams. Dams considered for this program no longer meet State Dam Safety requirements due to changes in evaluation criteria or hazard class. During the planning process, NRCS considered options for addressing the initial problem and for addressing all other issues identified in the site assessment. After rehabilitation, all of the components of the dam must be in compliance with current NRCS criteria. This often involves modifications to the principal spillway, auxiliary spillway, and embankment. For the nine completed rehabilitation projects, innovative solutions have been used to upgrade the vegetated earth auxiliary spillways to meet the required criteria for integrity, stability, and capacity. The original spillway designs and most of the rehabilitation solutions were based upon the research conducted by the USDA Agricultural Research Service (ARS) Hydraulic Engineering Laboratory in Stillwater, Oklahoma. An evaluation of the performance of these structures demonstrates the effectiveness of the partnership between ARS and NRCS to collaborate on design, construction methods, and effective implementation of economical solutions. As the dams that are part of our national infrastructure continue to age, NRCS and other entities responsible for the safety of these dams will be looking to the ARS Hydraulics Laboratory to continue to develop and improve the tools that we use.

Introduction. From 1954 to 2001, the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS), built 150 flood control dams in Virginia. There were 109 single-purpose flood control dams and 41 multiple-purpose structures installed under the Pilot Watershed Program of 1953; Public Law 78-534 (PL-534), the Flood Control Act of 1944; and Public Law 83-566 (PL-566), the Watershed Protection and Flood Prevention Act of 1954. The cost of installing these structures was over $151 million. However, these dams are aging. In 2000, Congress passed the Small Watershed Rehabilitation Amendments to the Watershed Protection and Flood Prevention Act. Since 2005, Virginia NRCS has rehabilitated nine dams and has seven additional dams in various stages of planning, design, and construction. NRCS has also received requests for Federal assistance on ten more dams. Dams considered for this program no longer meet NRCS or State Dam Safety requirements due to changes in evaluation criteria or hazard class.

Basic Description of a Dam. Every flood control dam has essentially the same main components. There is a principal spillway; a normal or sediment pool; a floodpool; an auxiliary spillway; and an

embankment or dam. The principal spillway controls the day-to-day elevation of the water in the lake and it is set at the elevation needed to provide sediment storage for the planned life of the structure. In Virginia, the principal spillway riser and pipe are typically made of reinforced concrete. The principal spillway also provides a way to control the release of the water from the floodpool. By NRCS policy, the flood pool of a structure with a vegetated earth auxiliary spillway will detain the volume of water associated with the 100-year, 10-day storm event. Water volumes exceeding this amount are passed around the dam through an auxiliary spillway. Of the 150 Virginia flood control dams, 127 were built with vegetated earth auxiliary spillways that were designed using research from the USDA Agricultural Research (ARS) Hydraulic Research Unit in Stillwater, Oklahoma. Two dams have structural auxiliary spillways and 21 dams have auxiliary spillways constructed in rock. The auxiliary spillways each have an inlet section, a level (control) section, a constructed outlet section, and an outlet section. All of the dams were constructed of compacted earth. The top of the earthen embankment is set at an elevation above the anticipated flows in the auxiliary spillway.

Reasons for rehabilitation. When the dams were built in Virginia, almost all of them were located in rural areas. Many of them were built as low hazard structures because there was no threat to loss of life or significant damage to infrastructure in the event of a dam breach. Others were built as Significant or High hazard structures. Over time, the downstream areas of some of the Low or Significant hazard structures have been developed and the hazard class has changed to High because there was a threat to loss of life. Rehabilitation was needed to bring the dams into compliance with the criteria for the higher hazard class. In most cases, the capacity of the existing auxiliary spillway was insufficient. Hazard class changes occurred on Marrowbone Creek No. 1; four dams in the South River Watershed (No. 10A, Mills Creek; No. 23, Robinson Hollow; No. 25, Tom's Branch; and No. 26, Inch Branch); and Upper North River 10, Todd Lake.

The dams in the Pohick Creek Watershed needed rehabilitation for a different reason. From 1970 to 1985, there were six High hazard flood control dams built in this rapidly urbanizing watershed in Fairfax County, Virginia, near Washington, D.C. As part of their ongoing operation and maintenance, Fairfax County hired a consultant to evaluate the condition of the vegetated earth auxiliary spillway of four of the dams. Gannett-Fleming, Inc., used the Water Resource Site Analysis Program (SITES) to make the assessment. It is used to evaluate the potential for a dam breach caused by flow in the auxiliary spillway. Lake Barton (Pohick No. 2), Woodglen Lake (Pohick No. 3), Royal Lake (Pohick No. 4), and Huntsman Lake (Pohick No. 8) all had problems with the integrity and stability of the materials in the auxiliary spillway.

Upper North River No. 77, Hearthstone Lake, is also a High hazard dam. Investigations performed during a breach inundation study commissioned by the State Division of Dam Safety showed that the capacity of the auxiliary spillway was insufficient due to changes in the hydrology of the watershed.

The Rehabilitation Planning Process. Every rehabilitation plan begins with a request for assistance from the Sponsor/Owner of the dam. Only dams originally constructed by SCS/NRCS under the Pilot Watershed Program of 1953; Public Law 78-534 (PL-534), the Flood Control Act of 1944; Public Law 83-566 (PL-566), the Watershed Protection and Flood Prevention Act of 1954, and the Resource Conservation and Development Program authorized by the Agriculture and Food Act of 1981 are eligible for rehabilitation assistance.

Once a dam has been accepted into the Watershed Rehabilitation Program, a watershed plan is prepared. The environmental, social, and economic conditions in the watershed, the concerns of State agencies and local residents, and the as-built and existing condition of the structure are part of the evaluation process. The plan also includes a discussion of the status of the operation and maintenance of the dam; the planned, actual, and future sedimentation rates; the breach analysis; the hazard classification (both NRCS and State criteria); potential modes of dam failure; consequences of dam failure; and alternatives for addressing the identified problems. One of the tools used in the evaluation is the Water Resource Analysis Computer Program (SITES) model.

SITES Model. The SITES model was developed jointly by NRCS, Kansas State University, and the USDA Agricultural Research Service using data from actual spillway flows and research conducted at the USDA-ARS Hydraulic Engineering Research Unit in Stillwater, Oklahoma. SITES is an initial decision tool that predicts the behavior of the materials in the vegetated earth auxiliary spillway in both the existing and proposed condition. It helps the designer to evaluate the treatment alternatives to identify those with a reasonable chance of success. The three primary factors that are evaluated are capacity, integrity, and stability.

For a High hazard dam, the capacity of the auxiliary spillway must be sufficient to pass the volume of water associated with the Probable Maximum Precipitation (PMP) without overtopping the dam. The integrity of the auxiliary spillway is a measure of the strength of the underlying materials. When the materials below the surface of the auxiliary spillway erode to the point where a headcut advances upstream through the leading edge of the control section, the dam is considered to be breached. The stability is a measure of the resistance of the auxiliary spillway to hydraulic stress on the vegetated surface. The stability of a surface is an indicator of the amount of maintenance that can be anticipated. If the maintenance of the surface will be too frequent or too expensive, then another design should be considered to avoid undue burden on the dam owner.

Rehabilitation in Virginia. Every dam that has needed rehabilitation in Virginia has had issues with the auxiliary spillway. When the capacity of the auxiliary spillway is inadequate, the primary mechanism of failure of the structure is erosion of the embankment caused by overtopping the dam. To address this, the choices are to widen the auxiliary spillway, raise the top of the dam, or a combination of the two methods. When the integrity of the materials in the auxiliary spillway is insufficient, the primary mechanism of failure is a breach of the auxiliary spillway. During the rehabilitation planning, all of the components of the dam are evaluated. On 8 of the 11 sites where rehabilitation was needed, there was also a need to replace or repair one or more of the principal spillway components.

Marrowbone No. 1. Marrowbone Dam No. 1, in Henry County, was constructed in 1961 as a low hazard structure which primarily protected agricultural lands. From 1960 to 2000, the population of Henry County increased by 44%. Approximately 160 people lived in the breach zone of the dam in 2003 when the State Division of Dam Safety changed the hazard class to High. The existing auxiliary spillway could pass less than half of the Probable Maximum Flood (PMF). Under the new classification as High hazard, the auxiliary spillway needed to pass the entire volume of the PMF without overtopping the dam. The SITES analysis confirmed the deficiency in the auxiliary spillway size. It also showed that the materials underlying the auxiliary spillway did not have the integrity needed to prevent a breach of the auxiliary spillway.

To achieve the needed capacity and integrity, the solution was to replace the existing vegetated earth spillway in the left abutment with a 228-foot wide Roller-Compacted Concrete (RCC) stepped

spillway (Figure 1) in the center of the dam and a concrete parapet wall across the top of the dam. The elevation of the RCC auxiliary spillway crest was set at the same elevation as the original spillway and the vegetated earth spillway was filled in. The stepped spillway design was based on research performed by the ARS Hydraulics Laboratory. A structural spillway, like this RCC stepped spillway, is different from a vegetated earth spillway in that flow through the spillway is allowed for storm events smaller than the 100-year storm. However, this combined solution was used in order to maintain the level of flood protection that was established in the original design. This precedent has been maintained by NRCS in Virginia for every dam that has been rehabilitated.

Figure 1. RCC stepped spillway at Marrowbone No. 1.

South River No. 10A. Mills Creek Dam, South River No. 10A, in southern Augusta County, was built in 1963 for flood control and water supply as a Significant hazard structure. In 2005, the Virginia Division of Dam Safety issued a conditional certificate of operation because downstream development had necessitated a change in hazard class and the vegetated earth auxiliary spillway had only 70% of the capacity needed to pass the PMF completely. The watershed planning showed additional problems with this structure. According to the SITES analysis, the upper layers of the auxiliary spillway profile did not have the integrity needed to avoid a breach. The surface of the auxiliary spillway also did not meet the stability criteria for prevention of surface erosion. The Sponsors were well aware of this problem. From 1969 to 2003, the auxiliary spillway charged seven times. On each occasion, there was significant damage to the vegetated surface that had to be repaired at the owner's expense.

The principal spillway system at Mills Creek also had major problems. Since the dam was built to include water supply, it had three gates for water removal and a pond drain. By 2008, the principal spillway riser had deteriorated to a point where replacement was the only solution. Two of the water supply gates were inoperable and the pipe from the pond drain to the riser was corroded. Although the pipe from the riser to the outlet was in good condition, there was a problem at the outlet. The outlet structure consisted of a concrete distribution box with a weir wall at the downstream end to impound water. Water hammer conditions in the distribution box had caused a break in the seal between the outlet pipe and the distribution box. During high flow conditions, the water squirted up from the outlet outside of the box.

Although this reservoir was built with the secondary purpose of water supply, the water was never used because the water quality was poor due to the presence of iron oxides. The sponsors chose to remove water supply from the purpose of the Mills Creek reservoir. This change allowed NRCS much more flexibility in the selection of alternative solutions.

To save money and preserve the integrity of the earthen embankment, the existing principal spillway riser system was abandoned in place. The pond drain, the outlet works for Gates 2 and 3, the pipe for Gate 3, and the valve operation box were removed, and the Gate 2 pipe was filled with concrete. The top of the riser was cut off about 3 feet below grade. The corroded pipe from the pond drain to the riser was slip-lined with HDPE pipe and grouted into place. Once this was complete, the old riser was filled with concrete and gravel. A new riser was built at the end of the pond drainpipe. A stepped baffle trash rack was installed on the top of the riser using a design developed by the ARS Hydraulics Laboratory and NRCS (Figure 2). The new riser was set at an elevation that would allow maintenance of the cold-water fishery at the lake. The decision to abandon the existing system in place saved about $1 million in construction costs.

At the outlet of the principal spillway, the water distribution box was removed and replaced with a riprap plunge pool (Figure 3). This part of the design was also based upon research done at the ARS Hydraulics Laboratory.

Figure 2. New riser at South River No. 10A.

Figure 3. New riprap plunge pool at South River No. 10A.

Removal of the water supply component allowed the NRCS designers to increase the capacity of the auxiliary spillway by lowering the crest elevation of the auxiliary spillway by about 3 feet. The level of flood control was actually higher than originally designed because the volume of water associated with the water supply component was very large. The new auxiliary spillway will not charge for events smaller than the 200-year storm. Lowering the crest also placed the auxiliary spillway into a rock layer that had greater integrity. Stability was addressed with the installation of Articulated Concrete Block (ACB) mattresses across the sides and bottom of the auxiliary spillway from the upstream end of the control section to the end of the constructed outlet section.

South River No. 23. As the result of the change from a low hazard structure to a High hazard structure, Robinson Hollow, South River No. 23, needed additional capacity in the auxiliary spillway. This site already had two auxiliary spillways, one on each side of the dam. The narrow

valley configuration precluded widening of the spillways and the need to maintain the existing level of flood protection eliminated the possibility of lowering the crests of the auxiliary spillways. To achieve the needed capacity, a 4-foot high concrete parapet wall was installed across the top of the dam (Figure 4). Both spillways were lined with ACBs to achieve stability (Figure 5). Armoring the auxiliary spillways also allowed the continued use of the right spillway as an access road to reach the home overlooking the lake. The existing riser was removed and replaced with a new one with a stepped baffle trash rack.

Figure 4. Parapet wall at South River No. 23.

Figure 5. ACB installation at South River No. 23.

South River No. 25. South River No. 25, Toms Branch, also had a hazard class change. However, on this site, it was possible to achieve the needed capacity by widening the auxiliary spillway. The site already had the needed integrity. Turf Reinforcement Matting (TRM) was used to achieve stability. During the rehabilitation, the old riser was removed and replaced with one with a stepped baffle trash rack.

South River No. 26. Inch Branch, South River No. 26, needed a wider auxiliary spillway to accommodate the volume of the PMF. A stable outlet was provided by extending the constructed outlet of the vegetated earth auxiliary spillway to the valley floor. The training dike was also extended. As with the other dams in the South River watershed, the riser was removed and replaced.

Upper North River No. 10. The Upper North River watershed is located in western Augusta County. Todd Lake, Upper North River No. 10, is the only one of the three dams in this watershed that was built as a Significant hazard structure. In 2008, the hazard class changed to High. The SITES analysis indicated that the capacity, integrity, and stability were inadequate. The rehabilitation design for this structure includes raising the top of the dam and widening the auxiliary spillway to achieve capacity, installing a concrete cutoff wall to achieve integrity, and armoring the spillway for stability. The principal spillway riser is showing signs of deterioration and will be replaced with a riser with a stepped baffle trash rack during the construction planned for the summer of 2015.

Pohick Creek No. 3, No. 4, and No. 8. There were six High hazard dams constructed in the Pohick Creek Watershed. Fairfax County requested assistance with rehabilitation of four of these

structures because the SITES analysis performed as part of the Gannett-Fleming evaluation showed that the auxiliary spillways were inadequate in integrity and stability. The solutions for correcting the auxiliary spillway problems at Pohick Creek No. 3 (Woodglen Lake), Pohick Creek No. 4 (Royal Lake), and Pohick Creek No. 8 (Huntsman Lake) were essentially the same. On each site, the constructed outlet section of the auxiliary spillway was extended to the valley floor and the training dike was raised and lengthened. The training dikes and the auxiliary spillways were armored with ACBs from the upstream crest of the control section to the valley floor. The principal spillway riser at Huntsman Lake had an open top and did not meet the current seismic criteria. It was replaced with a riser with a stepped baffle trash rack.

Pohick Creek No. 2. The fourth Pohick Creek structure that needed rehabilitation was Lake Barton, Pohick Creek No. 2. Although the initial plans called for installation of an ACB armored spillway like the other ones, the design was changed due to the proximity of the adjacent townhouses. Instead, the sponsors installed a secant pile wall across the lower end of the constructed outlet section (Figure 6) and a concrete cutoff wall across the downstream end of the control section (Figure 7). The SITES model was used to verify the adequacy of this solution.

Figure 6. Secant pile wall installation at Pohick Creek No. 2.

Figure 7. Cutoff wall installation at Pohick Creek No. 2.

Upper North River 77. Hearthstone Lake, Upper North River No. 77, was built as a High hazard structure. During the State-mandated breach inundation study, it was determined that the capacity of the auxiliary spillway was inadequate to contain the PMF event. NRCS prepared a draft rehabilitation plan for this structure in May 2015. The study showed that the hydrology of the watershed has changed from the original design. A combination of widening the vegetated earth auxiliary spillway and raising the top of the dam will be used to achieve the needed capacity. The SITES model also indicated the potential for a stability problem. The proposed solution is the installation of TRM. As part of the investigation, all of the components of the dam were evaluated. The two-stage riser itself is in good condition but the foundation is not adequate to meet current seismic criteria. The foundation will be retrofitted as part of the rehabilitation.

Figure 8. Inlet of existing auxiliary spillway at Upper North River No. 77.

Summary. From 1954 to 2001, SCS/NRCS in Virginia built 150 dams for the primary purpose of flood control. These dams have performed well for the conditions for which they were designed. However, over time, some of the conditions have changed. Watershed development, additional hydrology data, and new evaluation tools have created a need to rehabilitate some of these structures. Since 2005, NRCS in Virginia has completed rehabilitation of nine dams in Virginia. One is currently in construction, one is in the late stages of planning, and five more are in early stages of planning.

One tool that has been vital to the NRCS efforts in this process has been the SITES model. This model has allowed us to assess our vegetated earth auxiliary spillways in ways that were not available during the original design. It also helps us to identify solutions that have a reasonable chance of success. Other ARS research that is frequently utilized includes designs for vegetated earth auxiliary spillways, riprap plunge pools, stepped baffle trash racks, and RCC stepped spillways.

Conclusion. Virginia NRCS has been installing dams since 1954 and there is no end in sight to the workload needed to keep these dams in good working order. Even with the increased costs of rehabilitation, the Sponsors and the local community have recognized the value that the dams bring in both safety and quality of life and have chosen to support rehabilitation that will extend the life of the dams for an additional 50-100 years. As the dams that are part of our national infrastructure continue to age, NRCS and other entities responsible for the safety of these dams will be looking to the ARS Hydraulics Laboratory to continue to develop and improve the tools that we use.

References: Various Design Reports and Watershed Workplans.

The Unexpected Recreation Benefits of 60 Years of NRCS Flood Control Dams in Virginia

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Presented at the 2016 ASABE Annual International Meeting and
the 2015 National Watershed Coalition Meeting

Abstract. From 1954 to 2001, the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS), assisted sponsors with construction of 109 single-purpose flood control dams and 41 multiple-purpose structures in Virginia. These dams were installed under the Pilot Watershed Program of 1953; Public Law 78-534 (PL-534), the Flood Control Act of 1944; and Public Law 83-566 (PL-566), the Watershed Protection and Flood Prevention Act of 1954. Dams have been installed in 35 watersheds within 27 counties across Virginia at an original cost of over $151 million dollars. Over time, the recreational benefits have exceeded the levels expected during the planning process for many of the sites that were built. Of the 41 multiple-purpose structures, 25 were built with recreation as a purpose. Of those, 11 have public access recreational facilities. Ten of the 15 structures built with water supply as the only secondary purpose also have public recreation. The big surprise was that 16 of the single-purpose flood control dams have public recreation facilities. Together, 25% of the dams have public access recreation. Fishing, boating, camping, hiking, and bird watching are just a few of the recreational benefits. From the social perspective, the dams have become part of the fabric of the community. In several places, there are lake-based events that bring tourism into the county. All of these activities bring value to the community that is measured not only in the associated economics but in giving an appreciation of nature, improving physical and mental health, and contributing to the quality of life. Although the commitment to providing flood control remains, NRCS can be proud of the way that the people have made these reservoirs a part of their daily lives.

Introduction. From 1954 to 2001, the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS), assisted sponsors with construction of 109 single-purpose flood control dams and 41 multiple-purpose dams in Virginia. These dams were installed under the Pilot Watershed Program of 1953; Public Law 78-534 (PL-534), the Flood Control Act of 1944; and Public Law 83-566 (PL-566), the Watershed Protection and Flood Prevention Act of 1954. Dams were installed in 35 watersheds within 27 counties across Virginia at an original cost of over $151 million dollars. Since the time of installation, some of these dams have become a part of the community in ways that were not envisioned when they were planned.

The National Inventory of Dams (NID) allows each dam to be described by as many as four purposes. The main purpose of each dam was to provide flood control. In Virginia, 40 of the 41 multiple-purpose structures were built to include water supply, recreation, fish and wildlife, or a combination of these secondary purposes. There is one dam built with the secondary purpose of irrigation. Recreation was the only secondary purpose for 15 sites and water supply was the only secondary purpose for another 15 dams. Nine of the remaining 10 had both water supply and recreation. One site was built for the specific purpose of creating a fish and wildlife pool with recreation. As of 2015, 21 of these multiple-purpose structures had public recreation facilities at the reservoirs. Seventeen of them were also water supply structures. When all the public recreation sites associated with NRCS dams were evaluated, the big surprise was that 16 of the single-purpose flood control structures also had public recreation and one additional site is under consideration.

This paper provides an overview of the recreation provided by the 37 dams with general public access for recreation with highlights of selected dams.

Planned recreation. Briery Creek Lake (Bush River No. 1E) in the Bush River Watershed is the only flood control dam that was built for the explicit secondary purpose of developing fishing-based recreation. This 845-acre lake was opened in 1989. It is owned by the Virginia Department of Game and Inland Fisheries (VDWR) and is within the Briery Creek Wildlife Management Area in Prince Edward County. There are two concrete boat ramps and one unimproved boat ramp in three locations around the lake. There are abundant opportunities for shoreline fishing and there is a covered handicapped-accessible fishing pier. Discarded Christmas trees are placed near this pier as fish attractors. The pool area of this reservoir was not cleared during construction. The standing timber has died over time and has left some great fish habitat throughout the lake. Briery Creek Lake is considered to be the premier trophy largemouth bass lake in Virginia (Figure 1). Since 1993, 24 of the 25 heaviest largemouth bass entered into the Virginia Angler Recognition Program have come from this lake.

Figure 1. Largemouth Bass at Briery Creek Lake. Credit: VDGIF.

A second dam in the Bush River Watershed, Sandy River Reservoir (Bush River No. 12), was completed in 1994 and opened for fishing in 1996. The lake is owned by Prince Edward County and was built for flood control, water supply, and recreation. The fisheries are managed by the VDGIF. It is stocked with largemouth bass, black crappie, red-ear sunfish, chain pickerel, and bluegill. The lake is also known for its channel catfish. It has a double-lane concrete boat ramp, a 150-foot fishing pier, a large paved parking lot, and handicapped-accessible facilities. The other five dams in this watershed were built solely for flood control and are not open to the public.

Most of the 15 dams built with recreation as the only secondary purpose were built on private land and are not accessible to the public. One notable exception is Stony Creek No. 9, known locally as Lake Laura. The dam is owned by the Lord Fairfax Soil and Water Conservation District (SWCD) and the lake provides water-based recreation to Bryce Resort in Shenandoah County, Virginia. According to the General Manager of Bryce Resort, the resort probably would not be sustainable without the lake. In the summer, Lake Laura supports a swimming area with approximately 4,000 paying customers per year. Concessions and boat rentals supplement this use. The VDGIF stocks this lake with largemouth bass, channel catfish, and sunfish. The lake is considered to be one of the

best fishing areas in Virginia. Water from the lake is also used to irrigate the golf course where 18,000 rounds of golf are played annually. However, the main use of Lake Laura is to provide water to make snow at the Bryce Resort ski area. About 44,000 people come to Bryce Resort for the skiing, snowboarding, and snow tubing every year. Over 90% of the snow on the slopes is made from water supplied by this lake (Figure 2).

Figure 2. Snowmaking at Bryce Resort. Credit: Bryce Resort.

Slate River Lake, Slate River No. 7, was built in the Appomattox-Buckingham State Forest in 1991 and is managed by the VDGIF as a warm-water fishery. It was planned for recreation since the State Forest and its recreational uses were already established. This relatively shallow lake has great fish habitat due to the standing timber that was left in place. A boat ramp is located near the dam. Gasoline engines are not permitted on the lake. Visitors to the Appomattox-Buckingham State Forest can enjoy hiking, wildlife watching, biking, horseback riding, hunting, fishing, geocaching, and picnicking.

The reservoir at Cedar Run No. 4, Germantown Lake, is the focal point of C. M. Crockett Park, a planned recreational facility in Midland, Virginia. This dam was planned in 1975 for water supply and recreation in a rapidly developing part of northern Virginia. Construction was completed in 1985. When the watershed plan was written, Fauquier County planned to purchase 18 acres on the east side of the lake. Now the county owns 100 acres of parkland on three sides of the lake. There is no swimming allowed in this lake and no gasoline engines. However, the park has rentable picnic pavilions, picnic tables in the open, a handicapped-accessible fishing pier, a boat launch, and a concession stand that offers bait, soft drinks, and food. In 2014, there were 7,950 hours of boating in rented boats (Figure 3). The VDGIF stocks the lake as a warm-water fishery. The park is also the site of the Fauquier County Commemorative Grove where gardens and groves of trees have been established through donation of the plants. Germantown Lake serves as the backdrop to the amphitheater where weddings and other events are held. When this dam was planned, the anticipated use of the park was about 20,000 visitors annually. Thirty years after construction, the park serves 103,000 to 105,000 visitors each year. The park hosts two major events per year. The Family Earth Day Festival in the spring is designed to draw people's attention to nature and the environment through music and environmental education booths sponsored by groups such as the John Marshall SWCD. The Children's Festival in the fall is for children ages 3 to 12 and their

parents. About 1,500 people attend to see the soil tunnel, petting zoo, and more than 20 other activities and presentations. The Park staff also conducts environmental education programs for schools and Scouts.

Figure 3. Paddle boating on Germantown Lake. Credit: C. M. Crockett Park.

There are six other dams that were planned for recreation that have public access. All of them are stocked by VDGIF. Beaver Creek Reservoir (Beaver Creek No. 1), in Albemarle County, is a water supply reservoir that is used for fishing and picnicking. It is also used by the Western Albemarle High School rowing team as a practice facility. Lincolnshire Park is the site of Upper Clinch Valley No. 8, known as Lincolnshire Park Dam. The park has trout fishing in the lake. Around the lake, there are tennis courts, a basketball court, a sand volleyball court, three picnic shelters, two softball fields, and a Junior Olympic size pool. Upper North River No. 76 (Elkhorn Lake) in Augusta County, Ni River No.1 (Ni River Reservoir) in Spotsylvania County, and Great Creek No. 6A (Great Creek Lake) in Brunswick County, were built for flood control, water supply, and recreation. They are primarily used for boating and fishing. Lake Braddock (Pohick Creek No. 7) was built for recreation. Fishing is the primary use.

Water supply. Of the 15 dams built with a secondary purpose of water supply, ten sites are now also used to provide recreation. The watershed plans for these dams put recreation as a minor, if not negligible benefit. Perhaps that was true in the context of the benefits of the flood control but the towns and counties that own these structures have added value to the community by developing the recreation.

Although Upper Clinch Valley No. 1B, Lake Witten, was built with water supply as the dominant purpose, the recreation at the lake has become a hub of activity in southwestern Virginia. The lake has been complemented with the addition of the Cavitts Creek Park. The park has primitive camping sites and the only full-service RV camping sites in the area. It is usually full every weekend during the summer. There is a large playground, picnic shelters, and boat rentals. Lake Witten is also the site for the Annual Kids Fishing Day hosted by the Tazewell SWCD and the Tazewell County Board of Supervisors. This event regularly has attendance of more than 1,300 people. The VDGIF provides a special stocking of trout the night before the event and only the children are allowed to fish. There are booths hosted by law enforcement, Search and Rescue, Farm Bureau, VDGIF, and many other organizations. Lunch is provided as well as prizes for every child.

The Tazewell SWCD also participates in the State Heritage Day sponsored at the lake by VDGIF and has used the area around the lake to host the State Envirothon and farm tour picnics.

Lake Arrowhead (Dry Run No. 101), in Page County, Virginia, was planned in 1964 to provide water supply to the Town of Luray. Although the Town was planning to build a park at the lake, the Watershed Plan for the site indicated that the recreational value would be limited by the variable water levels and recreational benefits were not used for project justification. The 39-acre impoundment was built in 1971 and is now the focal point of the 134-acre Lake Arrowhead Park Recreation Area. The lake has a maximum depth of 43 feet and is stocked with largemouth bass, walleye, northern pike, bluegill, crappie, red-ear sunfish, and channel catfish. The Page Valley Bass Anglers club have added fish attracters to the lake to increase habitat. Shoreline fishing access is available around about 70% of the lake. The park offers Night Catfishing until midnight from April to October on the 2nd and 4th Fridays of each month. Lake Arrowhead has not yet been needed as a source of water and the Town allows swimming from Memorial Day to Labor Day. The Town made nearly $10,000 in 2014 on swimming fees and boat rentals alone, not including Lake Arrowhead fishing permit and shelter rental sales. Allowing water-contact sports gives Luray the opportunity to host the Luray Triathlon which is held at Lake Arrowhead Park (Figure 4). In 10 years, this one-day, 250-athlete event has grown into a two-day event with over 700 athletes per day. In 2013, the Luray Triathlon was chosen as the Best Mid-Atlantic Triathlon by Competitor Magazine. The 2015 Spring Triathlon has been designated as a championship race by the USA Triathlon which is an organization that establishes national accreditation of triathlon races. Other recreational opportunities include hiking the one-mile marked trail that goes completely around the lake. Park amenities include a white sand beach with a volleyball net and a roped off swimming area with lifeguards on duty, concessions, six picnic shelters, playground area, horseshoe pits, a softball field, and a scout camping site.

Figure 4. Triathlon swimming at Lake Arrowhead. Credit: Arrowhead Park.

There are eight other water supply dams with public access. They are all currently stocked by VDGIF except for South River No. 10A, Mills Creek. The Mills Creek dam was recently rehabilitated by NRCS and the reservoir is in the recovery period.

Flood control. There are 109 single-purpose flood control dams. Most of the dams are located on private property with no public access. However, there are 16 flood control dams around Virginia

that are different. These sites range from isolated, forested areas to rural farmland to highly urbanized watersheds. The common element is that their communities have taken these reservoirs into frequent and even daily usage.

Six dams are located in the George Washington and Thomas Jefferson National Forests. The U.S. Forest Service owns the recreation facilities at Upper Sherando Lake (South River No. 27), Todd Lake (Upper North River No. 10), Hearthstone Lake (Upper North River No. 77), Briery Branch (Lower North River No. 78), Hone Quarry (Lower North River No. 83), and Slate Lick Lake (Shoemaker River No. 4C). The VDGIF stocks five of the six lakes with trout multiple times each year. Todd Lake is not stocked because it is drained every other year for maintenance of the beach.

The 7-acre Upper Sherando Lake was built in 1958 upstream of Lower Sherando Lake which was built in the mid-1930's by the Civilian Conservation Corps. Recreation facilities associated with these lakes include campgrounds, a swimming beach, bathhouses, and hiking trails. There are no boat launches but small boats are regularly carried in. Upper Sherando has a handicapped-accessible fishing dock.

Todd Lake was designed and built to accommodate a planned campground and swimming area. It has bathrooms, barbeque and picnic areas, campsites, and a sand beach (Figure 5). Other activities include hiking and canoeing. There are approximately 4,400 recreational users annually.

Figure 5. The sand beach at Todd Lake. Credit: NRCS.

Hearthstone Lake is a 12.3-acre lake that is managed for both cold water and warm water fisheries. In 2001, the lake was stocked with northern pike and yellow perch. A small primitive boat launch allows boating access. Shoreline fishing is available on the south side of the lake and along the face of the dam. The estimated usage is about 1,800 people per year. NRCS and the Sponsors are in the planning stage of rehabilitation of the dam and there was good attendance at the public meetings for this process. The lake is highly valued by the local residents. According to one local man, it was a romantic place to propose marriage.

The fishing at Briery Branch Lake is primarily bank access but small boats or canoes can be carried in. It is stocked with trout eight times per year but also has channel catfish, largemouth bass, and bluegill.

Hone Quarry is a 5.5 acre lake that has a primitive boat launch. In addition to the trout, the lake has bass, sunfish, crappie, and channel catfish. In 1998, the lake was also stocked with walleye to better manage the sunfish and crappie populations. There is a campground and picnic area below the dam.

Although Slate Lick Lake is stocked by VDGIF, access to the lake requires a hike of about 0.8 miles from the road.

The U.S. Forest Service also assists the City of Harrisonburg with Dry Run Dam, Lower North River No. 22B. It has some fishing but is not stocked by VDGIF.

Amherst County owns the three dams that SCS built in the Buffalo River Watershed. Of these, one was built for flood control and water supply and the other two were built solely for flood control. All are stocked as warm water fisheries with largemouth bass, bluegill, red-ear sunfish, and black crappie. Each site has a boat ramp, but none allow gasoline engines. There are picnic tables, restrooms, and play areas at all three sites. Stonehouse Lake, Buffalo River No. 3, also has picnic shelters that are available on a first come, first serve basis (Figure 6). Thrasher Lake, Buffalo River No. 2, is the site of an annual Easter egg hunt with approximately 250 participants up to 5th grade. The largest lake, Mill Creek Reservoir (Buffalo River No. 4A), has 189 acres of surface water. It has been used as the site of bass fishing tournaments sponsored by local groups. It also is the site for an annual fishing clinic in June that has had up to 60 participants.

Figure 6. Stonehouse Lake recreation facilities. Credit: NRCS.

Fairfax County, just outside of Washington, D.C., is the location of the Pohick Creek Watershed. This urban watershed has five single-purpose flood control dams and one structure built for flood control and recreation (Lake Braddock, Pohick Creek No. 7). The watershed plan was completed in 1969 and the dams were constructed from 1970 to 1985. After the passage of the Small Watershed Rehabilitation Amendments of 2000, NRCS prepared plans for the rehabilitation of Royal Lake (Pohick Creek No. 4), Woodglen Lake (Pohick Creek No. 3), Lake Barton (Pohick Creek No. 2), and Huntsman Lake (Pohick Creek No. 8). There were between 25 and 50 participants at each of the nine public meetings held during the planning process and a recurring theme was the importance of the recreation at the lakes.

Lake Braddock was planned for recreation, but Fairfax County identified fishing as the only activity at the lake. It is owned by a Homeowners Association that has some restrictions on access. The other five dams also have fishing. Bird watching and walking are other activities that these flood control dams have in common. There are walking trails at all five of the flood control dams. At Lake Barton, the trail goes all the way around the pool with a stop at the "tot-lot" at the upper end. Woodglen Lake and Huntsman Lake both have trails across the top of the dam. Huntsman Lake also has a boat launch.

Royal Lake has many more amenities (Figure 7). Lake-based recreation and other activities associated with the recreational facilities developed around the lake include boating, fishing, picnicking/barbequing, outdoor concerts, environmental education activities, cycling, walking and jogging, skateboarding and rollerblading, youth sports (baseball, basketball, cross-country training, soccer, and tennis), and swimming at the nearby Lakeview Swim Club. In 2006, there were an estimated 15,321 user days enjoyed at the lake. A user day is eight hours. The estimated value to the community is $292,000 annually.

Figure 7. Aerial view of Royal Lake. Credit: Virginia Geographic Information Network.

Lovills Creek Lake (Stewarts Creek-Lovills Creek No. 9B), in Carroll County, Virginia, provides flood control to the City of Mt. Airy, North Carolina, and Surry County, North Carolina. The VDGIF stocks the 55-acre lake with largemouth bass, bluegill, red-ear sunfish, channel catfish, black crappie, chain pickerel, yellow perch, and suckers. A one-mile section of the stream below the dam is stocked with trout two times between October 1 and April 30. A boat launch is available; however, no gasoline engines are allowed. The fishing pier is handicapped-accessible. Water-contact activities are not allowed. The park area has a picnic shelter, swings, and a slide. The park has a lot of visitors during the summer months and it is a popular location for birthday parties.

The dam at Stony Creek (South River No. 6), also known as Senger's Mountain Lake, is owned by the Headwaters SWCD but the property around the lake is privately owned. There is a private campground with tent and RV camping, cabins, volleyball, and a camp store. Since this campground was built in the flood pool of the dam, flooding has occurred several times. However, it is a very popular place for families and has been used for multiple generations.

The City of Waynesboro has expressed an interest in developing South River No. 8, Jones Hollow, for fishing. The lake is not currently stocked, and limited parking may restrict the potential for use.

Summary. Of the 150 dams built in Virginia by SCS for flood control since 1954, 37 are currently used by the public for recreation. Eleven of the 25 structures built with recreation as a purpose are actually used by the public. These sites are owned by a unit of government for the most part. There are 14 multi-purpose recreation structures built on private land with no public access. The 15 reservoirs built for the purpose of water supply are owned by counties, cities and towns, and one Soil and Water Conservation District. Ten of them have been developed for recreation in some way. There are 16 single-purpose flood control dams that have recreation and one is proposed for development. Together, 25% of the dams built by NRCS/SCS in Virginia have public recreation developed by the community.

Conclusion. Flood control dams built by SCS/NRCS are part of the infrastructure of Virginia and relatively few people are aware of their existence and purpose. However, many of the sites that are used for recreation have become a part of the fabric of their communities in ways that were not envisioned during the planning process. In some cases, like Germantown Lake, the anticipated usage is much greater than planned. The annual visits to this park are over five times the number mentioned in the planning report. In other places, like Lake Witten and Lake Arrowhead, the local people have expanded the usage beyond water supply to involve their communities in events such as the Kids Fishing Day and the Luray Triathlon. The amount of recreation at the 16 lakes that were planned only for flood control was a surprise. Fishing and boating are the main activities at these lakes. Other activities include camping, hiking, birdwatching, and picnicking. All of these activities bring value to the community that is measured not only in the associated economics but in giving an appreciation of nature, improving physical and mental health, and contributing to the quality of life (Figure 8). Although the commitment to providing flood control remains, NRCS can be proud of the way that the local people have expanded upon the planned use of these dams to make these reservoirs a part of their daily lives.

Figure 8. Fishing Day. Credit: Tazewell SWCD.

References

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Acknowledgements: Thanks to the Virginia Department of Wildlife Resources, Tazewell SWCD, Bryce Resort, Town of Luray Department of Parks and Recreation, C. M. Crockett Park, Fairfax County Park Authority, Carroll County, and the Virginia NRCS staff for their assistance with information and pictures.

Reservoir sediment impacts on the rehabilitation of NRCS-assisted flood control dams in Virginia

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Abstract. Sediment storage is a vital component of an NRCS-assisted flood control dam. Because most people do not notice sediment unless there is a problem, they are unaware of its role in the design of the dam and its influence on the options for rehabilitation of the dam. Sediment accumulation directly or indirectly impacts several factors such as project lifespan, normal pool elevation, future sediment storage and flood storage capacity. Since the enactment of Section 313 of Public Law 106-472, "The Small Watershed Rehabilitation Amendments of 2000," the USDA Natural Resources Conservation Service in Virginia has prepared 16 dam rehabilitation plans. Each plan began with a survey of the amount of sediment in the reservoir. NRCS used several different techniques to collect the information. The technique used in each case depended on the reservoir characteristics. The amount of accumulated sediment was dependent on the watershed characteristics. For the suburban watersheds in Northern Virginia, the actual sedimentation rates were closer to the design sedimentation rates than those seen in the forested mountains in west central Virginia where the actual sedimentation rate was much lower than anticipated. Where there were dams in series, the dam in the upper watershed trapped more sediment than designed while the lower dam trapped less. On some sites, the sediment volume was the limiting factor in the expected life of the structure. These different situations affected the alternatives that were available for rehabilitation.

Introduction. Since 1954, the USDA Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS), has built 150 flood control dams in Virginia. For some of these dams, the downstream watershed conditions have changed, resulting in a change of hazard class from Low or Significant hazard potential to High hazard potential. When the auxiliary spillways of these dams were evaluated using the criteria for a High hazard potential dam, they did not meet the criteria for capacity, integrity, or both. In Fairfax County, the auxiliary spillways of four dams constructed as High hazard potential did not meet current criteria for integrity. For a High hazard dam, the capacity of the auxiliary spillway must be sufficient to pass the entire volume of water associated with the Probable Maximum Flood (PMF) event without overtopping the dam. The soil materials in the vegetated earth auxiliary spillway must have the strength (integrity) to prevent a breach in the PMF event.

Since 2000, NRCS approved 16 dams in Virginia for inclusion in the NRCS rehabilitation program authorized by Section 313 of Public Law 106-472, "The Small Watershed Rehabilitation Amendments of 2000. NRCS has completed rehabilitation on twelve dams. One dam is currently under construction and three are in the final stages of planning.

One of the initial steps of rehabilitation planning is an evaluation of the volume of sediment currently in the reservoir behind the dam. NRCS designed each dam to store all the sediment that would accumulate over the planned life of the dam. A dam must have at least 50 years of remaining service life after completion of the rehabilitation.

The amount of submerged sediment present in the reservoir directly affected the potential rehabilitation alternatives for four of the rehabilitated dams. These four dams are Pohick Creek

Dam No. 2 (Lake Barton), in Fairfax County; Mountain Run Dam No. 11 (Mountain Run Lake) and Mountain Run Dam No. 50 (Lake Pelham), in Culpeper County; and South River Dam No. 10A (Mills Creek), in Augusta County. NRCS performed three of the sediment survey investigations. Fairfax County conducted the fourth investigation.

Pohick Creek No. 2, Lake Barton. The Pohick Creek watershed is in Fairfax County, Virginia, near Washington, D.C., and is dominantly urban. Dam No. 2, Lake Barton, was constructed in 1978 for flood control. The dam was designed and built as a High hazard potential structure and is owned and operated by Fairfax County. In 2001, Fairfax County contracted with Gannett Fleming, Inc., to evaluate the condition of the auxiliary spillway. Using the NRCS Water Resources Site Analysis Program (SITES), Gannett Fleming determined that the vegetated earth auxiliary spillway would experience significant erosion in a storm event that exceeded 70% of the Probable Maximum Flood (PMF). A breach would occur at about the 2,000-year flood event. Based upon this finding of insufficient integrity, the Virginia Division of Dam Safety issued a conditional certificate of operation in March 2004. A conditional certificate serves as notification to the owners that the dam no longer meets State requirements and must be modified as soon as possible to meet State law. Fairfax County requested assistance from NRCS to conduct the watershed planning and identify the improvements needed to regain a full dam safety certification.

Fairfax County completed a sediment survey of the reservoir in March 2007. The survey showed that the as-built sediment pool had a volume of 46.2 acre-feet instead of the 64 acre-feet called for in the design. At the time of construction, the amount of borrow taken from the pool area was less than originally planned. The design called for a 100-year sediment storage volume of 64 acre-feet with a sediment deposition rate of 0.64 acre-feet per year.

The 2007 sediment survey showed that there was 17.5 acre-feet of sediment in the pool. Approximately 10.3 acre-feet of sediment was removed by dredging from 1985 to 1990. The Lake Barton dam trapped a total of 27.8 acre-feet of sediment in its first 29 years. The sedimentation rate for this time period was 0.96 acre-feet per year.

When NRCS wrote the Pohick Creek watershed plan in 1967, 6% of the watershed was ‘Residential/Business’ and 70% of the watershed was wooded (table 1). In the original design for Lake Barton, prepared in 1976, NRCS identified 463 acres of the watershed as “subject to construction.” As of 2009, NRCS classified about 400 acres (74%) of the 539 acres in the watershed as having a land use of ‘Residential/Business’ or ‘Transportation.’ ‘Woodland’ occupied 20.2% of the Lake Barton watershed. This pattern of development also occurred in the watersheds of Pohick Creek Dams No. 3, No. 4, and No. 8 where ‘Residential/Business’ or ‘Transportation’ land uses covered 81.2%, 81%, and 73.6%, respectively. In those watersheds, ‘Woodland’ was 15.9%, 17.1%, and 20.9%, respectively. Fairfax County proactively zoned the pre-dam, 100-year floodplain in the Pohick Creek watershed in the early 1970’s to prevent development in the floodplain. Most of the woodland is in the zoned floodplain.

Since the majority of the construction in the Lake Barton watershed had already occurred by the time of rehabilitation, NRCS determined that a lower sediment accumulation rate of 0.68 acre-feet per year could be expected for the remainder of the dam life. There were 28.7 acre-feet of storage remaining in the reservoir in 2007. Based upon the projected sedimentation rate, there were 42 years of sediment life remaining at that time.

Table 1. Land use in the Pohick Creek watershed in 1967 and Lake Barton in 2007.

Land Cover Type	1967 Overall watershed		2007 – Lake Barton	
	Drainage Area (acres)	Percent of Total	Drainage Area (acres)	Percent of Total
Residential/Business	1,361	6	336	62.3
Woodland	15,883	70	109	20.2
Transportation	-	-	64	11.9
Grassland	2,723	12	21	3.9
Water	-	-	9	1.7
Cropland	1,135	5	0	0
Other	1,588	7	-	-
Totals	**22,690**	**100%**	**539**	**100.0%**

Under the federal rehabilitation requirements, a minimum of 50 years of sediment storage must be available upon completion of the rehabilitation project. Since the average project has two years of design and construction before completion and the anticipated project completion date was 2010, the needed additional capacity of Lake Barton was 11 years of storage. This was about 7.5 acre-feet (12,100 cubic yards). NRCS evaluated two options for gaining the necessary capacity.

NRCS Option 1: Remove 7.5 acre-feet of sediment by dredging. This was about 43% of the sediment in the lake as of 2007. Most of, if not all, the people concerned about the lake considered this solution incomplete, because the majority of the sediment would still be present. NRCS estimated a cost of $760,000 to remove 7.5 acre-feet of sediment.

NRCS Option 2: Add 7.5 acre-feet to the capacity of the sediment pool by raising the water level by 0.8 feet (~10 inches). This entailed enlarging the existing principal spillway orifice to a total size of 22” W x 29” H and then closing off the bottom 10 inches by placing a steel plate across the orifice. The finished orifice size would be 22” W x 19” H. NRCS estimated a $20,000 cost for this option. Raising the permanent water level by 0.8 feet would increase the surface area of the lake from 9.23 acres to 9.67 acres. The trails around the lake were above the proposed pool elevation but would be affected by more frequent flooding. Fairfax County would have to acquire the landrights to the approximately 0.44 acres around the perimeter of the lake in the area impacted by the elevated water level. Use of this option did not preclude dredging of the lake by the Sponsors at a later time.

The sediment pool volume and the floodpool detention volume together made up the total amount of water and sediment stored below the crest of the auxiliary spillway. Increasing the sediment storage capacity by raising the permanent pool 0.8 feet would cause a decrease of 7.5 acre-feet in floodwater detention volume. However, the auxiliary spillway for the structure was 0.5 feet too low for a vegetated earth auxiliary spillway. Raising the auxiliary spillway crest by 0.5 feet would increase the floodwater detention capacity by 20.9 acre-feet for a net gain of 13.4 acre-feet.

Sponsor option: Rather than only removing enough sediment to meet NRCS requirement, the Sponsors chose to remove nearly all of the sediment from the lake. There were 20.1 acre-feet of sediment in the lake as of 2011 when dredging began (fig. 1). Approximately 17.1 acre-feet were removed, leaving 3 acre-feet. This restored 93.5% of the original submerged sediment storage capacity of 46.2 acre-feet. This volume of storage was sufficient to give a new submerged sediment life of 63.5 years at the anticipated sediment accumulation rate of 0.68 acre-feet per year. For the entire dredging project, including site restoration, the cost was $1,512,922.

Figure 1. Dredging of Lake Barton.

The rehabilitation alternative selected for the Lake Barton dam was a structural solution consisting of a reinforced concrete cutoff wall at the existing auxiliary spillway crest elevation and a secant pile wall at the end of the constructed outlet section. NRCS did not raise the crest of the auxiliary spillway and there was no change in the normal pool or floodpool capacity.

Mountain Run No. 11, Mountain Run Lake, and No. 50, Pelham Lake. The Mountain Run watershed is in Culpeper County, which is in the northern Piedmont region of Virginia. Development has occurred in less than 16% of the 16,736-acre watershed. Over 80% of the watershed is in woodland or hay/pasture. NRCS constructed two single-purpose flood control dams and three multi-purpose (flood control and water supply) dams from 1959 to 1973.

NRCS built Mountain Run Lake in 1959 as a Low hazard potential structure with the purposes of flood control and water supply for the Town of Culpeper. The Virginia Division of Dam Safety changed the hazard potential of the dam to High in 2007. The existing vegetated earth auxiliary spillway did not meet the capacity or integrity criteria for a High hazard dam.

NRCS built Lake Pelham as a High hazard potential dam in 1973 for the purposes of flood control and water supply. In 2007, the Virginia Division of Dam Safety issued a conditional certificate of

operation for the dam because the vegetated earth auxiliary spillway did not have sufficient capacity or integrity to pass the PMF event without overtopping the dam or breaching the auxiliary spillway.

Sediment survey. The Sponsors requested rehabilitation assistance from NRCS for both dams in 2012. NRCS staff conducted a sediment survey September 2014. The staff used a Garmin GPSMAP 541s mounted on the back of a boat to take GPS-referenced sonar readings of the top of the sediment. They took 1,648 data points on Mountain Run Lake and 2,033 data points on Lake Pelham in a grid pattern (figs. 2 and 3). They used a Trimble R8 GNSS to compare elevations near the water's edge and to calibrate the sounder survey with the geodetic survey. NRCS staff used this information to determine the current water volume in each lake. They subtracted the water volume from the as-built volume of the lake to determine the existing sediment volume.

The planned service life of the Mountain Run 11 dam was 50 years with a predicted submerged sediment accumulation rate of 1.6 acre-feet per year. The actual submerged sediment accumulation rate was 1.76 acre-feet per year. In 2014, after 55 years of service life, the volume of sediment was 123 acre-feet. This volume was 35 acre-feet more than projected and the sediment volume had started to affect the available water supply. Table 2 shows the designed, as-built, and 2014 submerged sediment status.

Figure 2. Data points in Mountain Run Lake for sediment survey.

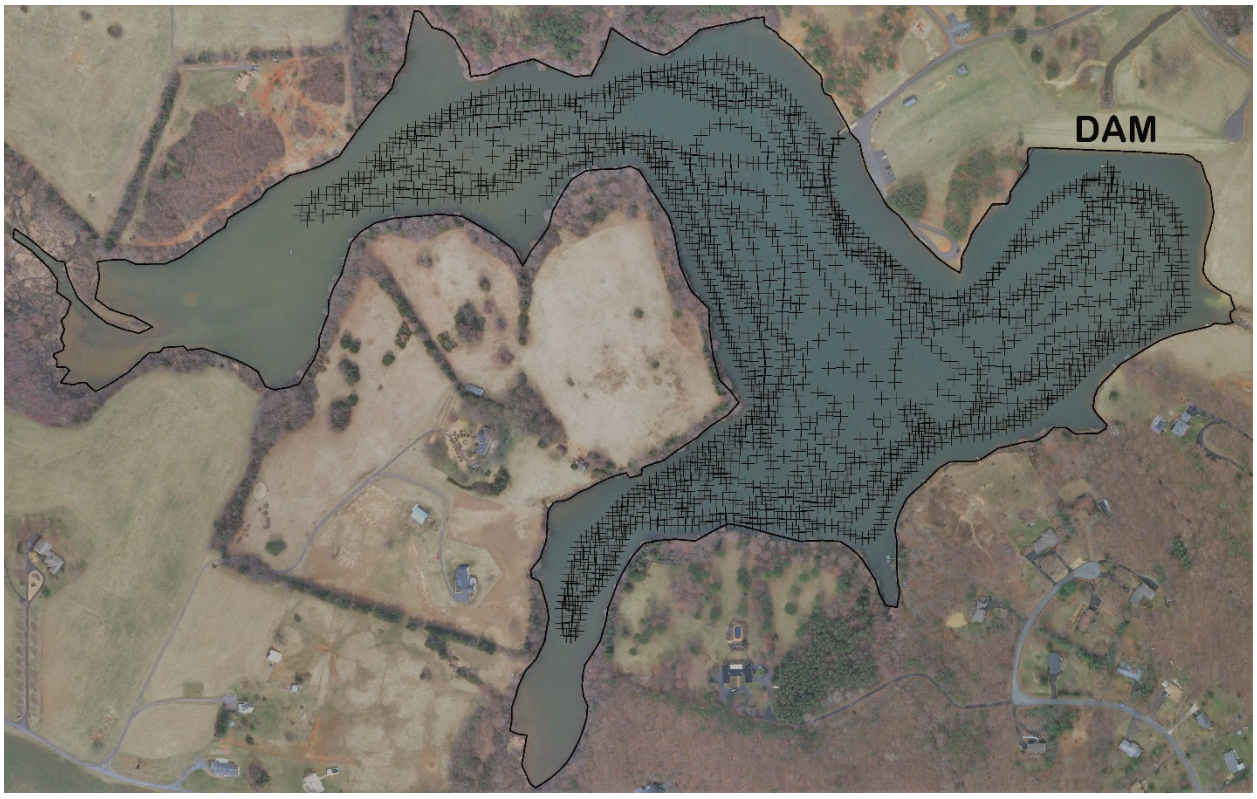


Figure 3. Data points in Lake Pelham for sediment survey.

Table 2. Planned, actual, and proposed submerged sediment and water supply storage for Mountain Run 11 (Mountain Run Lake).

Component	Designed	As-built (1959)	As of 2014 sediment survey	Planned Rehabilitation
Water supply, acre-feet	531	531	524	429
Submerged sediment, acre-feet	80	116	0	95
Total of water supply and sediment storage, acre-feet	611	647	524	524
Sediment accumulation rate, acre-feet/year	1.6	1.6	1.76	1.76

Lake Pelham, on the other hand, had a substantially lower amount of sediment accumulation than anticipated. There are three NRCS dams and two non-NRCS dams in the upper watershed of Lake Pelham. The three NRCS dams control about two thirds of the watershed above the lake and the two non-NRCS dams control another 10 percent of the drainage. After 41 years of service, nearly 74% of the as-built sediment storage capacity remained. The historic sediment accumulation rate of

4.2 acre-feet per year was less than half of the planned rate of 8.77 acre-feet per year. Table 3 shows the designed, as-built, and 2014 submerged sediment status.

Table 3. Planned, actual, and proposed submerged sediment and water supply storage for Mountain Run 50 (Lake Pelham).

Component	Designed	As-built (1973)	As of 2014 sediment survey	Planned Rehabilitation
Water supply, acre-feet	1,000	1,000	1000	1486
Submerged sediment, acre-feet	877	962	709	223
Total of water supply and sediment storage, acre-feet	1,877	1,962	1,709	1,709
Sediment accumulation rate, acre-feet/year	8.77	8.77	4.2	4.2

Rehabilitation alternatives. Since the sediment survey information for both dams was known, NRCS planned the rehabilitation of these two dams concurrently. Based upon the historic sediment accumulation rate, Mountain Run Lake needed a sediment volume of 95 acre-feet after rehabilitation. The first two choices for obtaining the additional capacity were similar to those for Lake Barton in Fairfax: remove 127 acre-feet of sediment or raise the lake level by 2 feet. The third choice was to change the distribution of the submerged sediment and the water supply. Since Lake Pelham had more than enough submerged sediment storage for the next 50 years, NRCS reduced the amount of water allocated to water supply in Mountain Run Lake and increased the amount of water supply in Lake Pelham. Tables 2 and 3 show the changes in the sediment and water supply volumes.

South River No. 10A, Mills Creek. The South River watershed is in Augusta County, Virginia, near Waynesboro, and is dominantly rural. NRCS constructed South River Dam No. 10A, Mills Creek, in 1963 for the purposes of flood control and water supply. NRCS designed and built the dam as a Significant hazard potential structure on land owned by the US Forest Service in the George Washington and Jefferson National Forest. Nearly all (99.2%) of the watershed of the dam is forested. The Virginia Department of Wildlife Resources (VDGIF) stocked the lake as a put-and-grow, cold-water fishery. The VDGIF stocked the lake with juvenile trout and allowed the fish to grow to a legal size for keeping.

The dam is owned and operated by the Augusta County Board of Supervisors and maintained by the Headwaters Soil and Water Conservation District (SWCD) through a contract with Augusta County. In 2005, the Virginia Division of Dam Safety raised the hazard class of the dam from Significant potential to High potential due to increased development in the breach inundation zone of the dam. Preliminary investigation by the Virginia Division of Dam Safety indicated that the vegetated earth auxiliary spillway could only pass 70% of the PMF before failure of the dam would occur due to overtopping the dam or breaching the auxiliary spillway.

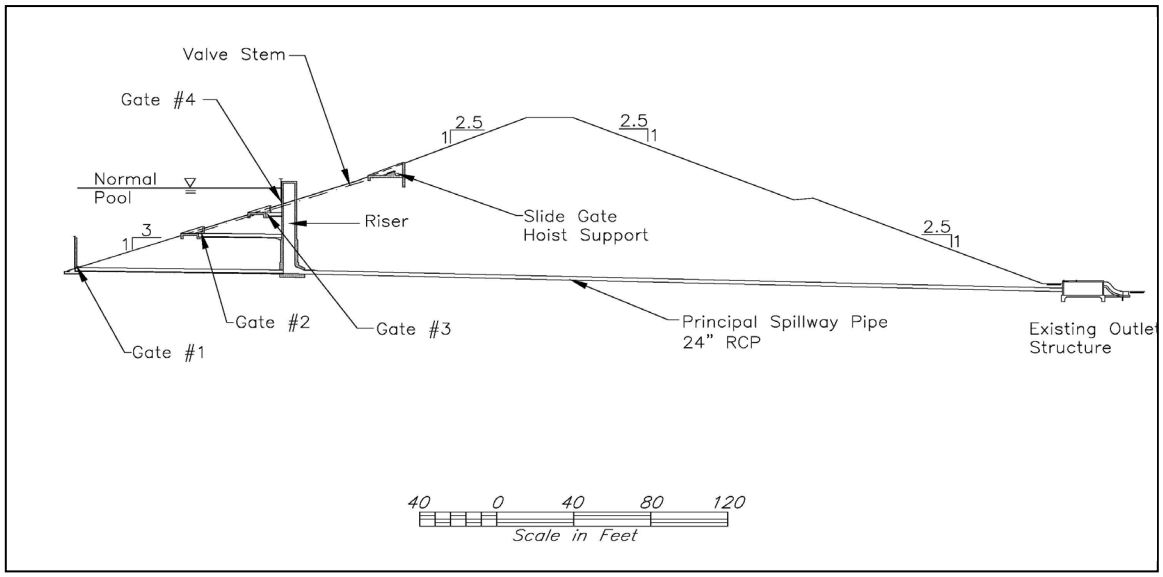
Based upon the change in hazard classification, the Virginia Division of Dam Safety issued a conditional certificate of operation. Augusta County requested assistance from NRCS to conduct

the watershed planning and identify the improvements needed to regain a full dam safety certification.

Using the NRCS Water Resources Site Analysis Program (SITES), NRCS determined that the vegetated earth auxiliary spillway had sufficient capacity to pass about 89% of the 6-hour PMF event. The integrity of the spillway was also an issue. From August 1969 (Hurricane Camille) to November 2005 (Hurricane Rita), the auxiliary spillway flowed seven times. The largest of these events was slightly smaller than the 500-year, 24-hour storm event. The erosion that occurred in the outlet of the auxiliary spillway from these events exposed rock that was more competent (less erosive). However, the SITES model indicated that the integrity of the auxiliary spillway was not competent enough to withstand a PMF event.

NRCS built South River 10A dam across a mountain valley. The dam is a 95-foot tall, earthen embankment with a drainage area of 2,459 acres (3.84 square miles). The as-built principal spillway riser was a multi-stage, covered structure located in the embankment of the dam (fig. 4). The spillway included three gated openings (gates 2, 3, and 4) for water supply and one gate (gate 1) to drain the reservoir. The water was 61 feet deep at the normal pool elevation (1862.0 feet).

Figure 4. Cross-section of the South River 10A dam showing the as-built principal spillway system.



Sediment survey. In December 2008, the Sponsors drew down the lake level to Gate 3 (elevation 1844.0 feet) to allow for repair of the riser. This lowered the lake level by 18 feet. The lower water levels provided a unique opportunity to document and evaluated the sediment located in the sediment pool of the reservoir. The low water level allowed direct contact for surveying the actual top of the sediment rather than using a boat on the water at normal pool. The low water level also provided an opportunity to determine the lower limits of the sediment by observing the deposition profile as the inlet waters eroded through the sediment. The incoming flow incised a channel to cobbles and rocks that were too big to for normal inflow to carry (fig. 5). The location of these rocks established the original reservoir bottom upon completion of construction of the dam. The top of the exposed sediment at the inlet end of the pool area was surveyed in January 2009.

Figure 5. Top of exposed sediment and incised channel at South River 10A.

At the request of NRCS, the Sponsors lowered to pool to Gate 2 (elevation 1834.0 feet) after the first topographic survey. The water level was then 28 feet below normal pool. In July 2009, additional topographic surveys were performed to document the top of the sediment exposed by this lower water surface elevation. The incised streams were also surveyed, and a lower limit of sediment was identified by the exposed layer of cobbles and rocks.

NRCS used AutoCAD Civil 3D to generate the upper and lower sediment surfaces. The lower surface was projected horizontally to the sides of the reservoir to approximate a uniform layering of the deposition. The upper surface was adjusted to eliminate the areas that were incised after the water level was lowered. The differences between these two surfaces determined the volume of sediment deposited in the lake. A prismoidal calculation showed a volume of 11.2 acre-feet of sediment. The sediment deposition rate was calculated to be 0.24 acre-feet per year for the 46 years between the time the dam was built (1963) and the time of the sediment survey (2009).

The projected sediment deposition rate at the time of design was 1.16 acre-feet for the designed service life of 50 years (58 acre-feet). The future sediment life of a rehabilitated must be at least 50 years. Based on the historic sedimentation rate of 0.24 acre-feet per year, a volume of 12 acre-feet would be needed for the next 50 years (not including the 2 years needed for design and construction). However, because there is always the potential for fires to occur in a forested watershed, the projected sediment accumulation rate was increased by a factor of safety of 1.5 to allow for additional sediment that would be generated in a burned area. The needed sediment volume was set at 18 acre-feet.

Almost all of the sediment in the original pool area was deposited in the upper reaches of the pool. The new pool elevation of 1837.5 was lower in elevation than the downstream edge of the

depositional area. Therefore, all of the sediment storage volume in the proposed pool area was available for use.

Rehabilitation alternatives. Unlike Pohick Creek Dam 2 and Mountain Run Dams 11 and 50, the volume of sediment was not a limiting factor in the rehabilitation solution. Rather, the small volume of sediment in the lake allowed choices. When the dam was built, water supply accounted for 307 acre-feet of the total water in the lake. Due to water quality problems, the lake was only briefly used for water supply. During the 2009 video inspection of the principal spillway system, all of the components (riser, gates, pipes, and outlet structure) were determined to be in poor condition due to material deterioration. The Sponsors decided that the water supply would be removed as a purpose of the dam. This decision allowed NRCS to lower the crest of the auxiliary spillway by about 3 feet to obtain the capacity needed to pass the PMF event without overtopping. The integrity issue was addressed by the installation of articulated concrete blocks.

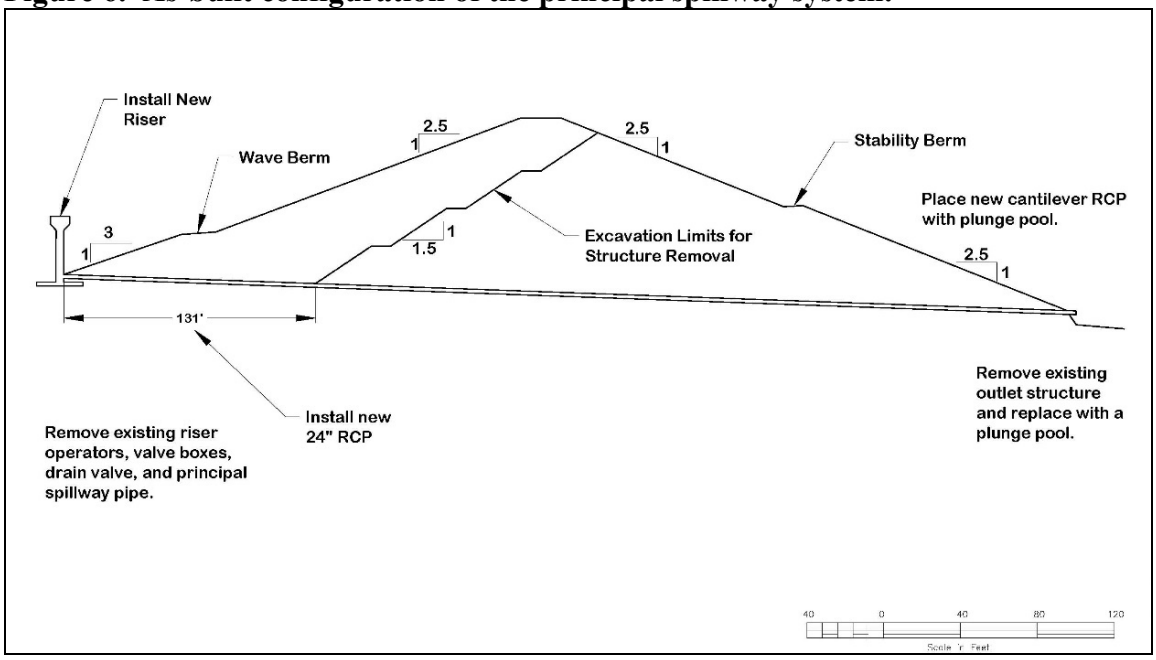
With the water supply storage no longer needed, NRCS evaluated the site as if it were a new, single-purpose structure. Initially, the future sedimentation rate of 0.36 acre-feet per year was used to set the crest of the principal spillway riser at an elevation of 1826.0 feet. This was 58 feet lower than the new auxiliary spillway crest elevation. The water in the lake would be 14 feet deep and the surface area would be about 2.75 acres. This is about 15% of the previous surface area of the lake. The stormwater detention storage would be sufficient to hold the water from a 260-year, 24-hour storm event. The new riser would be placed at the toe of the embankment and 130’ feet of reinforced concrete pipe would be installed from the riser to the existing pipe.

The Virginia Department of Game and Inland Fisheries (VDGIF) did a preliminary evaluation of the proposed system for its effects on the fisheries. At the 14-foot depth, the water would be much warmer than it is at present. The fisheries upstream of the lake, in the lake, and downstream of the dam were all cold-water fisheries that were populated with trout. The temperature of the lake could affect these populations. According to VDGIF, the cold-water fishery in the lake could be maintained if the water depth was increased to 26 feet (fig. 6). This would put the elevation of the principal spillway crest at 1837.5 feet and would increase the surface area of the lake to 6.3 acres. The stormwater detention storage at the new auxiliary spillway crest would be enough to contain the 200-year, 24-hour storm. Table 4 shows the final as-built elevations and volumes.

Table 4. As-built information for the original and rehabilitation conditions.

Component	As-built	As-built Rehabilitation
Normal pool elevation, feet	1862.0	1837.5
Auxiliary spillway crest elevation, feet	1887.4	1884.3
Total sediment storage capacity		
Submerged sediment, ac-ft	58	73.8
Water supply, ac-ft	307	0
Flood storage, ac-ft	580	733.8

Figure 6. As-built configuration of the principal spillway system.



Conclusion. The amount of sediment in the normal pool of the dam often affects the options for rehabilitation of the structure. For Lake Barton, the Sponsors provided a solution that added sediment life beyond the required 50 years and avoided making changes to the riser structure and easements. The sediment storage component of Mountain Run Dam 11 functioned as designed for the planned 50-year service life. Even though the sediment accumulation rate was slightly higher than planned, trapping the sediment in Mountain Run Lake had the benefit of increasing the sediment life of Lake Pelham. Addressing Mountain Run Lake and Pelham Lake as a pair allowed reallocation of the water supply that would not have been possible if NRCS had considered the structures independently. Although the sediment volume was not a limiting factor for Mills Creek, the combination of removing the water supply purpose, lowering the auxiliary spillway crest, and maintaining the fishery created a situation where the sediment life will not be an issue for over 200 years after completion of the rehabilitation.

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APPENDIX G: PROFESSIONAL PAPER ON LAND TREATMENT

Treating Abandoned Mine Lands in the North Fork Powell River Watershed

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Written for presentation at the 2009 ASABE Annual International Meeting

Abstract. The North Fork Powell River Watershed in Lee County, Virginia, has been significantly damaged by 70 years of unrestricted surface mining of coal that occurred prior to the passage of the Surface Mining Control and Reclamation Act (SMCRA) of 1977. At the present time, there are 61 identified sites in the watershed that contribute acid mine drainage (AMD), sediment, or both to 116 miles of streams in eight subwatersheds. In cooperation with the US Army Corps of Engineers and the Virginia Department of Mines, Minerals, and Energy, the USDA Natural Resources Conservation Service prepared a plan to address the AMD and critical erosion problems in the watershed. Under this plan, 39 sites will be treated for an estimated construction cost of $1,800,000. Benefits include 18.4 miles of stream protected, 315 gpm of AMD treated, and 56.25 acres of critical erosion treated. The results would be a reduction of sediment delivery of 252 tons/year and 22.95 miles of fishery gained (74.3% of total potential fisheries improvement). Habitat would be improved for 15 Threatened and Endangered mussel species and five fish species. The social and economic conditions of the watershed residents would also improve with better water quality and increased recreational opportunities.

Introduction

The North Fork Powell River Watershed, in Lee County, Virginia, has many tributary streams with poor water quality. This is due, in part, to the presence of abandoned coal mines that are emitting Acid Mine Drainage (AMD) and/or are experiencing critical levels of soil erosion. At the request of the project sponsors, the Lee County Board of Supervisors, the Daniel Boone Soil and Water Conservation District (SWCD), and the Virginia Department of Mines, Minerals, and Energy (DMME), the USDA Natural Resources Conservation Service (NRCS) provided assistance to assess the magnitude of the problems, identify viable alternatives to reduce the problems, and realize identified opportunities in the watershed. This work was done under the provisions of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566). The purpose of this project is to improve water quality throughout the watershed by reducing acid loading from AMD and reducing sediment loading from critical erosion (CE) sites associated with abandoned mines.

Project Setting

The North Fork Powell River Watershed is 57,620 acres in size. The watershed is located in the northeastern portion of Lee County, Virginia (Figure 1). The North Fork flows in a southwesterly direction to its confluence with the Powell River. Most of Lee County is in the Valley and Ridge province. This province consists of parallel valleys separated by long, narrow mountain ridges. The ridges are typically underlain by sandstone that is resistant to weathering. In contrast, the valleys are underlain by shale and limestone, both of which are less resistant to weathering than sandstones. The watershed is interspersed with mining pits and quarries. These sites have disturbed soils which are classified as unstable fill and consist of acidic mine spoils. Critical erosion from these unstable areas and water permeating these soils are sources of sediment and AMD.

Land use in the watershed is predominantly forest (77.1%). Farming (8.9%), Development and Transportation (2.5%), Open Water and Wetlands (0.6%), and Strip Mines, Quarries, and Barren Lands (10.9%) make up the remaining land uses.

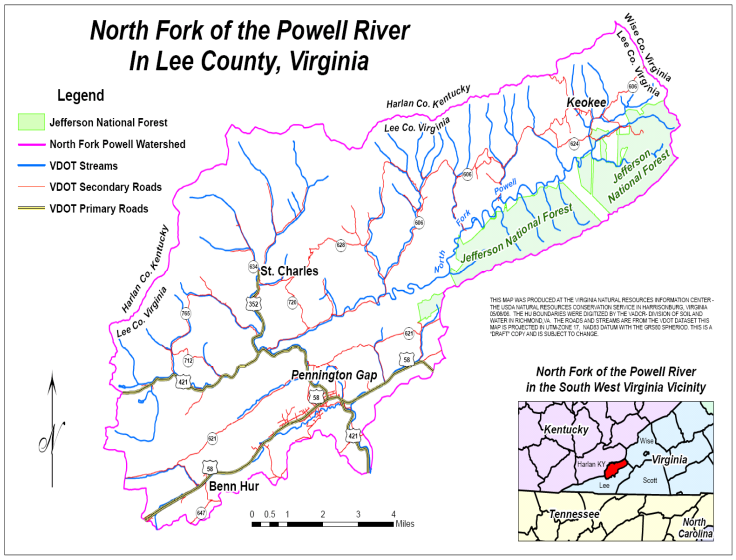

Figure 1. North Fork Powell River watershed map and location map.

Watershed Problems

Abandoned Mines. The watershed suffers from the effects of seventy years of unrestricted surface mining of coal prior to the passage of the Surface Mining Control and Reclamation Act (SMCRA) of 1977. Throughout the watershed, there are numerous mine openings that discharge acid ground water to surface streams. This low pH water reacts with the sulfates in the soil to form iron sulfates, sulfuric acid, iron hydroxides and ferric, aluminum, and manganese salts. When dissolved in water at critical concentrations, the copper, zinc, aluminum, and manganese that are associated with pyrites become toxic to the fish, invertebrates, and plant life of the aquatic ecosystem.

Many abandoned mine sites have eroding spoilbanks of mineral subsoil and waste piles that were pushed over steep hillsides and left unvegetated. Materials eroding from these sites contribute significant quantities of sediment into the streams. These sediments contain attached metals which are liberated into the streams under AMD conditions.

Since many of the mines and their associated handling areas and facilities in the watershed were worked before implementation of federal mine reclamation laws, they were simply abandoned when coal extraction activities ceased. The limited funds for mine reclamation received under the Abandoned Mine Land (AML) program are primarily used to address the high priority abandoned mine sites where there are existing threats to human safety and health. There is little, if any, of this money available to address environmental concerns. Under PL-566, the NRCS can provide assistance to address the environmental concerns associated with the abandoned mine lands.

Socio-economic Considerations. Lee County was established in 1792. Historically, coal, timber, and tobacco were very important to the local economy. Coal mining is still important but not as it was in the past because technological advances have decreased the need for laborers. In

2000, the population of the county was 23,589, of which 98.4% were white. The median age in the county is 39.7. By comparison, the median age for Virginia is 35.7 and for the nation is 35.3. Approximately 40% of the population over the age of 25 does not have a high school diploma or an equivalency diploma. Nearly 20% of the people over age 25 have less than nine years of education. Median household income in 2000 was $22,972. This is in contrast to the median household income of $46,677 for Virginia and $41,994 for the nation. About 20% of the families in Lee County lived below the poverty line in 1999. The general population poverty rate for the county is 2.5 times the state rate and two times the national rate. The overall health of the population is poorer as compared to state-wide data. Some of this can be linked to the degraded water quality in the area (GAO, 2007). Lee County in general, and the watershed in particular, are within an economically depressed region of the state.

Threatened and Endangered Species. The North Fork Powell River drainage is "likely to contain" 15 listed Federal and State Threatened and Endangered freshwater mussel species, one Federal Candidate Species, and one Federal and State Species of Concern. There are also three forage fish species, one rough fish species, one game fish species, and two bird species identified as threatened or endangered.

Methods of Analysis

Water Quality. Surface water quality in the watershed ranges from good to severely degraded. Abandoned mine lands account for the majority of the pollutants stressing the area's aquatic ecosystems. The pH values of AMD range from 1.5 to about 9.0 across the watershed. The concentration and loading of iron and aluminum in the water are directly related to the observed pH values.

There are 12 subwatersheds within the North Fork Powell River drainage of which eight are affected by mining activities. Water sampling data available in most of the eight subwatersheds included net acidity, dissolved oxygen, discharge, iron, aluminum, pH, total dissolved solids (TDS), and total suspended solids. Since soluble metal concentrations are a function of the pH of the water, pH was selected as the major indicator of water chemistry. For the purposes of this study, the pH values were categorized into these three groups: pH-Acceptable with values from 7.0-9.0; pH-Recovering with values from 6.0-6.9; and pH-Impaired with values less than 6.0.

Sites with erosion rates exceeding the soil loss tolerance value of "T" were described as CE-Impaired. Sediment delivery rates from critically eroding sites were estimated from the Total Maximum Daily Load (TMDL) study done on Straight Creek. The number of stream miles impaired by critically eroding sites was also estimated because there was little or no data on Total Suspended Solids that could have been used to quantify impairments from these sites.

Fisheries. The existing and potential warm water fisheries in the watershed were evaluated using the following assumptions:

First order streams do not have sufficient reliable flow to accommodate a viable fishery. Only the second, third, and fourth order streams are assumed to have the potential for sustaining fish.

A pH-Impaired section is a barrier to fish movement, but a pH-Recovering section is not a barrier.

When the pH in the water improves due to treatment of AMD, other chemical barriers will be reduced, improved, or removed from the water.

Physical barriers were not considered to be an impediment to the projected extensions of fish habitat.

Treating critical erosion in the subwatersheds will improve fisheries by reducing sediment delivery to the stream.

Site Descriptions

In eight subwatersheds, there are 61 AMD and/or critically eroding sites that have been identified as having an adverse effect on water quality (Figure 2). Of the 61 sites, 40 sites have AMD as the primary concern. Ten sites have AMD as the first concern with critical erosion as a secondary issue. An additional nine sites have critical erosion of either an abandoned mine site or a streambank as the primary concern. The two remaining sites have no major AMD issues but do have public safety and health concerns associated with abandoned tipples.

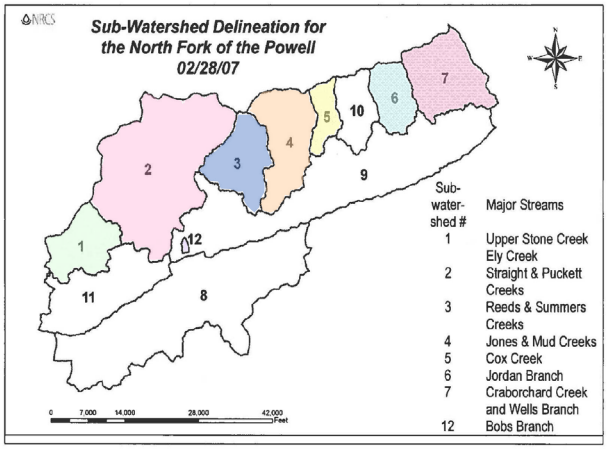

Figure 2. Subwatershed delineation and major streams.

The U.S. Army Corps of Engineers (USACOE) identified 12 sites that could be addressed under their mine reclamation program. As of 2007, five of these sites were completed. Five other sites will be addressed by the AML program or through local grant programs. Forty-four sites have been identified as eligible for participation in the PL-566 Small Watershed Program administered by NRCS. Of these, 39 sites will be completed with NRCS assistance. Reclamation of these sites will complement the work already done or planned by the USACOE. Only the 56 sites considered by NRCS and the USACOE will be addressed in the following section.

Subwatershed 1 – Upper Stone Creek and Ely Creek. There are eleven sites in the Upper Stone Creek and Ely Creek watershed. Eight sites have AMD only and three have both AMD and Critical Erosion. Of these, three AMD sites were treated by the USACOE in 2004 with Successive Alkaline Producing Systems (SAPS) and wetlands. These sites had a combined AMD flow of 440 gpm. Approximately 0.64 stream miles were recovered to a pH-Acceptable condition. However, there was only moderate fisheries recovery because the low pH water released from the untreated sites upstream prevented fish migration into the treated reaches.

There are five sites on the main stem of Ely Creek that are contributing AMD with very low pH (<2.7). Of these, two sites also have critical erosion that is impairing the water quality. The pH-

Impaired and CE-Impaired reach is concurrent and is about 0.40 stream miles long. There are 0.34 stream miles of pH-Recovering stream.

The sixth site in the Ely Creek drainage is at the upper end of an unnamed tributary. It has a highwall that is seeping water with pH values less than 3.5. The site also has critical erosion problems. Approximately 0.37 stream miles are pH-Impaired and an additional 0.12 stream miles are pH-Recovering. The entire length of the tributary is impaired by critical erosion (0.49 stream miles).

The two sites on Upper Stone Creek have small AMD seeps that cause 0.41 stream miles of pH-Impaired water and 0.47 stream miles of pH-Recovering water. The pH from the upper seep is less than 2.7.

This subwatershed has a drainage area of 2,659 acres and 9.57 stream miles. Of these, 1.18 stream miles (12.4%) are pH-Impaired and 1.32 stream miles (13.8%) are pH-Recovering. Approximately 6.08 miles (63.5%) of the streams in this subwatershed are headwater streams that have no known effects from mining. Another 0.64 stream miles (6.7%) became pH-Acceptable upon completion of the USACOE work. There are 0.35 stream miles (3.7%) of pH-Acceptable stream in the lower watershed but its location below the impaired sites makes it vulnerable to pH drainage in high flow events. A total of 0.40 miles (4.2%) of the streams are impaired by critical erosion. There are 0.93 miles of existing fishable waters. There is the potential for a total of 1.84 miles of fishable water in this subwatershed.

Subwatershed 2 – Straight and Puckett Creeks. The Straight Creek subwatershed has four major tributaries with 16 abandoned mine sites. Of these, ten sites have AMD only, one site has critical erosion only, and five sites have both AMD and critical erosion.

There are two sites on a hillside directly above the community of St. Charles. One is a 0.5 acre landslide that is eroding 6.84 tons/year of sediment directly into Straight Creek. Although this landslide is not mine related, it is contributing to the water quality impairment of Straight Creek. It also has the potential to cause flooding in St. Charles if a major precipitation event produces a significant mass movement of soil into the creek. The critical erosion from this site could impair as much as 2.2 miles of Straight Creek. Adjacent to this is an AMD seep that is emitting low pH water (~2.9). Although no water quality impacts from this site have been observed on Straight Creek, an overland flow event, projected to occur once in four years, would cause a pH-Impairment of 0.42 stream miles and a pH-Recovery length of 0.43 stream miles.

Baileys Trace has two critically eroding sites with landslides located adjacent to the stream. At the larger site, the sediment delivered to the stream is estimated to be 30.8 tons/year and it impairs 1.73 miles of stream. The fishery is impacted for 0.86 stream miles. The smaller site delivers 1.7 tons/year into the stream with an impairment of 1.87 stream miles. Because this site is high in the watershed, only 0.33 miles of fishery are affected. Another landslide is located in the headwaters of Gin Creek. This slide becomes active during precipitation events and contributes approximately 20.5 tons/year of sediment to the stream. There are 2.23 miles of fishable water in the 3.01 miles affected by the sediment. However, downstream pH impairments prevent fish access to these reaches.

At the confluence of Baileys Trace and Straight Creek, there is an AMD site with pH values as low as 2.1. The available stream data shows little direct impact from this site, but it is estimated that a rainfall event large enough to cause overland flow from the site into Straight Creek will

occur once every four years. The resulting pH-Impairment would be approximately 0.69 stream miles with a pH-Recovery zone of 0.62 stream miles. During the recovery period, estimated to be about two years, the upstream fishery would be limited to the population existing in the 6.33 miles upstream of the site.

There are two AMD sites located on a small tributary to Straight Creek just south of St. Charles. The upper site has a pH-Impaired effect on 0.29 stream miles. It also has some streambank erosion. The pH-Recovering reach extends 0.16 stream miles to the confluence with Straight Creek. The second site is a little intermittent seep that has no defined channel. However, the pH was 4.8 in one sample. The pH-Impaired section is estimated to be 0.23 overland miles during wet conditions. During high flows, the pH-Impaired water could damage 0.55 miles of Straight Creek. An additional 0.73 stream miles would be pH-Recovering.

The third major tributary to Straight Creek is Big Branch. The abandoned mine site in the upper reaches of this subwatershed encompasses 8 acres and has both critical erosion and AMD. Water quality data indicates that the stream is pH-Impaired for about 0.42 miles and pH-Recovering for an additional 0.03 miles. Critical erosion impairs 1.25 stream miles due to an estimated sediment delivery rate of 54.7 tons/year. The existing fishable stream length is 0.42 miles.

Puckett Creek is the fourth tributary to Straight Creek. There are two AMD sites that have been reclaimed by the USACOE. Approximately 139 gpm of flow were treated at these two sites. A total of 0.73 stream miles of impairment was removed.

Another site on Puckett Creek has both critical erosion and AMD (pH=4.9). Overland flow from this site has the potential to cause a pH-Recovering reach of 0.24 miles of stream while Critical Erosion impairs 0.28 stream miles with sediment eroded from the site. There are two additional AMD sites on Puckett Creek. One site drains into a wetland that was created on the second site. Together, there are 0.06 stream miles of pH-Impaired water and 0.18 miles of overland flow associated with these two sites. At the present time, there are no fishable waters in this stream.

There are two sites on Straight Creek upstream of the community of St. Charles that the USACOE plans to address as funding becomes available. The first site has an AMD flow rate of about 50 gpm and is causing a pH-Impaired section of 0.04 stream miles. The pH-Recovering section is 0.14 stream miles. The second site has four seeps with a combined flow rate of 10 gpm of AMD with pH values from 2.0 to 2.8. The pH-Impairment extends for 0.20 miles on the tributary and 0.05 stream miles on Straight Creek. A pH-Recovering zone extends about 0.07 stream miles downstream of the impairment.

The Straight Creek and Puckett Creek watershed has a drainage area of 10,533 acres and a total stream length of 36.27 miles. Of these, 1.66 miles (4.6%) are pH-Impaired, 1.55 miles (4.3%) are pH-Recovering, and 10.34 miles (28.5%) are CE-Impaired. Some of these impairments are concurrent. There are 22.25 miles of upland streams that have no known pH-Impairments. The remaining 10.81 miles are located where they could be impacted by AMD but are not presently impaired. There are 1.20 miles of existing fishery of the potential 11.72 miles of fishable water in the watershed.

Subwatershed 3 – Reeds and Summers Creeks. Reeds Creek, and its tributaries Summers Creek and Meadow Fork, is a major tributary to Jones Creek. Meadow Fork has no identified water quality impairments. Summers Creek has one AMD site that will be addressed by the USACOE.

There are eight AMD sites and one AMD/Critical Erosion site on Reeds Creek. Three of these sites are located directly on the main stem. The three sites have a combined pH-Impaired length of 0.44 stream miles and approximately 0.29 miles of pH-Recovering stream. A fourth site on Reeds Creek has two mine openings and a historic tipple (Figure 3). There is also some erosion occurring on site with an estimated sediment delivery rate to the stream of 3.42 tons/year. The stream is pH-Recovering for 0.09 miles downstream of the site. Approximately 0.24 stream miles are impaired by the sediment from the mine. Another nearby site consists of an old mine bench and a small pond located on a hillside above Reeds Creek. This AMD site has the potential to impact surface water during high flow events due to low pH (<4.0).

Figure 3. Portal on abandoned mine site on Reeds Creek.

There are two sites associated with the Bee Mines. The upstream site will be addressed by NRCS. It has a pH-Recovering section of 0.21 miles. The downstream site will be addressed by the USACOE. This site has a pH-Impaired reach of 0.07 stream miles and is pH-Recovering for an additional 0.08 stream miles.

A large abandoned mine site in the upper watershed will be reclaimed by the USACOE. Sampling done at the site indicate that there may be multiple AMD sources. There are pH impairments noted at the site for about 0.42 stream miles and 0.20 overland miles. Reeds Creek is pH-Recovering for an additional 0.35 stream miles.

This watershed has a total drainage area of 3,004 acres. Summers Fork and Meadow Fork have a total of 6.11 stream miles. Of these, 0.37 stream miles are pH-Impaired (6.2%) and 0.80 stream miles are pH-Recovering (13.3%). There are 1.30 potential fishable miles on these two tributaries. Of these, 0.97 miles are currently accessible. Reeds Creek has 7.95 stream miles with 0.93 miles of pH-Impaired stream (11.7%) and 1.11 miles of pH-Recovering stream

(14.0%). There are 1.94 miles of pH-Acceptable water (24.4%) but they are vulnerable to pH impairments during high flow times. The existing fishery for Reeds Creek is 1.43 miles. The potential fishery is 3.10 miles.

Subwatershed 4 – Jones and Mud Creeks. There are six abandoned mine sites in the Jones Creek/Mud Creek watershed. Four of these sites are located in the headwaters. The biggest obstacle to fisheries in the watershed is a small AMD seep located on Jones Creek which has 0.07 stream miles of pH-Impairment. Access to 2.68 miles of fisheries is blocked due to this impairment.

Two mine pit sites in the upper Mud Creek drainage have both critical erosion and AMD (Figure 4). Approximately 0.13 stream miles are impaired at one site and 0.10 stream miles are impaired on the other site. The streams exiting the sites join to have a shared pH-Recovering zone of 0.14 stream miles. Critical erosion from each site is estimated to cause 34.2 tons/year of sediment delivery to Mud Creek. The CE-Impaired stream length is 1.44 miles. Approximately 0.77 miles of fishery are impacted.

One site in the headwaters has two seeps with a pH of less than 5.0. The pH-Impaired section extends for 0.15 stream miles downstream. There are 0.08 miles of pH-Recovering stream below the impaired section. Although there are no water quality data samples from or below the fourth site, the DMME has concerns about the site. Therefore, it is included as a potential site.

In the lower watershed, the USACOE has plans to complete one site which is located on a small tributary to Jones Creek. The pH-Impaired section is approximately 0.03 miles long. The stream is pH-Recovering for another 0.05 stream miles. AMD flow from this site is estimated to be 60 gpm.

The Jones Creek/Mud Creek watershed has a drainage area of 3,781 acres with 19.04 stream miles. Of these, 0.41 stream miles are pH-Impaired (2.2%) and 0.48 stream miles are pH-Recovering (2.5%). Critical erosion impairs 1.44 miles of the headwaters streams. The existing fishery in this subwatershed is 1.64 miles of a potential 5.15 miles.

Figure 4. Highwall on a site in the Mud Creek subwatershed.

Subwatershed 5 – Cox Creek. Cox Creek is the second smallest of the eight subwatersheds. There are two AMD sites and one critically eroding site. The first site has an AMD flow rate of 15 gpm. The outflow from the site is pH-Recovering for about 0.05 stream miles. The second site has a sealed mine portal and a highwall. Water seeping from these areas has a pH between 4.0 and 5.0. The pH-Impaired reach is about 0.05 stream miles long with 0.04 stream miles of pH-Recovering water downstream. The critically eroding site has both sheet and gully erosion. This abandoned mine site is currently used for dirt-track racing and it is not feasible to treat the erosion from overland flow. However, the gully erosion from the perimeter of the site delivers about 34 tons/year to the stream and can be treated and maintained. The sediment delivered from this site impairs about 0.86 stream miles.

There are 5.77 stream miles in the 1,143 acre Cox Creek subwatershed. Of these, 0.05 stream miles (0.9%) are pH-Impaired, 0.9 stream miles are pH-Recovering, and 0.86 stream miles (14.9%) are impaired from critical erosion. The possible fishery is 2.79 miles, but none are presently available due to the effects of critical erosion and pH-Impairment.

Subwatershed 6 – Jordan Branch. The 1,869 acre Jordan Branch subwatershed has four AMD sites that have been identified as candidates for treatment. Of these, only two sites have sufficient data at the sites to draw definite conclusions about the water quality effects of these sites. However, there are some pH-Recovering reaches that would indicate that pH-Impairment is occurring at the other sites. There are 9.79 stream miles in the watershed. It is estimated that there are 0.42 miles (4.3%) of pH-Impaired stream and 0.79 miles (8.1%) of pH-Recovering stream. There are 1.48 miles of potential fisheries. Based upon the available data, all of these waters are accessible to fish.

Subwatershed 7 – Craborchard Creek and Wells Branch. The North Fork of the Powell River begins at the confluence of Craborchard Creek and Wells Branch. The main stem of Craborchard Creek has one AMD site just above the confluence with Wells Branch. This site has 0.12 stream miles of pH-Impaired water and 0.33 stream miles of pH-Recovering water.

In the headwaters of the east branch of Craborchard Creek, there are two sites with AMD discharges. There is significant beaver activity influence in this area which has a mitigating influence on the pH. One site has 0.17 miles of pH-Impaired water and 0.41 miles of pH-Recovering water. The other site has 0.23 miles of pH-Impaired stream and 0.37 miles of pH-Recovering stream. Together, the two sites have an additional 1.09 miles of pH-Recovering stream below their confluence.

The west branch of Craborchard Creek has one site with an estimated AMD discharge of 45 gpm. The pH-Impairment extends for 0.53 miles below the site. The pH-Recovering section downstream is 0.17 stream miles in length. Approximately 0.22 miles of fishable water are present, but they are not available due to the impairments caused by a site downstream. The USACOE plans to reclaim this site.

Wells Branch has one site that has 1.75 stream miles of pH-Recovering stream above it and 1.11 stream miles of pH-Recovering stream below it. There are no potential fisheries because the entire stream is first order.

The Craborchard Creek/Wells Branch subwatershed has a total of 21.14 stream miles in 3,835 acres. Of these, 1.05 stream miles (5.0%) are pH-Impaired and 5.20 stream miles (24.6%) are

pH-Recovering. There are 0.33 miles of existing fishery of the potential 3.51 miles in the watershed.

Subwatershed 12 – Bobs Branch. The subwatershed named as Bobs Branch is actually a small drainage area (61 acres) used to identify the location of two sites adjacent to the North Fork Powell River. These critically eroding sites are two acres each and drain directly into the river (Figure 5). The sediment delivery from these sites is about 27.4 tons/year. Contaminants associated with tipple activities also drain from the sites. There is no data on water quality from these two sites, but typical contaminants include heavy metals, chemicals used on site, and AMD.

Figure 5. Abandoned tipple site on Bobs Branch.

Formulation and Comparison of Alternatives

Criteria for Alternatives. Several types of AMD treatment systems were discussed during the planning process. "Active" treatment systems, such as chemical treatment facilities which require high amounts of capital costs, management, and labor, were not pursued due to the cost and due to the difficulty in maintaining the facilities on remote sites. Instead, the emphasis was placed on "passive", gravity-fed land treatment systems, which treat the acidity and may also separate/trap heavy metals for removal. Critical erosion will be treated with common NRCS erosion control practices.

Collaborative Interagency/Watershed Planning Approach. The partners involved in this project are NRCS, the Daniel Boone SWCD, the Virginia DMME, and the USACOE. The partnership approach reduces the duplication of effort and optimizes the use of available funds. It also ensures that the planned projects are complementary to each other. This collaborative approach will contribute to higher levels of pollution control and will serve to better protect the investments of each partner.

The USACOE Ecosystem Restoration Project, which involves treatment of 12 sites, will address about three quarters of the known AMD loading that occurs on abandoned mine land in the watershed. However, loadings from untreated AMD sites could sporadically and temporally negate the water quality improvements from their investments. To assist NRCS in addressing this concern, DMME and the USACOE provided data, knowledge, and interpretations. The USACOE contracted with the consulting firm of David Miller and Associates for the sole purpose of providing technical support to the NRCS planning efforts.

Alternative Treatments Evaluated. The following practices comprised the array of potential AMD treatment solutions considered:

- Anoxic Limestone Drain
- Aerobic Wetland
- Anaerobic Wetland
- Limestone Pond
- Open Limestone Channel (OLC)
- Reducing Alkaline Producing System (RAPS)
- Settling Ponds
- Successive Alkaline Producing System (SAPS)

NRCS Conservation Practice Standards Land Reclamation, Abandoned Mine Land (Code 543), Land Reclamation, Landslide Treatment (Code 453), Land Reclamation, Toxic Discharge Control (Code 455), and Mine Shaft and Adit Closing (Code 457) will be used to implement these practices.

For critically eroding sites, the following NRCS practices were evaluated:

- Critical Area Planting (Code 342)
- Diversions (Code 362)
- Lined Waterway or Outlet (Code 468)
- Tree/Shrub Establishment (Code 612)
- Spoil Spreading (Code 572)
- Upland Wildlife Habitat Management (Code 645)
- Analysis of Alternative Treatments
- Selection of Treatment for Each Site

The “AMDTREAT” software developed by the Federal Office of Surface Mining, Reclamation, and Enforcement (OSMRE) was used to evaluate potential project performance and costs. This program identified a recommended treatment system for specific AMD sites. Some AMD sites with limited input data were evaluated without use of the AMDTREAT program by comparing

them to sites with similar characteristics. Treatments for critically eroding sites were selected from NRCS practices The least cost alternative was identified for each site.

Development of Evaluation Units. Evaluation Units (EUs) were developed within each subwatershed by grouping individual sites based on characteristics such as proximity to one another, ownership, effect on USACOE sites, and degree of expected improvements to water quality and fisheries. Evaluation units within each subwatershed are listed in the order in which the most benefits will be derived. There is an underlying assumption that all of the USACOE and AML sites will be completed prior to installation of the NRCS projects. The projected additional benefits to the water quality for each evaluation units are then attributable to the NRCS work. It is further assumed the NRCS projects will take approximately two years after completion to attain the projected water quality benefits. The anticipated fishery benefits will also accrue in that time frame. It should be noted that all first order streams are ecologically linked to the downstream segments, and they contribute to the well-being of the aquatic ecosystem although they are not fishable.

For the purposes of this analysis, the projected effects of individual Evaluation Units were identified first and then the projected cumulative effects when multiple Evaluation Units were implemented within a subwatershed. These effects and estimated construction costs are described in the following section.

Selected Treatments and Anticipated Effects

Subwatershed 1 – Upper Stone and Ely Creeks (SW1)

SW1-EU1. ($248,600) This Evaluation Unit encompasses the five AMD sites on the main stem of Ely Creek. Due to the individual toxicity of each site, all five sites must be treated in order for any benefit to accrue on Ely Creek. Treatment includes a SAPS and aerobic wetland, an anaerobic wetland, and three OLCs. The sites will also be graded and revegetated, as needed. With treatment, 0.40 miles of pH-Impairment will be removed. Fishery access will be gained on 0.62 stream miles to make the entire subwatershed (1.84 miles) available for fish movement.

SW1-EU2. ($84,500) The tributary site on Ely Creek will be treated with SAPS and an aerobic wetland. The critical erosion will be treated also. Completion of this site will remove 0.37 miles of pH-Impairment and 0.49 miles of CE-Impairment.

SW1-EU3 & EU4. ($46,300) Both of the sites on Upper Stone Creek will be treated with OLCs. Some grading and revegetation will also be done. The pH-Impairment to 0.41 miles of stream will be removed. Approximately 0.29 miles of fishery will be added to the existing 0.24 miles to achieve the total potential fishable length of 0.53 miles.

Upon reclamation of these eight sites, 2.11 miles of stream will be protected, 10 acres of critical erosion will be treated, sediment delivery to the streams will be reduced by 44.8 tons/year, and 182 gpm of AMD will be treated. About 0.91 miles of fishery will be regained to achieve 100% of the potential fishery.

Subwatershed 2 – Straight and Puckett Creeks (SW2)

SW2-EU1. ($74,500) The landslide and AMD seep in St. Charles will be treated in the first Evaluation Unit because they both have the potential to impact Straight Creek in a large precipitation event. If these periodic impairments are prevented by treatment of these two sites, then fish access to 2.75 miles of upstream water and 2.58 miles of downstream fishery will be

maintained. The landslide will be treated with a rock toe buttress and then graded, shaped, and revegetated. A water control feature will be added. The portal on the AMD site will be closed and seepage will be treated with an OLC.

SW2-EU2. (82,900) The three critically eroding sites on Baileys Trace and Gin Creek would be treated together because they have one owner. Each site will be treated with a rock toe buttress and then grading, shaping, revegetation, and water control. Treatment of these sites will remove the CE-Impairment from 6.61 miles of stream. This would add 3.42 miles of fishable stream to the upper watershed. Permanent fish access is dependent on treatment of Evaluation Unit 1.

SW2-EU3. ($124,100) The AMD site at the confluence of Baileys Trace and Straight is the next priority within the subwatershed. The very low pH water coming from the site does not enter Straight Creek except during precipitation events that cause overland flow from the site. An overland flow event is projected to occur once in four years with an estimated stream recovery time of two years per event. The site will be treated with two sets of SAPS and aerobic wetlands. Treatment of this site, in conjunction with EUs 1 and 2, will maintain fisheries access to 6.33 miles of the upper watershed and 2.58 miles downstream of the site.

SW2-EU4. ($143,500) The two AMD sites on the small tributary south of St. Charles will be treated with OLCs. As with the previous Evaluation Units in this watershed, the pH-Impairment to Straight Creek primarily occurs during storm events.

SW2-EU5. ($21,900) For the site on Big Branch, the impairment is only observed on the tributary with no effect on Straight Creek. The proposed treatment is an OLC and a wet mine portal closure. With treatment, the fishable portion of this stream will increase from 0.42 to 0.63 miles.

Treatment of Evaluation Units SW2-EU1 through SW2-EU5 will allow fish access to the entire main stem of Straight Creek and all of the major tributaries except Puckett Creek. Of the 9.36 miles of potential fishery, only 0.38 miles of Straight Creek are consistently available at the present time. With these treatments, 8.98 miles will be added to this number.

SW2-EU6. ($90,500) Treatment of the eroding mine site on Puckett Creek will include an OLC, an aerobic wetland, water control, grading and shaping, and revegetation. This work will eliminate the pH-Impaired overland flow and remove the sediment impairment from 0.28 miles of stream. Approximately 0.78 miles of fishable stream will be added to the existing 0.82 miles.

SW2-EU7. ($192,200) The remaining two AMD sites on Puckett Creek will be treated as one unit since the upper site drains into the wetland on the lower site. Treatments for these sites will include two anaerobic wetlands and an OLC. Since the drainage from the wetland blocks the confluence of Puckett Creek and Big Branch of Puckett Creek, treatment of these two sites will add 0.76 miles to the fishable waters.

There are twelve sites in this subwatershed. Upon completion of the work, 51 gpm of AMD and 26.75 acres of critical erosion will be treated. There will be a reduction in sediment delivery of 120 tons/year. About 10.65 stream miles will be protected from impairment and 10.52 miles of fishery will be regained.

Subwatershed 3 – Reeds and Summers Creeks (SW3)

SW3-EU1. ($149,800) The five AMD sites that are clustered along the main stem of Reeds Creek must be treated together in order to eliminate the water quality impairments on this reach.

This work will involve rehabilitating one pond and draining another pond. Three OLCs and one wetland will be created, one wetland will be rehabilitated, and the mine opening on one site will be closed. With treatment, 0.44 miles of pH-Impaired water and 0.38 miles of pH-Recovering water will be restored to an acceptable condition. Completion of these sites will optimize the effectiveness of the USACOE sites in this watershed. The entire potential fishery of Reeds Creek will be accessible (3.14 miles).

SW3-EU2. ($7,200) The NRCS site at the Bee Mines will be treated by installation of a pond. No fisheries would be regained because it is a first order stream.

Treatment of these six sites will result in the protection of 1.01 miles of stream. Twenty six gallons per minute of AMD will be treated and 0.5 acres of critical erosion. Sediment delivery will be reduced by 2.24 tons/year. About two miles of fishery would be regained to achieve 100% accessibility.

Subwatershed 4 – Jones and Mud Creeks (SW4)

SW4-EU1. ($19,800) The small AMD site in the lower reach of Jones Creek will be treated with an aerobic wetland and a pond for a cost of $19,800. With treatment, 0.07 miles of pH-Impaired water and 0.23 miles of pH-Recovering water will be restored to a pH-Acceptable condition. There are 5.15 miles of potential fishery in this subwatershed. About 2.68 miles will be gained with treatment.

SW4-EU2. ($72,100) The two mine pits in the Mud Creek drainage have very similar site conditions and will be treated in the same way. The mine pits will be backfilled and regraded, the highwall will be eliminated, and an OLC and pond will be installed. Water quality will improve on 0.37 miles of pH-Impaired and pH-Recovering stream. The sediment impairment on 1.44 miles will be removed. There will be 0.77 miles of fisheries gained.

SW4-EU3. ($12,100) The AMD site in the headwaters of Mud Creek will be treated with a ditch and a pond. Because of its location, fisheries recovery will only be 0.06 miles.

SW4-EU4. ($16,700) An OLC is the proposed treatment for the AMD site in the headwaters of Jones Creek. There is very little data for this site and the treatment may change. It is a first order stream and no fisheries will be gained.

There are five sites that will be treated in this subwatershed. Upon completion, 2.17 miles of stream will be protected, 16 gpm of AMD and 10 acres of critical erosion will be treated, and 3.51 miles of fishery will be regained. The reduction in sediment delivery will be 44.8 tons/year.

Subwatershed 5 – Cox Creek (SW5)

SW5-EU1. ($207,800) All three of the sites in this subwatershed will be treated as one Evaluation Unit due to their proximity to one another. The site with the 15 gpm AMD flow will have a SAPS and an aerobic wetland. The site with the highwall seeps will be treated with an OLC and an aerobic wetland. A riprap ditch will be used to control water on the racetrack site along with grading, shaping and revegetation.

Treatment of the AMD and eroding sites in this subwatershed will result in the recovery of 100% (2.79 miles) of the potential fisheries with the treatment of 30 gpm of AMD and 5 acres of critical erosion. The sediment delivery rate will be reduced by 22.4 tons/year.

Subwatershed 6 – Jordan Branch (SW6)

SW6-EU1. ($42,400) The two sites that have pH information will be treated with OLCs at an estimated cost of $15,000 each. No fisheries will be recovered since both sites are located on first order streams. About 0.42 miles of pH-Impaired water and 0.73 miles of pH-Recovering water will be converted to pH-Acceptable after treatment.

SW6-EU2 and EU3. ($0) Water quality data for these sites does not indicate any pH-Impairment. For this reason, no treatment is recommended at this time.

Only two sites in this subwatershed will be treated. About 1.15 miles of first order stream will be protected.

Subwatershed 7 – Craborchard Creek and Wells Branch (SW7)

SW7-EU1. ($54,400) The AMD site located in the lower reach of Craborchard Creek is causing a significant impediment to fisheries improvements in the subwatershed. The planned treatment is to install an OLC and a pond. Approximately 0.45 miles of stream will become pH-Acceptable and there will be fish access to the 3.17 miles of stream not currently available. Treatment of this site will allow fish access to the portion of stream that will be treated by the USACOE project on the west branch of Craborchard Creek.

SW7-EU2 and EU3. ($0) The two remaining sites on Craborchard Creek and the one site on Wells Branch will not be treated because the beaver ponds on these sites are already causing some improvement in the water quality.

Reclamation of the one major site in this subwatershed will protect 0.45 miles of stream but will allow fish access to 3.24 miles of water. A 10 gpm AMD flow will be treated.

Subwatershed 12 – Bobs Branch (SW12)

SW12-EU1. ($109,200) The two critically eroding tipple sites will be treated by removing of the waste material, grading and revegetating the site, and providing water control. Due to the nature of the sites, the eroding sediment is assumed to be contaminated with coal refuse, waste liquids, and heavy metals. These sites are recommended for treatment because of their location within the put-and-take trout waters on the North Fork Powell River.

Treatment of four acres of critical erosion will reduce the sediment delivery to the North Fork Powell River by 17.9 tons/year.

Description of Alternative Plans Considered

Once the Evaluation Units were identified, NRCS evaluated several Alternative Plans for action. As with any Federal project, one Alternative that was considered was to do nothing. With this Alternative, the water quality and fisheries in the North Fork Powell River drainage would still be poor even after the USACOE and local projects were completed because of the 44 sites that were not addressed. The second Alternative, the Net Positive Benefits Plan, would only treat the two subwatersheds where the economic benefits would be greater than the costs (Benefit: cost ratio = 1.5 to 1.0). The two subwatersheds are SW-4 Jones and Mud Creeks and SW-7 Craborchard Creek and Wells Branch. Only six sites would be treated in this Alternative for an estimated construction cost of $175,100. Water quality would remain poor in the six untreated subwatersheds. The third Alternative was to treat 39 of the 44 sites for an estimated construction cost of $1,800,500. (During the evaluation process, there were five sites that did not need

treatment at this time.) This Alternative would treat all sites which impact stream segments capable of supporting fish or that impact the health of the aquatic ecosystem. The benefit: cost ratio for this Alternative is 0.5:1.0.

Recommended Plan. The Recommended Plan is to treat 39 sites within the eight subwatersheds. This plan comprehensively addresses all known AMD and Critical Erosion problems of significance in the North Fork Powell River watershed. The added increment of investment (beyond the Net Positive Benefits plan) is justified due to the substantial non-monetary benefits to the ecosystem and the fact that this project will complement the ongoing USACOE and DMME efforts. The recommended alternative will also inject greater resources and provide benefits to an economically and socially disadvantaged community.

Summary

When combined with the other concurrent activities in the watershed, the recommended alternative will result in restoration of higher water quality from reduced acidity, lower sediment loadings, and reduced deposition and transport of heavy metals. These improvements will help create stream ecology conditions conducive to the return of benthic organisms. Return of the benthic population will provide a basis for a re-established warm water fishery. A cleaner watershed will contribute cleaner water and, therefore, should significantly help the Threatened and Endangered mussel species downstream of the watershed to achieve higher survival rates.

Benefits from this work include:

- 18.40 miles of stream protected from AMD and sediment
- 315 gpm of AMD treated
- 56.25 acres of Critical Erosion treated
- 252 tons/year of sediment kept out of the streams
- 22.95 miles of fishery gained (74.3% of fishery recovered of potential 30.89 miles)
- 7.8 acres of wetland created

Conclusion

The Recommended Plan involves treating 39 sites identified in the watershed as needing treatment. Completion of this plan will address all of the identified impairments that are eligible for the PL-566 Program. This plan will improve the water quality in the watershed by remediating the effects of pre-SMCRA coal mining within the watershed. Implementation of this plan will neutralize the low pH values and their associated pollutants that are presently impairing the use of the water for drinking, recreation, and fisheries. It will also reduce erosion from abandoned surface mines and landslides, thereby reducing the effects of sediment in the water.

This Plan was authorized in 2009. Partial funding will come from the American Reinvestment and Recovery Act. Additional funding will be requested through the Watershed Operations portion of the PL-566 Watershed Protection and Flood Prevention Act. Work will begin in the Fall of 2009 with an anticipated completion date of 2019.

References

USDA, Natural Resources Conservation Service. 2008. Final Plan and Environmental Assessment North Fork Powell River Watershed.

GAO. 2007. Poverty in America – Economic research shows adverse impacts on health status and other social conditions as well as economic growth rate. GAO-07-344.