NATURAL RESOURCES

INTRODUCTION

This section describes both the land and water resources of Shenandoah County. It presents information on the County's topography, geology, soils, and water resources. These resources provide many opportunities, but also pose some severe environmental problems. Development should be guided away from areas with serious limitations, such as steep slopes, shallow depth to bedrock, flood plains, prime agricultural lands, wetlands, and sinkholes. Maps showing general geology, general soils, the hydrogeologic survey of Shenandoah County, and generalized development limitations are included.

Natural resources were briefly addressed in individual paragraphs about topography, climatology, minerals, soils, hydrology, and forests in the 1973 Plan, along with a general soils map. Soils data has since been updated with the Shenandoah County Soils Survey.

LAND RESOURCES

Topography

Shenandoah County lies within the Ridge and Valley physiographic province of Virginia. This province is known for its steep slopes in the mountainous areas with wide valleys lying between.

The County's topography is steep to gently rolling, and well drained. Elevations vary from 537 feet above mean sea level in the valley to approximately 2500 feet msl along the Massanutten Mountains on the east and over 3,300 feet msl along the North Mountains on the west. Intersected by narrow valleys in a northeast to southwest direction, these mountains comprise approximately one-half of the County's total land area.

The central portion of the County is the valley proper which is relatively level. Meandering through this area is the North Fork of the Shenandoah River, a major tributary of the Potomac River. Other major watersheds include Cedar Creek, Passage Creek, Stony Creek, and Smith Creek.

Approximately 45 percent of the County contains steep slopes ranging from 15 to 25 percent and, along the eastern and western borders, lands containing slopes of from 25 to 45 percent. The land along the eastern and western sides has severe slope limitations for both farm and non-farm uses.

Geology

Shenandoah County is underlain by bedrock which geologists have assigned to many different formations and groups which are shown on Figure 2-A on the following page.

The formation and group classifications are combined into major geologic belts, and the County lies within three of them. Both the eastern and western sections are made up of Appalachian Sandstones and Shales. The eastern-central part of the County is underlain by the Valley Shale belt and the west-central area is part of the Valley Carbonate belt.

Appalachian Sandstones and Shales are made up of several rock types. The major geologic units found in the belt are the Hampshire, Brallier, Chemung, Tuscarora Formations and the Clinton and Cayuga Groups. Where the bedrock is exposed at the earth's surface, sandstone forms the many high, narrow, linear, northeast-trending ridges characteristic of the area.

The Valley Shale belt is made up of a single rock unit, called the Martinsburg Formation. Shale and easily erodable sandstone are the major rock type of this belt.

Valley Carbonates are made up of six major formations or groups. The most common rock types are limestones and dolomites of sedimentary origin. The major geologic units included are the Edinburg Formation, Lincolnshire and New Market Limestones, the Beekmantown Formation, and Conococheaque Limestone.

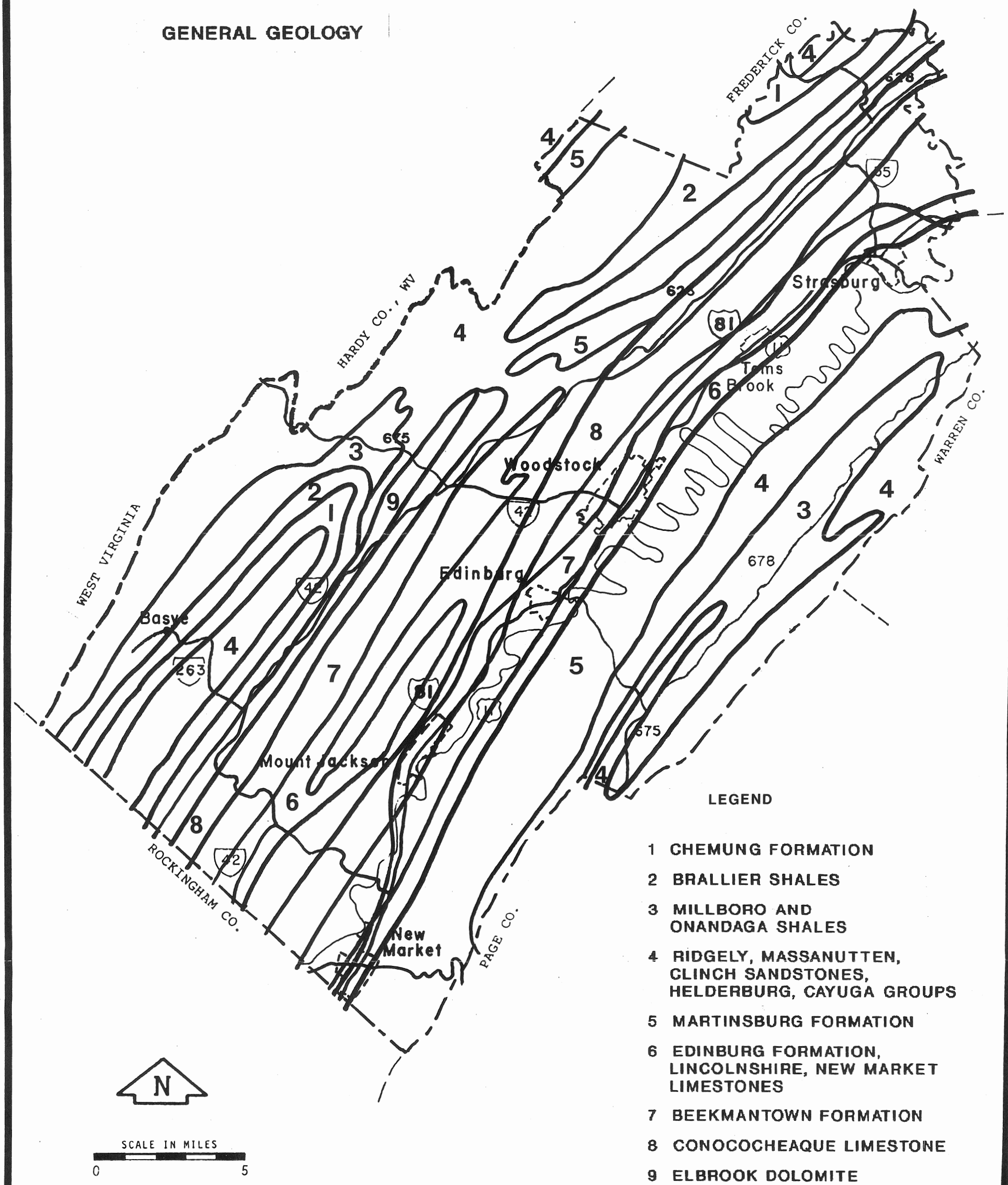
The bedrock underlying the County influences almost every other feature of the environment and directly or indirectly affects many of man's land use decisions. Each of the major belts shows up in distinct land forms, and each also has an influence on water and its movement above or below the surface.

Carbonate rocks (limestone and dolomite) commonly show considerable solution activity and surface collapse features consisting of sinkholes and caves. Such features are direct conduits into the County's groundwater.

SHENANDOAH COUNTY

VIRGINIA

GENERAL GEOLOGY



LEGEND

1 CHEMUNG FORMATION

2 BRALLIER SHALES

3 MILLBORO AND ONANDAGA SHALES

4 RIDGELY, MASSANUTTEN, CLINCH SANDSTONES, HELDERBURG, CAYUGA GROUPS

5 MARTINSBURG FORMATION

6 EDINBURG FORMATION, LINCOLNSHIRE, NEW MARKET LIMESTONES

7 BEEKMANTOWN FORMATION

8 CONOCOCHEAQUE LIMESTONE

9 ELBROOK DOLOMITE

FIGURE 2-A

One of the direct effects of geology on the use of land is the presence or possibility of rocks and minerals having commercial value. High-calcium limestone is quarried northeast of Strasburg to produce lime. Limestone for roads, concrete and other uses is quarried near Forestville.

In the past, limestone and dolomite have been quarried at many other sites. Clay materials near Strasburg and Woodstock were used in the manufacture of brick. Clay near Strasburg was also used to make pottery products and drain tile.

Sand and gravel were produced near Edinburg and Maurertown. Manganese minerals have been mined in the Cedar Creek Valley-Capola Mountain and Massanutten Mountain areas. Iron minerals have been mined in the western part of the County and in the Massanutten Mountain area. A small quantity of zinc ore was mined near Forestville.

Samples of shale from selected localities in the County have been tested and found potentially suitable for use in the manufacture of brick, tile, and lightweight aggregate.

Sandstone and quartzite at some localities may have potential as sources of high-silica raw materials.

Soils

The information in this sub-section was provided by the Soil Conservation Service from the preliminary draft of the Shenandoah County Soil Survey. Seven major soil associations are found within the County. They are listed below in Table 2-A, and shown in Figure 2-B, "Soils", on page 2-5.

TABLE 2-A
MAJOR SOIL ASSOCIATIONS

1. Frederick-Poplimento-Endcav
2. Chilhowie-Carbo-Endcav
3. Weikert-Berks-Laidig
4. Lehew-Gainesboro
5. Wallen-Laidig
6. Wallen-Rock outcrop-Drall
7. Unison-Monongahela-Braddock

Source: Draft Soil Survey of Shenandoah County, Virginia

The soil associations in the survey were grouped into four general kind of landscapes for broad interpretive purposes. Each of the broad groups and the soil associations in each group are described below.

SOILS IN THE SHENANDOAH VALLEY FORMED IN RESIDUUM OF LIMESTONE AND INTERBEDDED LIMESTONE AND CALCAREOUS SHALE; ON UPLANDS:

1. Frederick-Poplimento-Endcav

This association is composed of very deep, well drained soils that have clayey subsoils.

Areas of these soils are located on broad uplands whose slope varies from gently sloping to steep; they generally have long smooth slopes.

This map unit makes up about 23 percent of the County. It is about 35 percent Frederick soils, 24 percent Poplimento soils, 15 percent Endcav soils and 26 percent soils of minor extent.

The Frederick and Poplimento soils are dominantly gently sloping and sloping. Both soils have a surface texture of silt loam and are gravelly or rocky in some areas. The Endcav soils are dominantly gently sloping and sloping and have silt loam surface textures. Some areas are rocky.

Of minor extent in this map unit are well drained Carbo and Timberville soils. Also of minor extent are somewhat poorly drained Toms soils and poorly drained Maurertown soils along small streams and drainageways and areas of rock outcrop.

The soils in this map unit are used mainly for crops and pastures. The non-rocky soils are used mostly as cultivated cropland and are well suited to this use. The steeper soils and the rocky soils are suited to grasses and trees. The hazard of erosion, rockiness, and steep slopes are the main limitations for farming. The clayey subsoil, rockiness, and steep slopes are the main limitations for community development and most other uses.

2. Chilhowie-Carbo-Endcav

This association is composed of moderately deep to very deep, well drained soils that have clayey subsoils.

Areas of these soils are mainly on gently sloping to moderately steep slopes and broad ridge tops. Rock outcrops and sinkholes are numerous throughout the unit.

This map unit makes up about 10 percent of the County. It is about 30 percent Chilhowie soils, 15 percent Carbo soils, 12 percent Endcav soils and 43 percent soils of minor extent.

Carbo and Endcav soils are dominantly gently sloping to strongly sloping and have silty clay loam surface textures. The Carbo soils are moderately deep and the Endcav soils are very deep. The Chilhowie soils are on ridge tops and short, steep side slopes. Chilhowie soils are moderately deep and have a surface texture of silty clay loam. Rock outcrops and sinkholes are numerous throughout this map unit.

Of minor extent in this unit are shallow, well drained Opequon soils, deep well drained Edom and Timberville soils and pits and dumps.

This unit is mainly used for crops and pasture. Most of the steep and rocky areas are in pasture and woodland.

The hazards of erosion, rockiness and slope are the main limitations for farming. The clayey subsoil, depth to bedrock, and steep slopes are the main limitations for community development and most other uses.

SOILS FORMED IN RESIDUAL OR COLLUVIAL MATERIAL FROM SHALE AND SANDSTONE ON UPLANDS AND MOUNTAIN FOOTSLOPES:

3. Weikert-Berks-Laidig

This association comprises shallow to very deep, well drained soils that have loamy subsoils.

Areas of these soils are on hills and ridges, lower side slopes and foothills, and are generally gently sloping to very steep.

This map unit makes up about 38 percent of the county. It is about 21 percent Weikert soils, 20 percent Berks soils, 12 percent Laidig soils and 47 percent soils of minor extent.

The Weikert and Berks soils are predominantly in moderately steep to very steep areas. Both have silt loam surfaces and are closely intermingled on the landscape. Weikert soils are shallow and Berks soils are moderately deep. They are on hills and ridges in the Valley and lower mountains side slopes. Some areas are very stony.

The Laidig soils are very deep and well drained. Most areas are stony or very stony. It is on lower side slopes and narrow ridge tops and side slopes of the foothills.

Of minor extent in this map unit are well drained, Gilpin, Sequoia and Wheeling soils, somewhat poorly drained Toms and Guyan soils, and poorly drained Maurertown and Purdy soils.

This unit is mostly in woodland. A few areas are in cultivated crops and pasture. These areas are mostly along small streams and the North Fork of the Shenandoah River. Slope and depth to bedrock are the main limitations for community development and most other uses.

4. Lehew-Gainesboro

This association has moderately deep, well drained soils that have loamy subsoils.

Areas of these soils are on hills and ridges. They generally have short smooth slopes and are highly dissected.

They map unit makes up about 30 percent of the county. It is about 40 percent Lehew soils, 20 percent Gainesboro soils and 40 percent soils of minor extent.

The Lehew and Gainesboro soils are dominantly on steep side slopes. They are moderately deep and well drained.

Of minor extent in this unit are the moderately deep, well drained Berks, Gilpin and Wallen soils and shallow, well drained Weikert soils.

This unit is mostly wooded. A few small areas along the ridge tops are in pasture. Slope and depth to bedrock are the main limitations for community development and most other uses.

SOILS IN THE APPALACHIAN MOUNTAINS, MASSANUTTEN MOUNTAINS AND MOUNTAIN FOOT SLOPES THAT FORMED IN RESIDUAL OR COLLUVIAL MATERIAL WEATHERED FROM SANDSTONE:

5. Wallen-Laidig

Soils in this association are moderately deep and very deep, somewhat excessively drained and well drained and have loamy subsoils.

Areas of these soils are gently sloping to very steep, on the tops and side slopes of the Appalachian Mountains. Most of this unit is in the George Washington National Forest. This unit makes up about 11 percent of the county. It is 38 percent Wallen soils, 35 percent Laidig soils and 27 percent soils of minor extent.

The Wallen soils are somewhat excessively drained and have very stony and extremely stony surfaces. They are on side slopes and tops of the mountains and are droughty in the summer. The Laidig soils are well drained and have very stony surfaces. They are on the lower side slopes and foot slopes.

Of minor extent in the map units are well drained Zepp, Lehew and Gilpin soils, excessively drained Drall soils and Rock outcrops.

All areas in this map unit are wooded. Slope and stones on the surface are the main limitations of this unit for community development and most other uses.

6. Wallen-Rock outcrop-Drall

This association contains moderately deep and very deep, somewhat excessively and excessively drained soils that have a loamy or sandy subsoil and areas of Rock outcrop.

Areas of these soils are gently sloping to very steep, on the tops and upper side slopes of the Massanutten Mountains. Most of this unit is in the George Washington National Forest. This unit makes up about 9 percent of the county. It is 40 percent Wallen soils, 18 percent Rock outcrop, 8 percent Drall soils, and 34 percent soils of minor extent.

The Wallen soils are somewhat excessively drained and have very stony and extremely stony surfaces. They are on upper side slopes and tops of the mountains. The Rock outcrops which consist of sandstone are mainly 30 feet apart and are on the upper side slopes and tops of the mountains. The Drall soils are excessively drained and have extremely stony surfaces. They are on tops and upper side slopes of the mountains.

Of minor extent in this map unit are well drained Massanutten and Laidig and Weikert soils.

All areas of this map unit are wooded. Slope, rock outcrops and surface stones are the main limitations of this map unit for community development and most other uses.

SOILS ON RIVER TERRACES THAT FORMED IN ALLUVIAL MATERIALS:

7. Unison-Monongahela-Braddock

These soils are very deep, well drained soils that have a loamy or clayey subsoil.

They are located in areas that are nearly level to moderately steep, on terraces along the North Fork of the Shenandoah River and Stony Creek.

This map unit makes up 6 percent of the county. It is 26 percent Unison soils, 15 percent Monongahela soils, 11 percent Braddock soils and 48 percent soils of minor extent.

The Unison and Braddock soils are well drained and are at slightly higher elevations that the Monongahela soils. In some areas these soils are gravelly or cobbly.

The Monongahela soils are moderately well drained and are usually adjacent to the flood plain. This soil has a seasonal high water table. Some areas of this soil are cobbly.

Of minor extent in this map unit are well drained Allegheny, Chavies and Nolin soils, and moderately well drained Cotaco soils.

This unit is used mostly for crops and pastures. A small acreage is wooded. The seasonal high water table in the Monongahela soils and the permeability of the Unison and Braddock soils are the main limitations of this unit for community development and most other uses. Flooding is a hazard on some of the minor soils.

Upon publication of the Soils Survey, more informaton will be available such as better interpretation of the soil data, and detailed mapping of soil types overlaid on aerial photography. In addition, through the use of the geographic information system now in development at the Soil Conservation Service's Culpeper office, generalized maps of soil limitations for various uses and maps of prime agricultural soils will be available. These resources should be incorporated as appropriate into proposed development plans.

Forests and Agriculture

The forests in Shenandoah County are a very important natural resource. Fifty-two percent of the County is forested; the most common forest type is the oak-hickory category, and pole-sized stands are the most numerous.

Forests and forest products have greatly influenced the economic activities in the County. Both the hardwood and pine forests of the County form an excellent source of raw material for a range of industries and domestic uses.

As can be seen in Table 2-B below, the growth in cords of wood and board feet of lumber is substantially greater than the "drain" on these resources. This means that, with proper management, the forest areas can supply needed resources in perpetuity, as well as provide all the benefits of cleansing the air, producing oxygen, and acting as a substantial ground cover.

TABLE 2-B
FORESTRY IN SHENANDOAH COUNTY - 1986

				Growth		Drain	
All Forest	Private Forest	Million Cords	1,000 Bd. Ft.	1,000 Bd. Ft.	1,000 Bd. Ft.	1,000 Bd. Ft.	1,000 Bd. Ft.
185,674	115,820	3.99	844,144	104.5	29760	1.5	518

Source: Virginia Department of Forestry

Approximately 39.4 percent of the land in Shenandoah County (127,782 acres) is classified as agriculture according to the 1988 existing land use map. Agricultural land includes crop land and pasture land, orchards, and confined feeding operations.

There were 830 farms in Shenandoah County as of the 1987 Census of Agriculture. While this represented a drop of ten percent in the number of farms since 1982, the average size of a farm rose by about ten percent from 151 acres to 167 acres due to consolidations--some of the current farms have absorbed the operations of former farms.

The recent trend in farming in Shenandoah County is toward less land-intensive uses, including the development of additional confined feeding operations (predominantly poultry).

Almost one-third (30 percent, or 98,506 acres) of the County is regarded as having prime agricultural soils. This is the highest percent and acreage of all the counties in the Lord Fairfax Planning District. The largest area of prime farm land is in the central part of the County. Every effort should be made to reserve prime agricultural land for agricultural uses.

WATER RESOURCES

This subsection is an inventory and description of the water resources, uses of water, and water-related problems which have been identified in the County. It was abstracted from the complete Shenandoah County Water Resources Assessment, which was prepared under a U. S. Environmental Protection Agency 205-J grant administered by the Virginia Water Control Board, and supplemented by county funds.

The assessment considered both surface and groundwater resources, and began the process of integrating management of those resources into the traditional county government function of land use regulation. Information was gathered from three types of sources: 1) analysis of U.S. Geological Survey 7.5 minute topographic maps; 2) communication with state and local agencies; 3) published papers and documents.

The report entitled Mapping Groundwater Pollution Potential for Shenandoah County, Virginia was prepared by the Virginia Water Project using the DRASTIC methodology, with funding by The Public Welfare Foundation and the Virginia Environmental Endowment.

The DRASTIC methodology was developed to show local officials and residents information necessary for making wise decisions regarding groundwater protection policies, in an easily understandable form. It assesses a combination of factors and results in an index showing the overall pollution potential. The resulting map shows the general groundwater pollution potential of the various areas in the County. However, DRASTIC results are very generalized, with a resolution of no less than a hundred acres. Detailed studies are needed to evaluate individual sites.

SUMMARY OF RESOURCES AND USES

Water Sources

On average, 34 inches of precipitation per year fall onto Shenandoah County land. Approximately 72% of this water returns to the atmosphere through evapotranspiration, leaving 28%, or 230 million gallons per day (MGD), over the whole county, which either runs off the land directly to become stream flow, or first infiltrates the soil to become part of groundwater.

Surface runoff (water which does not infiltrate) becomes part of approximately 1150 miles of permanent and intermittent county streams. The flows in five major streams begin in other counties: the North Fork Shenandoah River, Mill Creek, Smith Creek, and Holmans Creek have their headwaters in Rockingham County; Passage Creek has its headwaters in Page County. Within the county, other major streams - Cedar Creek, Stony Creek, Narrow Passage Creek, Toms Brook, Pughs Run, and Tumbling Run - arise from small tributaries in the eastern and western highlands. Nine dams temporarily impound the flows of seven county streams, resulting in a potential maximum storage of approximately 1800 MG (million gallons). All surface water in the county eventually enters the North Fork, which has averaged (over the period 1925-1988) 379 MGD as it passes the USGS gage at Strasburg (U.S. Route 55 bridge). Approximately two river miles farther downstream, the North Fork leaves the county, eventually entering, in order, the Shenandoah River, the Potomac River, and the Chesapeake Bay. Shenandoah County land represents 49% of the total North Fork watershed, and 7% of the total Potomac River watershed.

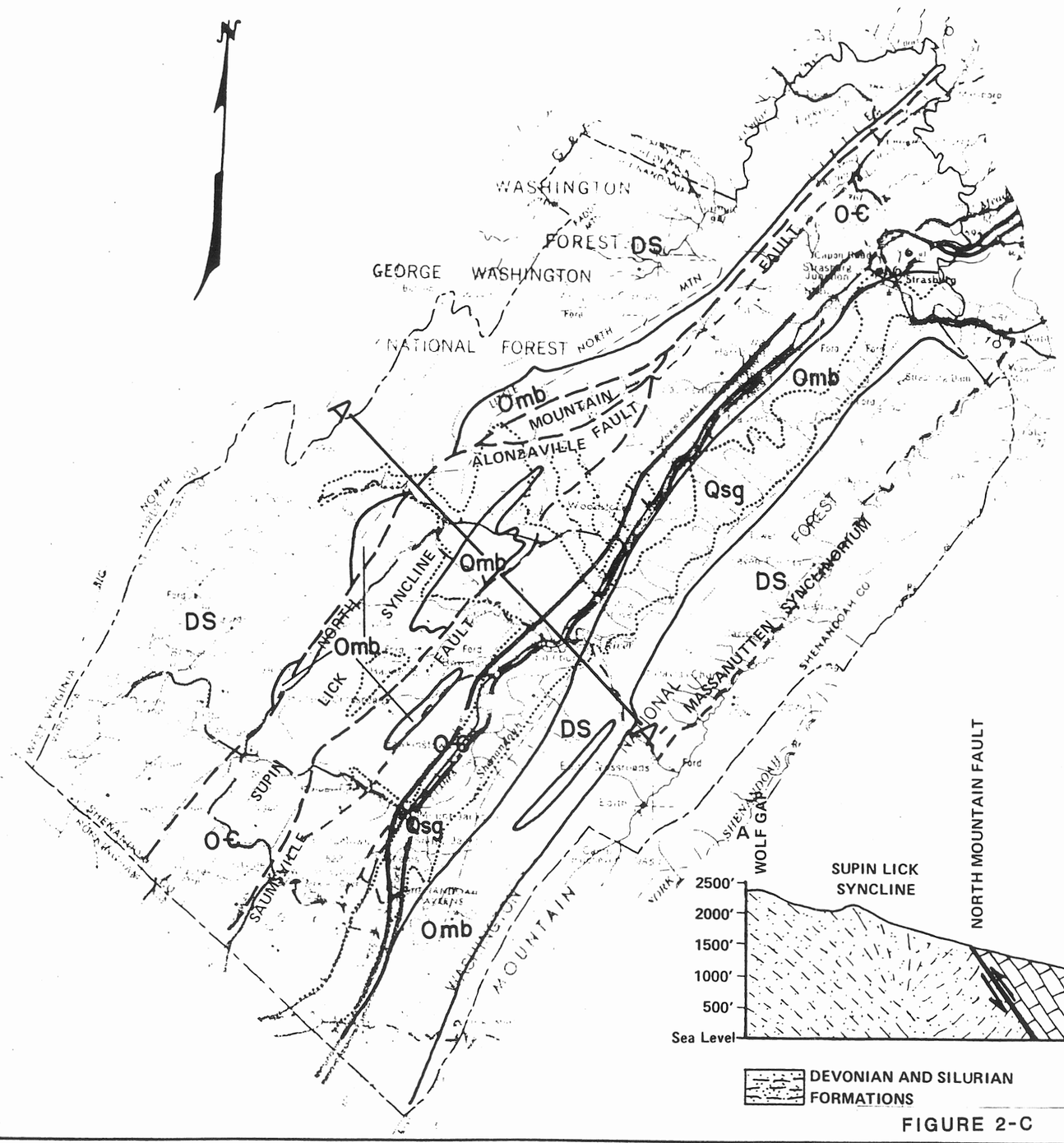
Water that infiltrates and percolates below the water table enters one of four hydrogeologic regions, representing the four primary aquifers in the county (Figure 2-C, page 2-13). Water may remain here, depending on local hydrogeologic conditions, for days, years, decades, or longer. At some point, however, much of this water returns to the surface, by one of three routes: 1) through one of 40 or more springs in the county; 2) through one of the many wells; or 3) through subsurface connections between groundwater and stream channels. During periods of base flow, when no surface runoff is occurring, all of a stream's flow comes from groundwater inputs.

Surface water may also enter (or re-enter) the groundwater system. This may occur through subsurface connections, or by way of surface depressions, also known as sinkholes, which occur especially in the areas underlain by carbonates.

These connections between surface water and groundwater are a part of the natural hydrologic cycle, whereby water (in solid, liquid, or gaseous states) circulates among the atmosphere, continents, and oceans. Movement both between the land surface and the subsurface system, and within this subsurface (groundwater) system, can be especially direct and rapid in the Valley and Ridge physiographic province of Virginia, where Shenandoah County lies, because of the presence of carbonate bedrock. In this type of bedrock, water moves from groundwater to the surface through springs, from the surface to groundwater through sinkholes, and within the groundwater system through subsurface solution channels. Approximately 30% of county land, in the central valley, overlies carbonate-bearing bedrock (solution limestone).

HYDROGEOLOGIC SURVEY OF SHENANDOAH COUNTY

FIGURE 2-C



LEGEND

Qsg — ALLUVIAL, TERRACE AND FLOOD PLAIN DEPOSITS
Chiefly gravel, some sand and clay. Good to excellent water-bearing properties depending upon thickness and lateral extent.

DS — DEVONIAN AND SILURIAN FORMATIONS
Predominantly shale and sandstone. Poor to fair water producer for domestic supplies.

Omb — MARTINSBURG FORMATION
Predominantly shale. Fair to good well yields, good to excellent when overlain by alluvial deposits.

0€ — ORDOVICIAN AND CAMBRIAN CARBONATE FORMATIONS
Predominantly limestone and dolomite. Fair to good well yields for all supplies, good to excellent when overlain by alluvial deposits.

——— FAULT

SCALE 1:250,000

5 0 5 MILES

5 0 5 KILOMETERS

SCHEMATIC CROSS SECTION

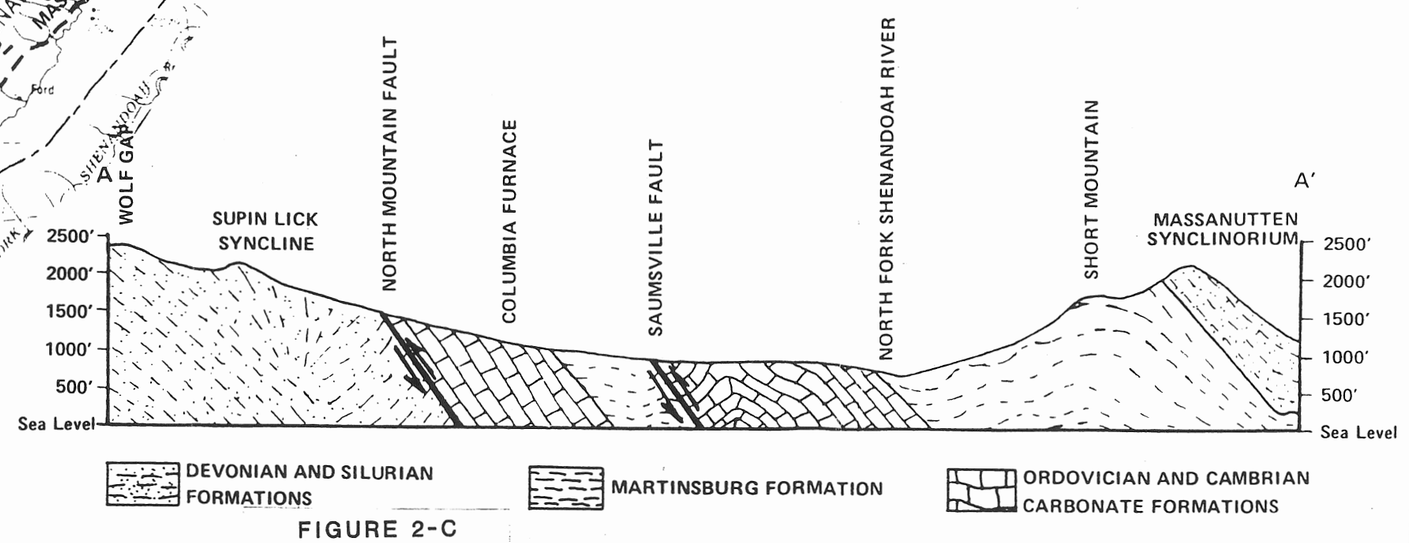


FIGURE 2-C

Source: Virginia State Water Control Board — VRO; Virginia Division of Mineral Resources

Water Quality

Water quality in general refers to the suitability of water for its intended or desired uses. Both aesthetic characteristics and safety influence water's suitability for a particular use. Water suitable for one use may not be suitable for another. For example the water in a high quality trout stream is still not safe to drink without treatment. Conversely, water that has been treated for human consumption may not, before further treatment, support aquatic ecosystems.

Surface water quality in Virginia is evaluated by the Water Control Board as to its suitability, not only for fishing and swimming but also for the maintenance of aquatic life and in-stream usage. Four parameters - dissolved oxygen (DO), temperature, pH, and coliform bacteria - are used in the evaluation. In its biennial report, covering 1985-1987, the Water Control Board rated the quality of the North Fork and Passage Creek as generally good, but identified problems of high bacteria in Smith Creek and Stony Creek. Results from monitoring during 1987-89 indicated fewer bacterial standard violations in Smith and Stony Creeks. Certain mountain streams that provide high quality habitat for wild and stocked trout show evidence of acidification from acid precipitation.

The North Fork and Smith Creek are the main streams used in the county as drinking water sources. High quality drinking water contains no potentially harmful substances in concentrations above acceptable levels (according to standards set by regulation), and has no problems of taste, odor, or appearance. Water from these streams, after treatment, is generally of good quality for drinking, but some taste and odor problems have occurred at Woodstock (North Fork). There have also been some cases of relatively high nitrate-N levels in the county, although the concentrations are still below the standard for public intakes.

Groundwater quality is primarily evaluated on the basis of its suitability for drinking, although characteristics such as hardness may also affect its suitability for other domestic uses or for industry. Available data on the quality of groundwater in the county shows two general patterns. First, water hardness is relatively high in the carbonate region of the central valley and in the Martinsburg Formation area, but low in the western and eastern highlands. Second, high iron and manganese levels are found in the highlands and the Martinsburg Formation, but levels are low in the central valley. Sulfate levels are relatively high in some parts of the central valley (e.g., the Toms Brook and Tumbling Run surface watersheds). Nitrate-N levels are high in several central valley watersheds, as well as in three surface watersheds in the western highlands: Stony Creek main stem; Falls Creek; and Foltz Creek.

Water Uses and Importance

Shenandoah County's water resources and their water quality are important to both the people of the county and the other organisms which inhabit or depend on aquatic systems.

County residents and industries withdrew approximately 4.7 MGD (excluding irrigation water) in 1980 from surface and groundwater sources. Projected use in 1990 is 5.3 MGD (also excluding irrigation). Irrigation for 1990 was projected to be 0.6 MGD based on voluntary

reporting to the County Extension Agent. These figures include groundwater and offstream use of surface water by households, businesses, industries, and farms. Surface water is also used instream for recreation, aesthetic enjoyment, receipt of treated wastewater, and aquatic habitat.

Water is supplied by public waterworks in seven population centers: Bryce Resort (Stoney Creek Sanitary District); Edinburg; Mt. Jackson; New Market; Strasburg; Toms Brook/ Maurertown; and Woodstock. In 1980, 43% of households were supplied by these waterworks. The remainder of households were on individual wells or had some other water source.

Protection of groundwater is extremely important to the county, because approximately 45% of public, commercial, and industrial water used in 1980 was groundwater, and at least 36% of households that year used wells for domestic water. This reliance on groundwater takes on added significance because of the susceptibility of groundwater to contamination, especially in the carbonate bedrock area of the central valley. Location of septic systems or other wastewater treatment systems near wells poses a significant risk of groundwater contamination, in areas where no other economical water source exists.

Besides water for human uses, habitat for many aquatic species is provided by county streams and riparian areas. This and other instream uses received recognition as beneficial uses, worthy of legal protection, by the 1989 Virginia General Assembly. The North Fork, Passage Creek, Cedar Creek, and Little Stony Creek are examples of many streams in the county with valuable ecological features to accompany their value for traditional offstream uses.

PROBLEM IDENTIFICATION

Surface Water Protection

1. Nonpoint source (NPS) pollution from agricultural practices affects county streams and eventually the Chesapeake Bay. Sediment and plant nutrients affect the quality of habitat for fish and other aquatic organisms. Bacteria, as well as excess enrichment from nitrogen and phosphorus, can affect the suitability of water for swimming or drinking. The North Fork, Stony Creek, and Smith Creek have been identified as Priority Water Bodies by the Water Control Board because of NPS pollution impacts: taste and odor problems in drinking water have occurred at Woodstock (North Fork water); Smith and Stony Creeks have occasional high fecal coliform bacteria levels. The fishability and swimmability of Cedar Creek and Passage Creek are threatened if NPS pollution continues at present levels.

2. Coldwater (trout) streams have been affected by acid precipitation, and are vulnerable to further acidification.

3. Riparian areas are very important to the ecological health of stream systems. Protection of riparian areas is needed to help maintain the ecological, aesthetic, and recreational qualities of streams, especially the coldwater streams.

4. More detailed information is needed on wetlands within the county.

5. The number of alternative wastewater treatment systems designed for surface discharge has increased substantially. Improperly constructed or maintained systems potentially threaten stream water quality. The number and location of these systems need to be monitored to ensure that they do not adversely affect streams.

6. Instream flow requirements are not well-defined for county streams, and conflicts with offstream uses may develop. The Water Control Board is in the process of designating minimum flow standards for streams.

Groundwater Protection

1. Recharge areas for aquifers have not been delineated, so the existence of threats to groundwater quality are difficult to assess.

2. Improperly-constructed wells threaten both the owner's domestic supply and the groundwater source. Abandoned wells, if not properly sealed, are a conduit for groundwater contamination. The number and location of improperly-constructed or improperly-sealed wells in the county are not known.

3. Groundwater can be contaminated by substances from a variety of sources and activities. Aquifers in the central valley of the county are especially vulnerable. Sources of potential contamination include: 1) location of septic systems near wells; 2) underground storage tanks; 3) improper management of animal waste; 4) excessive use of fertilizers and pesticides.

4. A limited program of locating and mapping existing occurrences of bacterial and nitrate contamination of wells has been started, and should be expanded throughout the County.

5. Sinkholes provide rapid entry of surface contaminants into groundwater. The location of sinkholes has not been adequately mapped, and it is not known whether or where sinkhole dumps exist.

6. At least 10 wells have been contaminated by petroleum products, suspected to be from underground storage tanks (UST's). Thirteen cases of leaking UST's in the county had been reported to the Water Control Board as of February 1, 1990.

Water Supply

1. There are a substantial number of households with water supplies of questionable safety.

2. Toms Brook/Maurertown is currently having trouble meeting demand. Service lines are too small for fire protection, according to Virginia Department of Health guidelines. (VWCB, 1988b)

3. Two public systems - Stoney Creek Sanitary District (SCSD) and Toms Brook/Maurertown - are projected by the Virginia Water Control Board to have source deficits by the year 2030, based on average use. Five systems, however - Edinburg, Mt. Jackson, SCSD, Strasburg, and Toms Brook/Maurertown - are projected to have deficits based on peak use. (VWCB, 1988b)

4. SCSD is projected to have a treatment deficit by 2030. Projected withdrawals are likely to exceed flows needed for waste assimilation, even without taking any instream flow requirement into account. (VWCB, 1988b)

5. Serious instream/offstream conflicts are projected to occur by the year 2030 for SCSD and New Market (VWCB, 1988b, Appendices p.160).

6. A substantial percentage of water used by some public waterworks is unaccounted for. The percentages are as follows (VWCB, 1988): Edinburg - 57%; Mt. Jackson - 38%; New Market - 21%; Strasburg - 12%; SCSD - No data available; Toms Brook/ Maurertown - 31%; Woodstock - 25%.

WATER RESOURCES RECOMMENDATIONS

Five general objectives of good water resource management are proposed to achieve the major goals of this plan relating to preserving and enhancing the environmental quality of the County and providing for the economical delivery of necessary public services. These objectives are:

A. Efficiency in the use of existing water supplies and wastewater facilities;

B. Appropriate development of needed new water supplies, water facilities, and wastewater facilities;

C. Protection of surface and groundwater resources from depletion, pollution, and ecological degradation;

D. Acquisition and maintenance of necessary data and information.

E. Involvement of local officials and citizens in water resource decisions.

Recommendations to help accomplish these objectives are presented below.

A. Efficiency in use of existing supplies and facilities

1. Develop a county-wide water conservation plan. The VWCB can assist this effort.

2. Reduce the percentages of unaccounted-for water from municipal systems.

3. Develop a plan for emergency water conservation or allocation in case of severe drought, or in case of contamination of a public water supply.

B. Appropriate development of new supplies or facilities

1. Maintain and improve as necessary existing public water supplies and wastewater facilities.

2. Guide growth into areas with existing water and sewer service.

3. Consider in-stream or off-stream water impoundments.

C. Protection of water resources

1. Use the watershed delineations done for this project to identify priority watersheds, based both on the value of the water resources and the potential risks within the watersheds, and concentrate available resources on these watersheds first.

2. Address nonpoint source pollution by: promotion of agricultural, urban, forestry, and other best management practices (BMP's); cooperation with the Division of Soil and Water Conservation and the Soil Conservation Service's programs to implement BMP's; promotion of techniques to reduce agricultural and household chemical use; and appropriate enforcement of the Erosion and Sediment Control Law.

3. Delineate wellhead protection areas for public water supplies, and incorporate wellhead protection into the development of new public supplies.

4. Use available local tools to protect groundwater from contamination by septic systems, underground storage tanks, animal wastes, excessive agricultural chemical use, or other threats as identified.

5. Locate sinkholes and sinkhole dumps, and implement sinkhole protection (sinkhole ordinance).

6. Continue improvement to municipal sewer facilities as needed. Encourage cooperation among towns and other water and sewer service providers and outlying areas to provide services where needed.

7. Monitor all discharge from alternative systems.

8. Support the efforts of the U. S. Forest Service and the Virginia Department of Game and Inland Fisheries to mitigate the effects of acidification in coldwater streams.

9. Follow the progress of VWCB instream flow regulations, and gather information of instream uses and flow requirements for county streams.

10. Encourage riparian landowners to maintain streambank vegetation and minimize disturbances in riparian areas, in order to protect stream habitat and water quality. Landowners can apply to the Agricultural Stabilization and Conservation Service (ASCS) to have riparian land (if it qualifies) placed in the Conservation Reserve Program.

11. Consider the development of site plan review criteria for the definition and protection of wetlands.

12. Stress the role individual land owners must play in the protection of groundwater by proper on-site wastewater system maintenance, and proper use and disposal of household chemicals and waste oil.

D. Acquire and maintain data

1. Consult with the Virginia Groundwater Protection Steering Committee on data needs of the county, and how the state can help.

2. Identify aquifer recharge areas.

3. Locate any existing contamination of groundwater by nitrates and bacteria.

4. Locate the significant threats to groundwater.

5. Work with the Water Control Board, other agencies, and private citizens to devise and implement a system for monitoring surface water flows and the quality of surface and groundwater.

6. Work with state agencies to determine instream flow requirements for county streams.

7. Identify existing wetland areas within the county. The National Wetlands Inventory can be reviewed, and soil survey data can be used to identify hydric soils.

8. Track the permitting and installation of alternative wastewater treatment systems designed for surface discharge.

E. Local involvement

To assist in implementing the recommendations listed above, the county Board of Supervisors should create a Water Resources Steering Committee. This committee would help provide both the leadership and the public participation needed to continue the process of water resource management and protection. The committee could investigate the funding sources available for implementation of this plan's recommendations, and advise the county on specific needs for regulation, education, or other water management tools.

NATURAL RESOURCE LIMITATIONS

Approximately 56 percent of the County's total land area has severe limitations for on-site septic systems and almost 40 percent has severe excavation limitations. These limitations include slow permeability, a seasonally high water table, flooding, rock fragments, shallow depth to bedrock, steep slopes, danger of well contamination, a high shrink-swell potential, surface rock outcroppings, and other factors.

Land with severe limitations for on-lot sewerage systems is located along the eastern and western portions of the County and in the extreme center. Generally this area corresponds to the Appalachian Mountain section (including the Massanuttens) and the land underlain by the Martinsburg Formation.

The best general areas for constructing septic tank and tile field systems are those underlain by limestone and terrace gravel, which generally occupy the valley lowlands in the center of the County. However, these areas also have the greatest potential for ground water pollution and the danger of well contamination from septic tanks because of the underground stream network and solution channels associated with the limestone formations.

Many of the County's soils are also rated poorly for building excavations, foundations, basements, and water and sewer lines. Excavation limitations arise because of the shallow depth of some soils to bedrock, a high percentage of rock fragments in the soil, frequent rock outcroppings, and other similar factors.

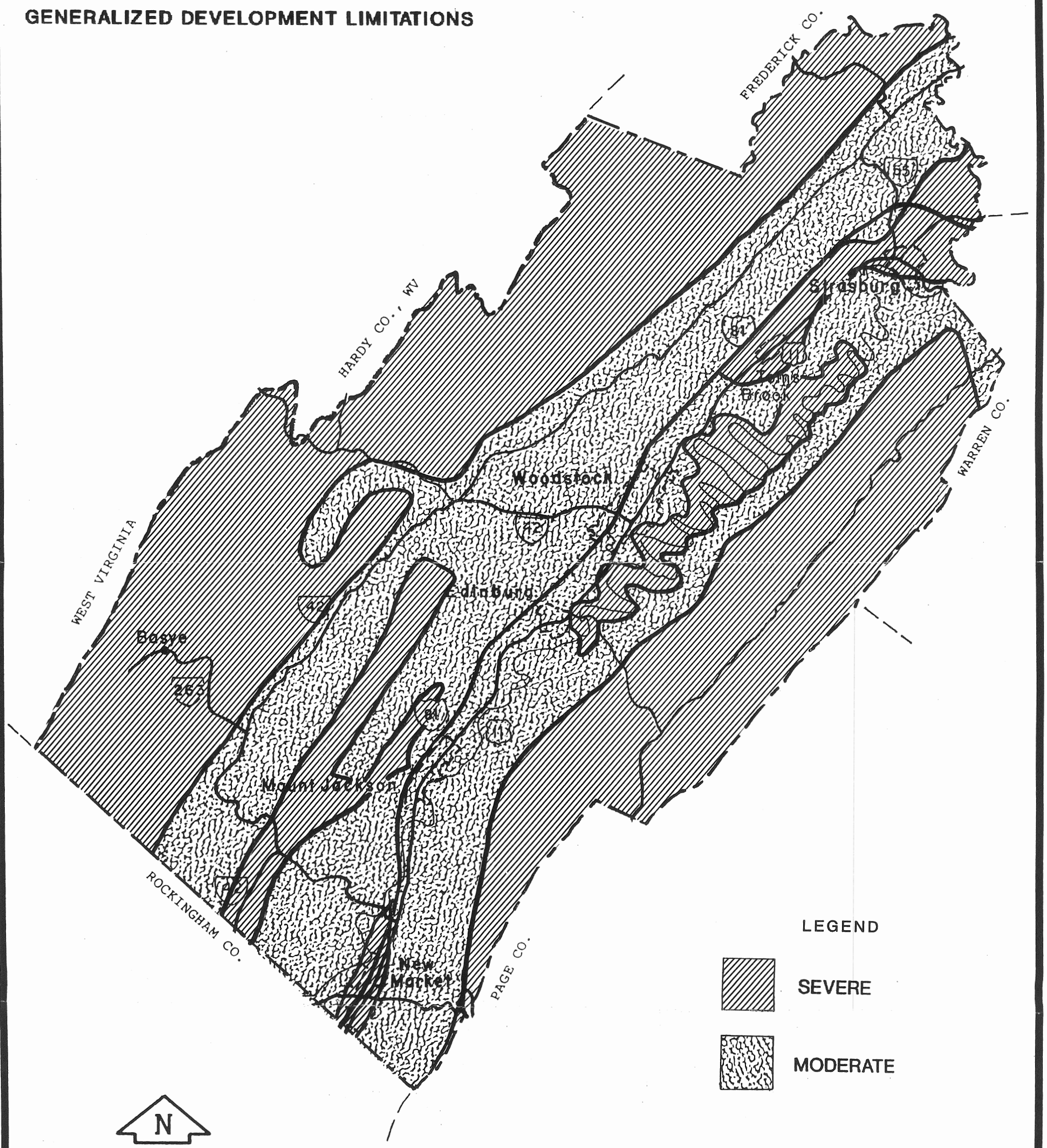
Approximately 40 percent of the land area in Shenandoah County has severe limitations for excavation, and about another 37 percent has moderate to moderate-severe limitations. Most of the land in these categories also occurs in the western and eastern parts of the County.

In summary, the major areas of severe natural restrictions-- land poorly suited for both septic systems and excavations--are located along the County's eastern and western flanks; this is shown on Figure 2-D on the next page. This is the same area as the Appalachian Mountain Belt of geography, including the Massanutten Mountain. Public policy should discourage non-farm or non-woodland uses of land in these areas. A second area, having severe limitations for septic systems is located on the east-central lowland, and is underlain by the Martinsburg (shale) Formation.

SHENANDOAH COUNTY

VIRGINIA

GENERALIZED DEVELOPMENT LIMITATIONS



SOURCE: DISTRICT NATURAL FEATURES ANALYSIS, 1976
LORD FAIRFAX PLANNING DISTRICT COMMISSION

FIGURE 2-D

SUMMARY

The natural resources of Shenandoah County provide many opportunities, but also pose some severe environmental problems. Development should be guided away from areas with serious limitations, such as steep slopes, shallow depth to bedrock, flood plains, prime agricultural lands, wetlands, and sinkholes.

Forest areas and agriculture should be preserved as major natural and economic assets. Floodplains along the North Fork of the Shenandoah River and its tributaries must be protected, and riparian lands kept in their natural state.

The water resources of the County must be protected, both surface water and groundwater. Because of the rock and soil conditions and the hydrogeologic cycle, the water resources are directly inter-connected.

A first step was the development of the Shenandoah County Water Resources Assessment as part of this plan. Now the recommendations of that assessment need to be carried out by the Planning Commission and Board of Supervisors. Specific recommendations for water resource protection are included on pages 2-18 through 2-20 of this section. The following points summarize the major efforts that are needed to implement those recommendations and to mount a comprehensive water resources management effort:

- Develop a comprehensive Shenandoah County Water Resources Plan which deals with both surface and ground water issues, and delineates and protects wells, wetlands, and sinkholes.

- Work with the other counties in the North Fork drainage basin and the State Water Control Board for a regional surface water management strategy.

- Look for long-term solutions for storm water management and non-point source pollution abatement.

- Monitor the progress of the Health Department and Water Control Board in their permitting and monitoring of individual alternative treatment systems.

- Consider special County ordinances which may require higher standards than the State for wells and septic systems.

- Explore a county-wide mechanism for the monitoring and maintenance of alternative and septic treatment systems.