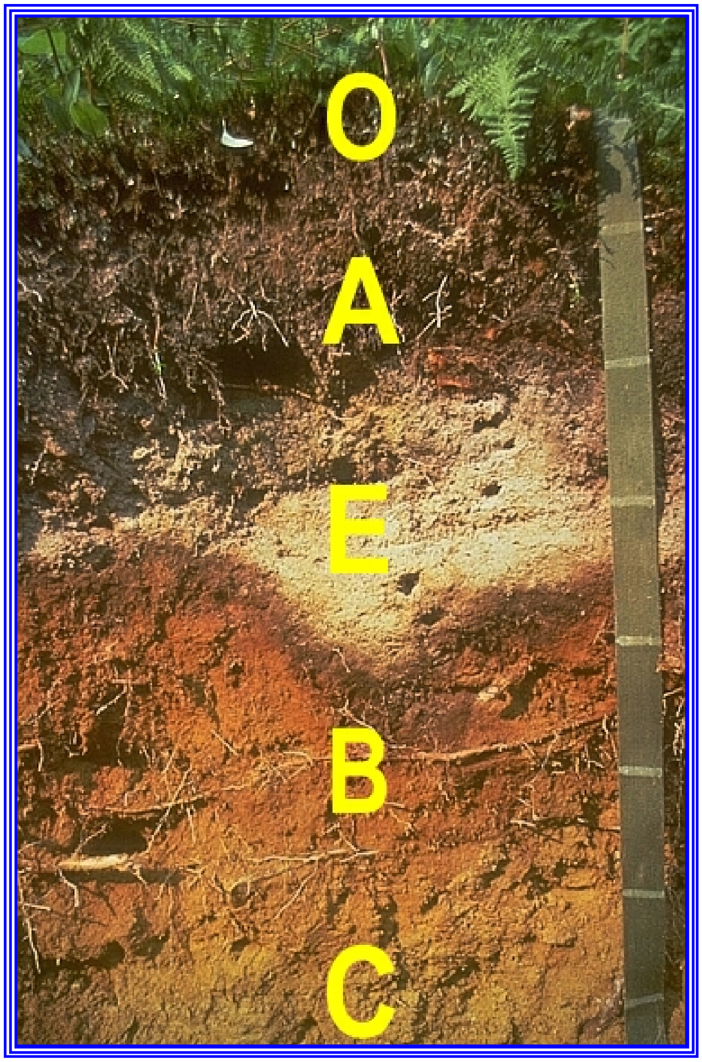
Maryland Envirothon Soil Study Guide



Compiled by the Maryland Envirothon Soils Workgroup September 2002

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Introduction

Sustaining our soil productivity and the management of our other natural resources is an important concern of farmers, rural landowners, homeowners and governmental agencies. This document will provide the scope by which farmers and landowners utilize soil and water conservation plans to maintain these important resources. It will also identify best management practices that will conserve, protect and enhance their land.

As soil scientists analyze and examine soils, they believe texture is the most important aspect of a soil. By determining a soil's texture, an individual is able to characterize the interrelationships among the other soil properties of the soil. Hence, the individual is better informed as to the ability and the uses of the land.

Stated below are objectives that an individual can learn to improve their awareness and knowledge of soils and it's capabilities:

1. Recognize the factors affecting soil formation and the composition of the soil.
2. Identify the various landforms and associated soil parent materials.
3. Identify in the field soil properties (such as texture, depth of bedrock, seasonal high water table, flooding, slope, etc.) that directly impact soil interpretations.
4. Utilize the soil survey to develop an assessment of the limitations for regional land us planning.
5. Develop an understanding of the soil properties that affect soil health and soil quality.
6. Determine the health and quality of the soil in the field.
7. Develop an understanding of, and the ability to apply the Land Capability Classification System in an effort to protect farmland from urban pressure.
8. Develop an understanding of the soil's impact on the hydrologic cycle.

We encourage the use of this document to develop a better understanding of soils, the factors associated with soils development, and its uses, as well as soil conservation districts and the various means to control soil erosion and water quality degradation.

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SOIL CONSERVATION IN MARYLAND

Things You Need To Know in This Section

- Be able to describe a conservation district and what purpose it serves.
- Know what a Soil Conservation and Water Quality Plan (Conservation Plan) is and its purpose.
- Know what a Best Management Practice (BMP) is and be able to understand its benefits.

Maryland Soil Conservation Districts and their Purpose

As a result of the careless use of land and the Dust Bowl in the early 1930's, the government saw the need for conservation. On April 27, 1935, by an act of Congress the Soil Erosion Service (now known as the Natural Resources Conservation Service) as part of the United States Department of Agriculture was formed. In 1937, President Franklin D. Roosevelt proposed the formation of local soil conservation districts. This would allow local citizens and leaders to determine local needs and directives to manage soil and erosion. On August 4, 1937, Hugh Hammond Bennett (known as the father of the conservation movement) organized the first conservation district in North Carolina. Kent County, Maryland was the first conservation district formed in this state on May 11, 1938. Today there are more than 3,000 conservation districts in all 50 states, Puerto Rico, and the Virgin Islands.

A board of supervisors leads each district. Their job is to provide overall supervision, establish the local needs of their community, and develop and implement programs to meet those needs of that community. In Maryland the conservation districts are made up of: Board of Supervisors; local district personnel; Maryland Department of Agriculture - Office of Resource Conservation (MDA-RC); and U.S. Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS). This partnership allows a team effort each having it own roles in preserving our natural resources.

The purpose of soil conservation districts in Maryland is to take available technical, financial, and educational resources, whatever their source, and focus them so that they meet the needs of the local landuser for the conservation and wise use of soil, water, and related natural resources.

Soil Conservation and Water Quality Plans

Agriculture has played a key role in protecting our country's waterways and natural resources. The farm community has been the leader in promoting soil and water conservation efforts. Farmers know that by conserving soil and water resources they will be maintaining and improving farm productivity in balance with natural resources. A Soil Conservation and Water Quality Plan (Conservation Plan) is the tool that can help farmers manage their individual resources.

The purpose of a Conservation Plan is to provide the framework for the sound use and management of soil, water, and related natural resources to prevent their degradation and assure their sustained use for the future. Conservation Plans are voluntary and site specific. A Conservation Plan includes resource information, a record of the landowner decisions, and a schedule of activities or treatments needed to solve identified natural resource problems. Like the pieces of a jigsaw puzzle each BMP fits together with others to complete a picture. But anybody who has spent a rainy Sunday afternoon piecing together a jigsaw puzzle knows it takes patience, organization, and teamwork.

When designing a Conservation Plan all the resources on a farm are to be considered. Take an inventory; think about every field, pasture, pond, stream, and wooded area. Then consider which soil conservation, water quality, wildlife habitat, and energy conservation practices would contribute to an environmentally and economically sound farm.

There are local, state and federal agencies providing technical and financial assistance through the Soil Conservation Districts to help farmers and landowners plan, implement, and maintain their Conservation Plan.

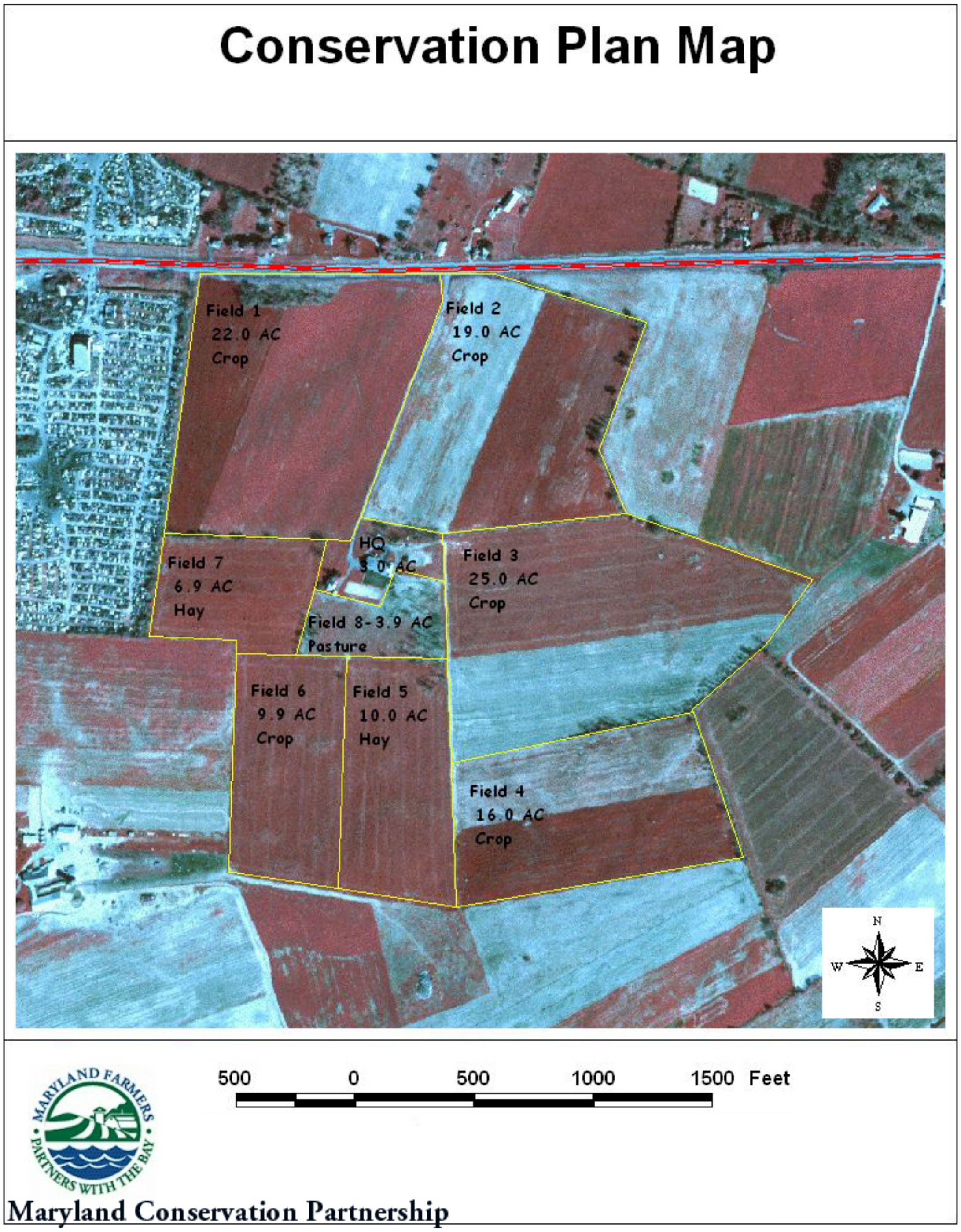
Developing a soil conservation and water quality plan: some basic questions

- What soils are present on the farm?
- What are the natural resources on a farm?
- What are the crops to be grown?
- Has water runoff been minimized?
- Are crop rotations being used to reduce disease and pest problems?
- What type of wildlife is desired on the farm?
- Does any BMP interfere with or cancel out other BMP's?
- Can wetlands or filter strips be used to filter nutrients from runoff water?
- Are animal manures being used properly as nutrients for plants?

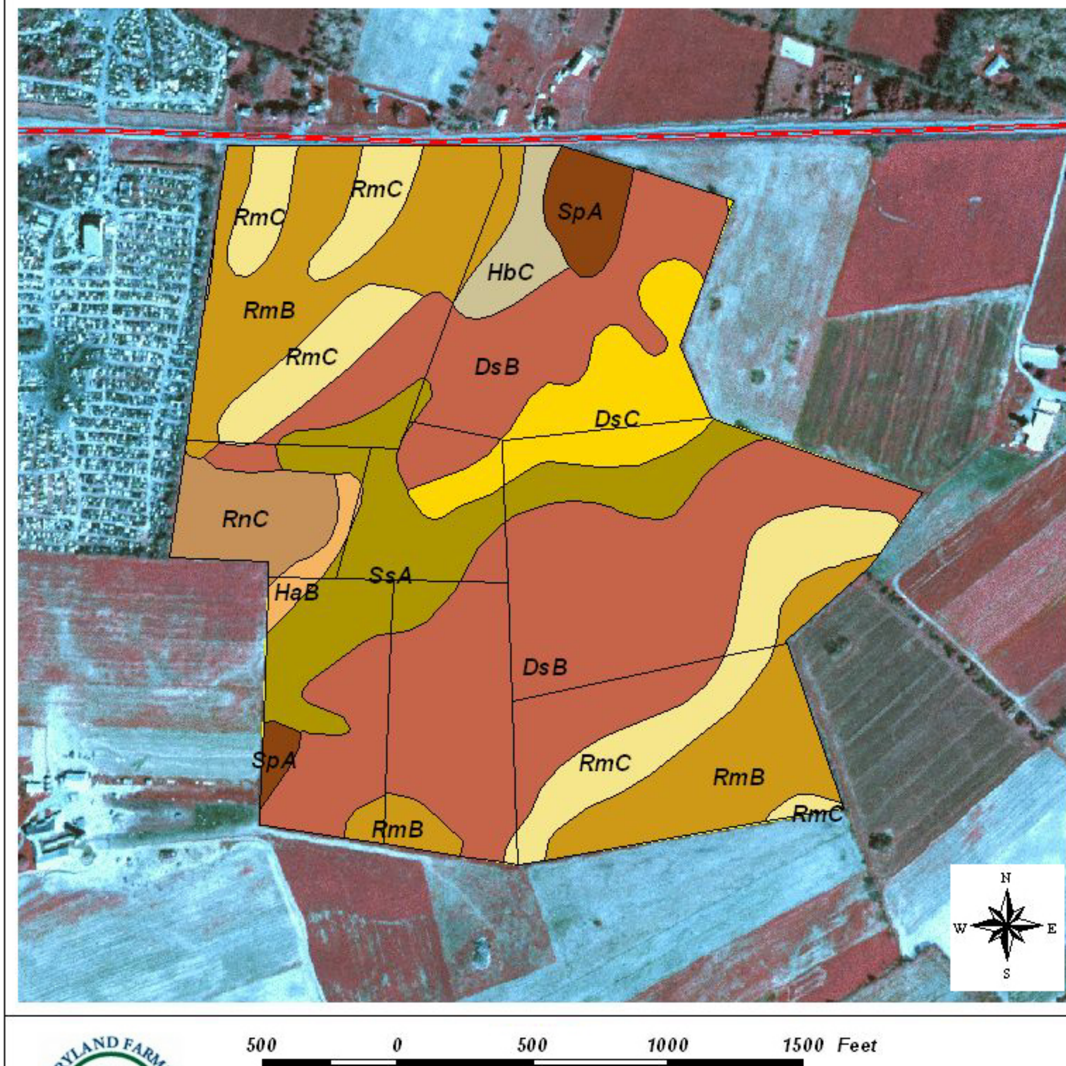
A Conservation Plan pulls all this information together in one location. A typical plan would include the following elements:

- A soils map. (see example)
- Soil descriptions of each soil series. (see example)
- A Conservation Plan Map, which is an aerial photograph showing farm and field boundaries and other important land features. (see example)
- A schedule of BMP installation contained in the actual planned narrative. (see example)

The example in this guide shows the elements of a basic Conservation Plan. Many Conservation Plans deal with complex agricultural conservation, cultural and economic issues, and include more in depth information regarding each.



Soils Map



Maryland Conservation Partnership

Soil Descriptions - Non-Technical

Anywhere County, Maryland

Only those map units that have entries for the selected non-technical description categories are included in this report.

Map DsB - Duffield silt loam, 3 to 8 percent slopes
Description Category: SO5

THE DUFFIELD SERIES CONSISTS OF VERY DEEP AND DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM IMPURE LIMESTONE. TYPICALLY THESE SOILS HAVE A DARK GRAYISH BROWN SILT LOAM SURFACE LAYER 10 INCHES THICK. THE SUBSOIL FROM 10 TO 53 INCHES IS YELLOWISH-BROWN AND BROWNISH-YELLOW SILTY CLAY LOAM. THE SUBSTRATUM FROM 53 TO 60 INCHES IS YELLOWISH-BROWN SHALY SILT LOAM. SLOPE RANGE FROM 0 TO 35 PERCENT.

Map DsC - Duffield silt loam, 8 to 15 percent slopes
Description Category: SO5

THE DUFFIELD SERIES CONSISTS OF VERY DEEP AND DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM IMPURE LIMESTONE. TYPICALLY THESE SOILS HAVE A DARK GRAYISH BROWN SILT LOAM SURFACE LAYER 10 INCHES THICK. THE SUBSOIL FROM 10 TO 53 INCHES IS YELLOWISH-BROWN AND BROWNISH-YELLOW SILTY CLAY LOAM. THE SUBSTRATUM FROM 53 TO 60 INCHES IS YELLOWISH-BROWN SHALY SILT LOAM. SLOPE RANGE FROM 0 TO 35 PERCENT

Map HaB - Hagerstown silt loam, 3 to 8 percent slopes
Description Category: SO5

THE HAGERSTOWN SERIES CONSISTS OF VERY DEEP, WELL-DRAINED, REDDISH SOILS ON UPLANDS. THEY FORMED IN MATERIALS WEATHERED FROM HARD LIMESTONE. TYPICALLY THESE SOILS HAVE AN 8 INCH PLOW LAYER OF BROWN OR DARK BROWN SILT LOAM. THE MATERIAL BELOW THIS DEPTH AND EXTENDING RATHER UNIFORMLY TO BEDROCK IS GENERALLY YELLOWISH RED CLAY OR SILTY CLAY, WITH LIMESTONE FRAGMENTS COMMON IN THE LOWER SUBSOIL AND SUBSTRATUM. SINK HOLES OCCUR IN SOME PLACES. LIMESTONE ROCK OUTCROPS ARE VERY COMMON BUT SOIL CAN USUALLY BE FARMED BETWEEN OUTCROPS. SLOPES RANGE FROM 0 TO 60 PERCENT.

Map HbC - Hagerstown silty clay loam, 8 to 15 percent slopes, very rocky
Description Category: SO5

THE HAGERSTOWN SERIES CONSISTS OF VERY DEEP, WELL-DRAINED, REDDISH SOILS ON UPLANDS. THEY FORMED IN MATERIALS WEATHERED FROM HARD LIMESTONE. TYPICALLY THESE SOILS HAVE AN

8 INCH PLOW LAYER OF BROWN OR DARK BROWN SILT LOAM. THE MATERIAL BELOW THIS DEPTH AND EXTENDING RATHER UNIFORMLY TO BEDROCK IS GENERALLY YELLOWISH RED CLAY OR SILTY CLAY, WITH LIMESTONE FRAGMENTS COMMON IN THE LOWER SUBSOIL AND SUBSTRATUM. SINK HOLES OCCUR IN SOME PLACES. LIMESTONE ROCK OUTCROPS ARE VERY COMMON BUT SOIL CAN USUALLY BE FARMED BETWEEN OUTCROPS. SLOPES RANGE FROM 0 TO 60 PERCENT.

Map RmB - Ryder-Duffield channery silt loams, 3 to 8 percent slopes
Description Category: SO5

THE RYDER SERIES CONSISTS OF MODERATELY DEEP, WELL-DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM SHALY LIMESTONE. TYPICALLY, THESE SOILS HAVE A YELLOWISH BROWN SILT LOAM SURFACE LAYER 8 INCHES THICK. THE SUFSOIL FORM 8 TO 30 INCHES IS YELLOWISH-BROWN FRIABLE SILT LOAM IN THE UPPER PART AND LIGHT YELLOWISH-FROWN FIRM CHANNERY SILTY CLAY LOAM IN THE LOWER PART. THE SUBSTRATUM FROM 30 TO 35 INCHES IS YELLOWISH-BROWN AND BROWN VERY CHANNERY SILT LOAM. SHALY LIMESTONE IS AT 35 INCHES

THE DUFFIELD SERIES CONSISTS OF VERY DEEP AND DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM IMPURE LIMESTONE. TYPICALLY THESE SOILS HAVE A DARK GRAYISH BROWN SILT LOAM SURFACE LAYER 10 INCHES THICK. THE SUBSOIL FROM 10 TO 53 INCHES IS YELLOWISH-BROWN AND BROWNISH-YELLOW SILTY CLAY LOAM. THE SUBSTRATUM FROM 53 TO 60 INCHES IS YELLOWISH-BROWN SHALY SILTLOAM. LIMESTONE OUTCROPS ARE VERY COMMON. SLOPES RANGE FROM 0 TO 45 PERCENT.

Map RmC - Ryder-Duffield channery silt loams, 8 to 15 percent slopes
Description Category: SO5

THE RYDER SERIES CONSISTS OF MODERATELY DEEP, WELL-DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM SHALY LIMESTONE. TYPICALLY, THESE SOILS HAVE A YELLOWISH BROWN SILT LOAM SURFACE LAYER 8 INCHES THICK. THE SUFSOIL FORM 8 TO 30 INCHES IS YELLOWISH-BROWN FRIABLE SILT LOAM IN THE UPPER PART AND LIGHT YELLOWISH-FROWN FIRM CHANNERY SILTY CLAY LOAM IN THE LOWER PART. THE SUBSTRATUM FROM 30 TO 35 INCHES IS YELLOWISH-BROWN AND BROWN VERY CHANNERY SILT LOAM. SHALY LIMESTONE IS AT 35 INCHES

THE DUFFIELD SERIES CONSISTS OF VERY DEEP AND DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM IMPURE LIMESTONE. TYPICALLY THESE SOILS HAVE A DARK GRAYISH BROWN SILT LOAM SURFACE LAYER 10 INCHES THICK. THE SUBSOIL FROM 10 TO 53 INCHES IS YELLOWISH-BROWN AND BROWNISH-

YELLOW SILTY CLAY LOAM. THE SUBSTRATUM FROM 53 TO 60 INCHES IS YELLOWISH-BROWN SHALY SILT LOAM. LIMESTONE OUTCROPS ARE VERY COMMON. SLOPES RANGE FROM 0 TO 45 PERCENT.

Map RnC - Ryder-Nollville channery silt loams, 8 to 15 percent slopes
Description Category: SO5

THE RYDER SERIES CONSISTS OF MODERATELY DEEP, WELL-DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM SHALY LIMESTONE. TYPICALLY, THESE SOILS HAVE A YELLOWISH BROWN SILT LOAM SURFACE LAYER 8 INCHES THICK. THE SUFSOIL FORM 8 TO 30 INCHES IS YELLOWISH-BROWN FRIABLE SILT LOAM IN THE UPPER PART AND LIGHT YELLOWISH-FROWN FIRM CHANNERY SILTY CLAY LOAM IN THE LOWER PART. THE SUBSTRATUM FROM 30 TO 35 INCHES IS YELLOWISH-BROWN AND BROWN VERY CHANNERY SILT LOAM. SHALY LIMESTONE IS AT 35 INCHES.

THE NOLLVILLE SERIES CONSISTS OF DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN RESIDUAL MATERIALS DERIVED FROM ARGILLACEOUS LIMESTONE AND LIMY SHALE NOLLVILLE SOILS ARE ON CONVEX UPLAND RIDGES OF LOW RELIEF. TYPICALLY THESE SOILS HAVE A DARK YELLOWISH BROWN CHANNERY SILT LOAM SURFACE LAYER 10 INCHES THICK. THE SUBSOIL FROM 10 TO 29 INCHES IS YELLOWISH BROWN SILTY CLAY LOAM OR ITS CHANNERY ANALOGUE, AND FROM 29 TO 41 INCHES IS STRONG BROWN SILTY CLAY. THE SUBSTRATUM FROM 41 TO 57 INCHES IS STRONG BROWN VERY CHANNERY SILTY CLAY LOAM. SLOPES RANGE FROM 3 TO 35 PERCENT.

Map SpA - Swanpond silt loam, 0 to 3 percent slopes
Description Category: SO5

THE SWANPOND SERIES CONSISTS OF VERY DEEP, MODERATELY WELL DRAINED, SLOWLY PERMEABLE SOILS. THEY FORMED IN RESIDUUM WEATHERED FROM CALCAREOUS SHALE AND LIMESTONE ROCK, ON BROAD FLAT SUMMITS, BACKSLOPES, DEPRESSIONS, AND UPLAND DRAINAGE SWALES. TYPICALLY THESE SOILS HAVE A BROWN SURFACE LAYER 12 INCHES THICK. THE SUBSOIL FROM 12 TO 70 INCHES IS A YELLOWISH BROWN CLAY. THE SUBSOILS FROM 70 TO 73 INCHES IS A BROWNISH YELLOW SILTY CLAY. SLOPES RANGE FROM 0 TO 8 PERCENT.

Map SsA - Swanpond-Funkstown silt loams, 0 to 3 percent slopes
Description Category: SO5

THE SWANPOND SERIES CONSISTS OF VERY DEEP, MODERATELY WELL DRAINED, SLOWLY PERMEABLE SOILS. THEY FORMED IN RESIDUUM WEATHERED FROM CALCAREOUS SHALE AND LIMESTONE ROCK, ON BROAD FLAT SUMMITS, BACKSLOPES, DEPRESSIONS, AND UPLAND DRAINAGE SWALES. TYPICALLY THESE SOILS HAVE A BROWN

SURFACE LAYER 12 INCHES THICK. THE SUBSOIL FROM 12 TO 70 INCHES IS A YELLOWISH BROWN CLAY. THE SUBSOILS FROM 70 TO 73 INCHES IS A BROWNISH YELLOW SILTY CLAY. SLOPES RANGE FROM 0 TO 8 PERCENT.

THE FUNKSTOWN SERIES CONSISTS OF VERY DEEP, MODERATELY WELL DRAINED, MODERATELY PERMEABLE SOILS ON UPLAND DRAINAGEWAYS AND HEAD SLOPES. THEY FORMED FROM LOCAL ALLUVIAL AND COLLUVIAL MATERIALS OVERLYING LIMESTONE RESIDIUUM. TYPICALLY THE SURFACE IS YELLOWISH BROWN SILT LOAM FROM 0 TO 12 INCHES, FOLLOWED BY STRONG BROWN GRAVELLY SILT LOAM FROM 12 TO 22 INCHES. THE UPPER SUBSOIL IS STRONG BROWN VERY GRAVELLY SILT LOAM FROM 22 TO 30 INCHES. THE LOWER SUBSOIL AND SUBSTRATUM IS YELLOWISH BROWN OR YELLOWISH RED SILTY CLAY LOAM, CLAY LOAM OR SILT LOAM. SLOPE RANGES FROM 0 TO 3 PERCENT.

Conservation Plan Narrative

Natural Resources Conservation Service
Anywhere County Field Service Center
234 Main Street, Building 4
Anytown, Maryland 21111
301-999-9999 Ext. 3

Assisted By:
S.P. Planner
Soil Conservationist

---------------- Conservation Plan--------------

Pasture

Tract: 536

FENCE
Install fences to exclude livestock from Conservation Reserve Enhancement Program (CREP)-Riparian Forest Buffer Area. O&M: Periodically checking of fences is recommended for the 15 year life span for this practice. Items that need checking are: (1) fence post, (2) wire, (3) staples, (4) braces at corner post. Also, check for down trees or other obstacles on the fence.

Field	Planned Amount	Month	Year	Applied Amount	Date
2b	343.0 ft.	12	2001	332.0 ft.	Apr-11-2002
5	276.0 ft.	12	2001	203.0 ft.	Apr-11-2002
Total:	619.0 ft.			535.0 ft.	

FENCE
Install fences as indicated on Plan Map. O&M: Periodically checking of fences is recommended for the 15 year life span for this practice. Items that need checking are: (1) fence post, (2) wire, (3) staples, (4) braces at corner post. Also, check for down trees or other obstacles on the fence.

***Fences are to be installed in conjunction with the Environmental Quality Incentives Program (EQIP) for the purpose of improved pasture management.**

Field	Planned Amount	Month	Year	Applied Amount	Date
1	1,040.0 ft.	10	2002		
5	2,375.0 ft.	10	2002		
Total:	3,415.0 ft.				

RIPARIAN FOREST BUFFER
Create or maintain an area of grass, trees, and/or shrubs adjacent to water bodies. This buffer along these areas, will provide wildlife habitat and corridor improvements, as well as help improve water quality. O&M: See attached job sheets for weed control, cover maintenance, and soil testing requirements. Noxious weeds (Johnson Grass, thistle, Shattercane) must be controlled at all times on contract acreage. Spot treatment of the acreage may be allowed during the primary nesting season, April 15 - August 15. Periodic mowing for cosmetic purposes is prohibited at all times, and annual mowing of CRP for generic weed control is prohibited.

RIPARIAN FOREST BUFFER (cont.)

Field	Planned Amount	Month	Year	Applied Amount	Date
2a	0.3 ac.	4	2002	0.3 ac.	Apr-15-2002
3	1.4 ac.	4	2002	1.4 ac.	Apr-15-2002
4	1.6 ac.	4	2002	1.6 ac.	Apr-15-2002
Total:	3.3 ac.			3.3 ac.	

UPLAND WILDLIFE HABITAT MANAGEMENT

Create, maintain or enhance areas to provide upland wildlife food and cover and to improve stream habitat.

Field	Planned Amount	Month	Year	Applied Amount	Date
2a	0.3 ac.	4	2002	0.3 ac.	Apr-15-2002
3	1.4 ac.	4	2002	1.4 ac.	Apr-15-2002
4	1.6 ac.	4	2002	1.6 ac.	Apr-15-2002
Total:	3.3 ac.			3.3 ac.	

PIPELINE

Install a pipeline to convey water from source to livestock trough or other use. See design for specifications. Disturbed areas shall be reestablished to vegetation or otherwise stabilized as soon as practical after construction.
***Watering Facilities are to be installed in conjunction with the Environmental Quality Incentives Program (EQIP) for the purpose of improved pasture management.**

Field	Planned Amount	Month	Year	Applied Amount	Date
1	400.0 ft.	10	2002		
5	300.0 ft.	10	2002		
Total:	700.0 ft.				

NUTRIENT MANAGEMENT

To supply plant nutrients for optimum forage and crop yields, minimize entry of nutrients to surface and groundwater, and to maintain or improve chemical and biological condition of the soil. O&M: Operation and maintenance plan will be developed by the NRCS/SCD staff and the University of Md. Nutrient Management Consultant. All agricultural operations grossing $2,500 or more annually, or livestock operations with more than 8 animal units, (A animal unit equals 1000 pounds of live weight), are required to develop and implement a nutrient management plan by specific deadlines: All farmers using chemical fertilizers - a Nitrogen & Phosphorus based plan developed by 12/31/2001, and implemented by 12/31/2002. All farmers applying animal manure, biosolids, or other organic nutrients, a Nitrogen based plan developed by 12/31/2001, and implemented by 12/31/2002. Development of a phosphorus based plan is required by 7/1/2004, with implementation due by 7/1/2005. Call your local University of MD Extension office for further guidance. In Anywhere County, 301-999-9999.

Field	Planned Amount	Month	Year	Applied Amount	Date
1	14.0 ac.	5	2002	0.3 ac.	Apr-15-2002
2b	5.6 ac.	5	2002	5.6 ac.	Apr-15-2002
5	3.5 ac.	5	2002	3.5 ac.	Apr-15-2002
Total:	23.1 ac.			9.4 ac.	

TROUGH OR TANK

Install a watering trough using reinforced concrete. Construct a concrete pad around the trough to prevent a mud area from forming. O&M: Clean out trough as needed to maintain good, clean water. Check annually for cracks, leaks, and vegetative cover around trough. Practice life span is 10 years.
***Watering Facilities are to be installed in conjunction with the Environmental Quality Incentives Program (EQIP) for the purpose of improved pasture management.**

Field	Planned Amount	Month	Year	Applied Amount	Date
1	1.0 no.	10	2002		
5	1.0 no.	10	2002		
Total:	2.0 no.				

WELL

Install well to provide water to livestock watering trough. O&M: Check annually for cracks, leaks, and vegetative cover around well. Keep all surface water from entering the well.
***Watering Facilities are to be installed in conjunction with the Environmental Quality Incentives Program (EQIP) for the purpose of improved pasture management.**

Field	Planned Amount	Month	Year	Applied Amount	Date
5	1.0 no.	10	2002		
Total:	1.0 no.				

PRESCRIBED GRAZING

Grazing will be managed according to a schedule that meets the needs of the soil, water, air, plant and animal resources and the objectives of the resource manager.

Field	Planned Amount	Month	Year	Applied Amount	Date
*1	14.0 ac.	10	2002		
2b	5.6 ac.	10	2002		
5	3.5 ac.	10	2002		
Total:	23.1 ac.				

Forest

Tract: 536

FOREST STAND IMPROVEMENT

The forester with the MD Forest, Parks and Wildlife Service can help you develop a plan to ensure a vigorous, productive woods, management can improve the growth rate and quality of your timber, help you decide when to harvest, and improve the conditions for wildlife. O&M: Refer to forester for detailed operation & maintenance plan.

Field	Planned Amount	Month	Year	Applied Amount	Date
6	9.7 ac.	12	2002		
Total:	9.7 ac.				

CERTIFICATION OF PARTICIPANTS

Certification of Compliance with the 1985 Food Security Act
I (We) concur in the conservation practices and installation schedules indicated in this conservation plan for all fields labeled Highly Erodible Land (HEL*). I (We) understand that, when this conservation plan for HEL fields is applied to the land and maintained on a continuing basis, the conservation system will meet all of the Food Security Act of 1985 requirements for conservation compliance. Furthermore, I (we) understand that if any fields other than those HEL fields specified in this plan will be used for the production of agricultural commodities, I (we) will contact FSA and NRCS for an HEL determination.

Certification of Compliance with the Conservation Reserve Enhancement Program (CREP)
I (We) agree to maintain land enrolled in the Conservation Reserve Enhancement Program according to the management plan provided by NRCS.

Landowner Name Date

CERTIFICATION OF:

District Conservationist | Anywhere Soil Conservation District

James D. Cee Date | Tom D. Manager Date

NONDISCRIMINATION STATEMENT
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To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call (202) 720-5964 (voice and TDD). USDA is an equal opportunity provider and employer.

Best Management Practices (BMP's)

The following will discuss a few of the Best Management Practices (BMP's) that can address soil conservation and water quality and improved production on agricultural land.

Each practice is based on USDA Natural Resource Conservation Service (NRCS) technical standards.

Each practice will work most effectively in combination with others as part of a farm plan. All of the 28 BMP's that will be discussed in this section provide multiple benefits. The following pages will describe each BMP and identify their benefits with the symbols below.

Benefit Symbols

	Helps reduce soil erosion & sediment runoff; or may add to the soil organic matter		Provides wildlife habitat or food.
	Helps protect or improve water quality		Helps improve air quality by reducing odor and other problems
	May help increase profits by reducing costs, increasing production or both		May qualify for state or federal cost-share assistance.

Grassed waterway

Shaping and establishing grass in a natural drainageway to prevent gullies from farming

How it works

A natural drainageway is graded and shaped to form a smooth, bowl-shaped channel. This area is seeded to sod-forming grasses. Runoff water that flows down the drainageway flows across the grass rather than tearing away soil and forming a larger gully. An outlet is often installed at the base of the drainageway to stabilize the waterway and prevent a new gully from forming.

How it helps

- Grass cover protects the drainageway from gully erosion.
- Vegetation may act as a filter, absorbing some of the chemicals and nutrients in runoff water.
- Vegetation provides cover for small birds and animals.

Grade control structure

Earthen, wooden, concrete or other structure built across drainageway to prevent gully erosion.

		
		
		

How it works

A dam, embankment or other structure built across a grassed waterway or existing gully controls and reduces water flow. The structure drops water from one stabilized grade to another and prevents overfall gullies from advancing up a slope.

How it helps

- Grade control structures are often used to stabilize the outlet of a waterway, preventing gully erosion.

- Grassed, non-eroding waterways made possible with a grade control structure give better water quality, can be crossed with equipment, and look better than non-stabilized gullies.

- If it is planned to store water, a grade control structure may provide a water source and habitat for wildlife.

Terrace

An earthen embankment around a hillside that stops water flow and stores it or guides it safely off a field.

How it works

Terraces break long slopes into shorter ones. They usually follow the contour. As water makes its way down a hill, terraces serve as small dams to intercept water and guide it to an outlet.

There are two basic types of terraces—storage terraces and gradient terraces. Storage terraces collect water and store it until it can infiltrate into the ground or be released through a stable outlet.

Gradient terraces are designed as a channel to slow runoff water and carry it to a stable outlet like a grassed waterway.

How it helps

- Both water quality and soil quality are improved.

- Terraces with grass on front or backslopes can provide nesting habitat.

Diversion

Earthen embankment similar to a terrace that directs runoff water from a specific source

How it works

A diversion is much like a terrace, but its purpose is to direct or divert runoff water from an area. A diversion is often built at the base of a slope to divert runoff away from bottomlands. A diversion may also be used to divert runoff flows away from a feedlot, or to collect and direct water to a pond.

How it helps

- Reduces soil erosion on lowlands by catching runoff water and preventing it from reaching farmland below.

- Vegetation in the diversion channel filters runoff water, improving water quality.

- Vegetation provides cover for small birds and animals.

- Allows better crop growth on bottomland soils.

Critical area planting

Planting grass or other vegetation to protect a badly eroding area from soil erosion

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How it works

Grass, legumes, trees or shrubs are established in small, isolated areas of excessive erosion. The vegetation provides surface cover to stop the raindrop splash and slow water flow.

How it helps

- Reduces soil erosion.

- A vegetated area improves water quality by reducing the amount of sediment, nutrients and chemicals running off farmland.

- Protects areas such as dams, terrace backslopes or gullied areas where vegetation may be difficult to establish.

- Vegetation can be planted to provide small areas of nesting cover for birds and small animals.

Sediment control pond

A water impoundment made by constructing a dam or an embankment, or by excavating a pit or dugout.

		
		
		

How it works

Helps maintain or improve water quality by preventing sediment from reaching local streams.

How it helps

- Captures eroding soil and protects water quality by collecting and storing runoff water. Provides water for wildlife.

Contour farming

Farming with row patterns nearly level around the hill – not up and down hill

How it works

Crop row ridges built by tilling and planting on the contour create hundreds of small dams. These ridges or dams slow water flow and increase infiltration, which reduces erosion. Can also be used with stripcropping, whereby the crop is alternated with strips of meadow or small grain planted on the contour. The small grain/meadow strip slows runoff, increases infiltration, traps sediment and provides overall cover. Crop rotation with legumes may also be included to add nitrogen as part of the stripcropping measure.

How it helps

- Contouring can reduce soil erosion by as much as 50% compared with up and down hill farming.
- By reducing sediment and runoff, and increasing water infiltration, contouring promotes better water quality.

Crop residue management

Leaving last year's crop residue on the soil surface by limiting tillage. Includes no-till and ridge till

How it works

Leaving last year's crop residue on the surface before and during planting operations provides cover for the soil at a critical time of the year. The residue is left on the surface by reducing tillage operations and turning the soil less. Pieces of crop residue shield soil particles from rain and wind until plants can produce a protective canopy.

How it helps

- Ground cover prevents soil erosion and protects water quality.

- Residue improves soil tilth and adds organic matter to the soil as it decomposes.

- Fewer trips and less tillage reduces soil compaction.

- Time, energy and labor savings are possible with fewer tillage trips.

Measuring crop residues

You can estimate residue levels by using a line that has 50 or 100 equally divided marks. Stretch the line diagonally across crop rows. Count the number of marks that have residue under the leading edge when looking from directly above the mark. Walk the entire length of the rope. The total number of marks with residue under them is the percent of residue cover. If the line has only 50 marks, multiply your count by two. Repeat this three to five times in a representative area of the field.

Crop rotation

Changing the crops grown in a field, usually year by year.

		
		
		

How it works

Crops are changed year by year in a planned sequence. Crop rotation is a common practice on sloping soils because of its potential for soil saving. Rotation also reduces fertilizer needs because alfalfa and other legumes replace some of the nitrogen corn and other grain crops remove.

How it helps

- Pesticide costs may be reduced by naturally breaking the cycles of weeds, insects and diseases.
- Grass and legumes in a rotation protect water quality by preventing excess nutrients or chemicals from entering water supplies.
- Meadow or small grains cut soil erosion dramatically. Crop rotations add diversity to an operation.

Cover crop

A small grain crop used in the fall primarily to uptake any leftover nitrogen from the root zone as well as prevent soil erosion.

How it works

Small grain crops such as cereal rye, oats and winter wheat are planted in early fall immediately following or before the harvest of corn or soybeans to reduce the leaching of unused crop nutrients to the groundwater during the fall and winter months. Erosion control is a secondary benefit.

How it helps

- Cover crops tie up unused crop nutrients and prevent leaching. Cover crops also protect the soil from wind and water erosion, add organic matter to the soil, improve soil tilth, reduce weed competition and may reduce fertilizer requirements in the spring.

Nutrient management

Applying the correct amount and form of plant nutrients for optimum yield and minimum impact on water quality.

How it works

After taking a soil test, setting realistic yield goals, and taking credit for contributions from previous years' crops and manure applications, crop nutrient needs are determined. Nutrients are then applied at the proper time by the proper application method. Nutrient sources include animal manure, biosolids and commercial fertilizers. These steps reduce the potential for nutrients to go unused and wash or infiltrate into water supplies.

How it helps

- Sound nutrient management reduces input costs and protects water quality by preventing over-application of commercial fertilizers and animal manure.
- Correct manure and biosolids application on all fields can improve soil tilth and organic matter.

Manure storage

Structure that protects water bodies from manure runoff by storing manure until conditions are appropriate for field applications.

How it works

The type of manure storage structure you would use depends upon your livestock operation, animal waste management system and nutrient management plan. Several options exist including an earthen storage pond, concrete in-ground structure or aboveground structure. Manure can be pumped, scraped and hauled, pushed or flushed into your storage structure. The structure's purpose is to safely contain the manure and keep nutrient loss and pollution of downstream water bodies to a minimum by preventing runoff.

How it helps

- Protects water quality by preventing runoff from feedlots.
- Cuts fertilizer costs and reduces nutrient losses.
- Allows for field application when conditions are right.

Dead bird composting

A roofed structure designed for composting the normal daily accumulation of dead birds from a poultry growing or breeding operation.

How it works

Composting converts nitrogenous materials (manure and birds) and carboniferous materials (straw or sawdust) into a humus-like substance which is an essential part of soil building and healthy plant growth.

How it helps

- When properly managed, composting greatly reduces the volume of carcasses, kills most pathogens, prevents odors and produces a stable odorless humus-like material which is useful as a fertilizer substitute and a soil amendment.
- By eliminating the on-site burial of large numbers of carcasses as the principal disposal method, composting facilities reduce the potential for groundwater contamination.

Watering facility

A trough or tank installed to provide livestock water from a spring, pond, well, or other source.

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How it works

Selectively placed watering troughs can make pasture management easier. By having water available in several locations, farmers can control grazing more efficiently, prevent erosion, and keep livestock from polluting streams.

How it helps

- Provides a clean, reliable, easily accessible water supply for animals away from streams.
- Can reduce mastitis problems caused by muddy stream banks or springheads. Can help reduce erosion from messy or muddy areas caused by cattle access to springheads or streams.

Vegetative filter strips

Strips of vegetation, which may include grass, shrubs or trees that filter runoff and retain contaminants before they reach water sources.

How it works

Vegetative strips of grass, shrubs and/or trees slow or intercept water flow capturing or providing temporary retention of pollutants like sediment. pesticides or nutrients, Vegetative uptake of nutrients or retention of other pollutants protects adjacent water supplies. Trees and shrubs used along a waterway also provide habitat and reduce stream temperature, providing wildlife and fisheries benefits.

How it helps

- Grass, trees and shrubs provide cover for small birds and animals.
- Ground cover reduces soil erosion.
- Vegetation prevents contaminants from entering water bodies and provides shade, food, and habitat for aquatic life.
- Increases stream stability.

Stream protection

Protecting a stream by excluding livestock, stabilizing the stream channel and establishing vegetative buffer zones.

How it works

Vegetative plantings or structural measures such as rip rap, vortex weirs, or drop structures may be utilized to stabilize stream banks and redirect or reduce stream flow energy. This reduces erosion and creates habitat. Fencing prevents livestock from trampling banks, destroying vegetation and stirring up sediment in the streambed. A vegetative buffer along the stream bank intercepts and filters runoff may absorb excess nutrients and provides shade and habitat.

How it helps

- Streams are stabilized, thereby reducing erosion, improving fisheries habitat, decreasing stream migration and improving flood attenuation.
- Water quality and fisheries habitat improvements result from reduced amounts of nutrients, pesticides and sediment entering the stream.
- Riparian buffer zones provide wildlife habitat. Trees reduce stream temperatures and increase food and cover to support fisheries resources.

Grazing land management

Manipulating the soil-plant-animal complex of grazing land in pursuit of a desired result

How it works

Pasture is divided into several mini-pastures or paddocks with fencing, usually electric. Animals are moved from paddock to paddock based on forage availability and nutritional needs.

How it helps

- Improves vegetative cover, reduces erosion by promoting even grazing while protecting water quality.
- Increases harvest efficiency and prolongs forage production throughout the grazing season.
- Maximizes forage quality and production by requiring less energy input, which improves the economic bottom line for the producer.
- Distributes animal waste more evenly, enabling forage plants to utilize the manure as plant nutrients.

Pasture renovation and planting

Planting grass and legumes to reduce soil erosion and improve production.

How it works

Drill or broadcast adapted grass or legumes into a low-producing pasture or a steep, eroding cropland field.

How it helps

- Heavy grass cover slows water flow, reducing soil erosion.
- Good pastures protect water quality by filtering runoff water and increasing infiltration.
- Lush pastures give cover and habitat for wildlife. As plants recycle and roots die, organic matter in the soil is improved.

Sinkhole protection

A method of treating sinkholes which can improve water quality by eliminating a direct channel for pollutants to enter groundwater.

How it works

A sinkhole is a depression in a limestone land surface formed by water. The overlying soil is eroded away or flushed down through the cracks in the limestone. Because there is little or no soil to filter runoff entering a sinkhole, pollutants entering surface water will contaminate groundwater very quickly. By surrounding a sinkhole with a grass filter strip or filling the sinkhole with large rocks, farmers can help reduce the threat of groundwater contamination.

How it helps

- Improves water quality and protects drinking water supplies.
- Provides more efficient use of farmland - once the sinkhole has been treated the area immediately around it may be farmed.
- Will improve the appearance of a farm while eliminating a potential hazard.

Integrated pest management

Evaluating and using a tailored pest management system to reduce crop and environmental damages. Scouting is done to identify insects, weeds and diseases.

How it works

Crops are scouted to determine type of pests—insects, weeds and diseases— and the stage of development. The potential damage of the pest is then weighed against the cost of control. Finally, if pest control is economical, all alternatives are evaluated based on cost, results, and environmental impact. Precaution is taken to keep any chemicals from leaving the field by leaching, runoff or drift.

How it helps

- Scouting and spot treatment for only those pests that are threatening can save money
- Using fewer chemicals improves water quality.
- Specific treatment for specific pests on specific areas of a field prevents over-treatment of pests.

Wellhead protection

Changing farming practices, which occur on or near the farmstead in order to reduce the risk of contamination of water sources.

How it works

The way you handle materials that could contaminate a water supply and the distance of possible contaminants from a well or other water source can have a dramatic effect on the quality of drinking water on the farm. For instance, if you typically mix pesticides near the well, your chances of drinking water contamination by pesticides escalates. To protect your well, take an inventory of farming practices like pesticide mixing and container washing and disposal. Then assess the risk of contamination and make necessary changes.

How it helps

- Modifications in farming operations may improve your efficiency and reduce operation or production costs.
- Soil conservation practices may be necessary to divert runoff from the well area.

Wetland creation and enhancement/ shallow areas for wildlife

Installing practices such as dikes in existing wetlands to manage water levels and improve habitat.

		
		
		

How it works

Most wetland enhancement work includes small structures built to add water or regulate water levels in an existing wetland. Subsurface and surface drains and tiles are plugged. Concrete and earthen structures—usually dikes or embankments—are built to trap water. These practices maintain a predetermined water level in an existing wetland. Adjustable outlets allow the landowner to fluctuate the water level during different seasons. Enhancement also includes planting native wetland vegetation if plant populations need to be supplemented.

How it helps

- Wetlands filter nutrients, chemicals and sediment before water infiltrates into groundwater supplies.
- Wetlands provide habitat for water-fowl and many other species of wildlife.
- Wetlands add beauty and value to a farm.

Woodland management

Improving the quality and quantity of woodland growing stock and maintaining ground cover and litter for soil and water conservation.

How it works

Existing woodland or other suitable land is dedicated to timber production. Livestock is excluded. Optimum tree populations are determined by the kinds of trees planted and their adaptability to your soils. Existing trees or newly planted trees are thinned, pruned and harvested to maintain desired production. Twigs, limbs and other debris are not removed, maintaining ground cover, reducing soil erosion and providing wildlife habitat. As trees mature they are harvested and replacements are established.

How it helps

- Adds income to your farm.
- Adds beauty to your farm.
- Ground cover provides wildlife habitat, reduces soil erosion and improves water quality by filtering nutrients from surface runoff.

Wildlife upland habitat

Creating, maintaining or improving food and cover for upland wildlife.

		
		
		

How it works

Planting trees, shrubs and other vegetation that provide cover and food will attract wildlife to an area. The type of habitat provided will determine the kind and numbers of wildlife attracted.

How it helps

- Ground cover helps reduce soil erosion, adds organic matter to the soil, filters runoff and increases infiltration.
- It can add value to your farmstead.
- Planned wildlife habitat provides food and cover for wildlife.

Heavy use area protection

Protecting ground surfaces that are used frequently and intensely by animals or vehicles by establishing areas that reduce erosion and improve animal health.

		
		
		

How it works

Stabilizing agricultural areas by controlling surface flow and reducing soil erosion and sedimentation by installing concrete, gravel, or gravel over geotextile fabrics.

How it helps

- Reduces soil erosion.
- Improves water quality by reducing the amount of sediment, nutrients and chemicals running off farmsteads.
- Protects areas where vegetation may be difficult to establish.

Roof runoff management

Directs clean water away from animal feed lots and erosive areas using gutters on roofs of buildings.

How it works

An important system associated with a waste storage facility that prevents clean water from reaching the waste system and in turn helps farmers manage their farms.

How it helps

- Protects water quality by preventing runoff from feedlots.

Fencing

A controlling barrier to exclude livestock.

		
		
		

How it works

Fences help control livestock from streams, ponds, and reservoirs and livestock grazing time in a particular pasture. There are many types of permanent and temporary fences.

How it helps

- Provides stream bank protection, reduces erosion, and increases water quality.
- Improves vegetative cover, reduces erosion by promoting even grazing while protecting water quality.
- Increases harvest efficiency and prolongs forage production throughout the grazing season.
- Maximizes forage quality and production by requiring less energy input, which improves the economic bottom line for the producers.

No-till farming

A method of farming where the soil is not tilled between each year's crops.

How it works

This method of farming includes no seedbed preparation other than opening a small slit for the purpose of placing the seed at the intended depth.

How it helps

- Ground cover prevents soil erosion and protects water quality.
- Residue improves soil tilth and adds organic matter to the soil as it decomposes.
- Fewer trips and less tillage reduce soil compaction.
- Time, energy and labor savings are possible with fewer tillage trips.

Soil in The Urban Landscape

Soil is the foundation upon which we build our homes, schools, businesses, workplaces, streets and highways. How we treat this soil resource as we build homes, construct highways and other structures, as well as how we treat the soil as we go about our daily activities after construction is complete, has a direct impact on the quality of our water and our lives.

Urban construction activity generates considerable potential for soil erosion, which may impact water quality as a result of construction "runoff. "

Clearing of vegetation such as grasses and trees exposes large site areas to erosion processes, which, in turn, can pollute streams with sediment and nutrients that wash off the areas not covered with vegetation. This type of pollution is referred to as a type of Non-Point Source Pollution because there is no specific point of discharge to streams and other waterways such as pipe discharge.

The basic principles of control for soil erosion are to:

- Keep disturbed areas as small as practicable.
- Stabilize and protect disturbed areas from raindrop and runoff energies as soon as practicable.
- Keep runoff quantities and velocities low.
- Protect disturbed areas from runoff from adjacent areas.
- Retain sediment within the construction site.
- Reduce the time that soil is exposed with no vegetation.

After the construction activities are completed it is still essential that urban residents maintain their soil resources by being sure that erosion does not occur around their homes or business. Maintaining a healthy lawn and incorporating appropriate plantings of tree and shrub species ensures that the soil will stay in place for many years into the future.

In Maryland, laws have been enacted that require developers and landowners who disturb soil to develop a Sediment and Erosion Control Plan to detail the measures they will use to minimize the effects of their activities. These plans are submitted to an approval agency such as the local Soil Conservation District. Local governments or the Maryland Department of the Environment have the responsibility to enforce the plan implementation.

The items detailed on the next several pages describe the majority of practices used to control erosion and sedimentation on urban lands.

Practices:

TEMPORARY SEEDING

DESCRIPTION

Temporary stabilization of soil with rapidly growing annual plants is used to prevent erosion on disturbed areas before final grading or in a season not suitable for permanent seeding. Areas of bare earth are often left exposed to rain and runoff for weeks. Damage from erosion or storm water runoff costs time and money for regrading or other repairs. Vegetative cover is the most efficient and economical means of managing sheet and rill erosion.

WHERE TEMPORARY SEEDING IS USED

Temporary seeding should be applied where final grading of exposed surfaces is to be completed within 15 days to a year. Such areas include denuded areas, soil stockpiles, dikes, dams, sides of sediment basins and temporary diversions. When the desired permanent seed cannot be applied due to the season, a temporary seed appropriate for the season may be applied. Such applications may prevent costly maintenance operations of other erosion control systems.

EROSION CONTROL MATTING

DESCRIPTION

The placing and securing of either jute mesh, excelsior matting, erosion control fabric, or other approved matting is used to prevent erosion on previously shaped and seeded drainage channels, slopes, or other critical areas. The basic objective of erosion control matting is to provide a stable seedbed for one or more growing seasons (though some may be designed to last longer in extreme conditions), then to biodegrade as vegetal matter builds up to produce a healthy cover crop.

WHERE EROSION CONTROL MATTINGS ARE USED

Erosion control matting can be used in any area subjected to erosive actions such as newly graded slopes, detention structures, and stream banks where moving water is likely to wash out new vegetative plantings.

STRAW BALE BARRIER

DESCRIPTION

A straw bale barrier is a temporary entrenched and anchored barrier used to intercept sediment-laden runoff and to provide some retention of sediment from small drainage areas. A straw bale barrier can be used to promote sheet flow and to reduce runoff velocity, thus reducing erosion and improving water quality. The expected life span is normally 3 months; therefore, straw bales must be replaced or a new barrier placed directly upslope of the old when a barrier is required for longer time periods.

WHERE STRAW BALES ARE USED

Straw bales can be used for slope protection in disturbed areas to control sheet and rill erosion.

SILT FENCE BARRIER

DESCRIPTION

A silt fence is a temporary barrier of geotextile fabric (filter cloth) used to intercept sediment-laden runoff from small drainage areas. A silt fence can be used to promote sheet flow, to reduce runoff velocity, and to help retain transported sediment on the site, thus reducing erosion and enhancing water quality. Expected life of a silt fence is dependent on ultraviolet stability and type of fabric.

DIVERSIONS

DESCRIPTION

A diversion is a berm (dike or ridge) and/or swale (excavated channel or ditch) used to prevent sediment-laden waters from leaving a site and to prevent off-site or upstream waters from entering a site. Typical diversions are combination berm/swale and may be temporary or permanent structures.

WHERE DIVERSIONS ARE USED

- At the toe of cuts or fills to direct sediment-laden runoff to sediment traps.
- At the top of cuts or around disturbed areas to divert clean runoff until the disturbed areas are permanently stabilized.
- At the top of steep slopes where excess runoff would cause erosion problems.
- At selected intervals on long, sloping routes to prevent erosion.
- Around a site to prevent entry of off-site runoff and to reduce flooding.

CHECK DAM

DESCRIPTION

A check dam is a small dam constructed in a drainageway to reduce channel erosion by restricting the flow velocity.

WHERE CHECK DAMS ARE USED

Check dams are appropriate for use in small drainage areas and are not for use in perennial streams.

OUTLET PROTECTION

DESCRIPTION

Outlet protection involves the use of an energy-dissipating device at the outlet of a pipe or conduit to prevent excessive erosion (scour) from the discharge of runoff.

WHERE OUTLET PROTECTION IS USED

Outlet protection is needed at outlets subjected to erosion and scour due to the exit velocity exceeding the allowable velocity for the soil discharged upon.

INLET PROTECTION

DESCRIPTION

Inlet protection involves using a temporary barrier to prevent the inflow of settleable sediments and debris into a storm drain or other form of conduit.

WHERE INLET PROTECTION IS USED

Inlet protection is used to prevent sediment from entering and clogging the storm drainage system prior to permanent stabilization of a construction area. This practice helps to keep the conveyance channel free from debris or sedimentation that could reduce the capacity of the channel.

TEMPORARY SEDIMENT TRAP

DESCRIPTION

A temporary sediment trap is a control device used to intercept sediment-laden runoff and to trap sediment to prevent/reduce off-site sedimentation. A temporary sediment trap can be formed by excavation and/or embankments constructed at designated locations accessible for cleanout.

WHERE TEMPORARY SEDIMENT TRAPS ARE USED

A temporary sediment trap may be located in a drainageway, at a storm drain inlet, or at other points of discharge from a disturbed area. They may be constructed independently or in conjunction with diversions.

Challenges Ahead

Maryland farmers are applying best management practices to their land in record rates.

They are protecting water quality in our streams and rivers and the Chesapeake Bay by managing nutrients more efficiently, scouting fields for pests, establishing buffer zones of vegetation along streams and creeks and storing animal manure until conditions are right for field application.

They are saving soil by leaving more residue on crop fields, building terraces, and farming the contour.

Farmers have accepted the challenge of protecting our natural resources – especially the Chesapeake Bay – and continue to educate themselves about new technologies and techniques being developed.

Consider this as another tool to help you meet your educational understanding of the challenges ahead. Review and learn about the practices the farmers are using right now on their farmland to help improve the waters of our state.

Parts of this section have been adapted from a booklet produced by the United States Department of Agriculture, Natural Resources Conservation Service, Iowa State Office. For more information on practices described in this section, contact your local soil conservation district or the Maryland Department of Agriculture, 50 Harry S. Truman Parkway, Annapolis, MD 21401. Phone 410.841.5863

Soils In The Urban Landscape: Sections from "Soil Erosion Prevention & Sediment Control" published by the University of Tennessee at Knoxville, James L. Smoot, Ph.D., P.E. Professor, Department of Civil & Environmental Engineering University of Tennessee, Knoxville and Russell D. Smith Water Resources Graduate Department of Civil & Environmental Engineering University of Tennessee, Knoxville

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This section of the manual includes material from the NRCS publications ***From the Surface Down*** *and* ***Field Book for Describing and Sampling Soils****, the University of Maryland publication* ***A Guide to Landjudging in Maryland*** *and the GLOBE program's publication* ***GLOBE 2002 Teachers Guide - Soils Chapter****. For more information, citations and websites for these publications are listed at the end of this section.*

Overview

Soils are a thin layer on top of most of the earth's land surface. This thin layer is a basic natural resource. Soils deeply affect every other part of the ecosystem. They are used by humans to meet many needs. Soils hold nutrients and water for plants and animals. Water is filtered and cleansed as it flows through soils. Soils affect the chemistry of water and the amount of water that returns to the atmosphere to form rain. The food we eat and most of the material we use for paper, buildings and clothing are dependent on soils. Much of our life's activities and pursuits are related and influenced by the behavior of the soil around our houses, roads, septic and sewage disposal systems, airports, parks, recreation sites, farms, forests, schools, and shopping centers. What is put on the land should be guided by the soil that is beneath it.

Land is a natural resource as are water and mineral deposits. It is essentially fixed; more land cannot be made, except what little might be reclaimed from the sea or filled into water bodies. Much land and its associated soil resources have been misused. Many acres misused to the point where reclamation is nearly impossible or impractical. As our population increases and the pressure for land intensifies, it is important that the wisest use be made of this resource. We can no longer afford to mismanage land and soil.

SOIL COMPOSITION

Soils are composed of three main ingredients: minerals of different sizes; organic materials from the remains of dead plants and animals; and open space that can be filled with water or air. A good soil for growing most plants should have about 45% mineral (with a mixture of sand, silt and clay), 5% organic matter, 25% air, and 25% water (fig. 1).

Soils are dynamic and change over time. Some properties, such as temperature and water content change very quickly. Others, such as mineral transformations, occur very slowly over hundreds or thousands of years.

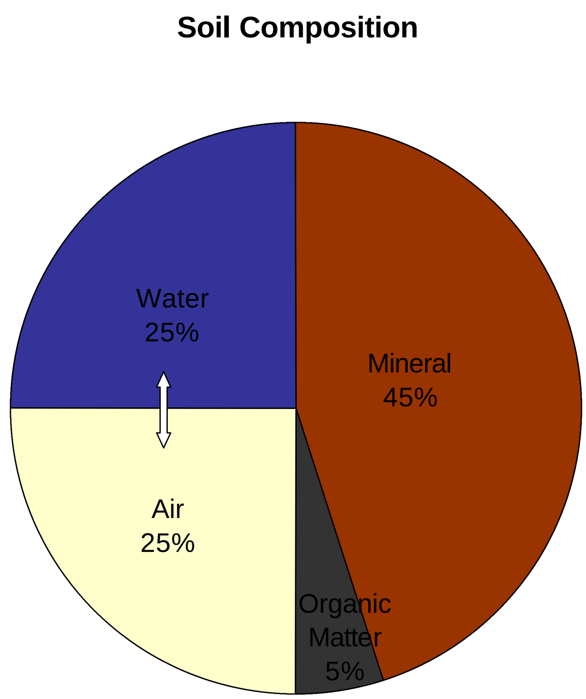

Figure 1. The relative proportion of mineral, organic matter, air and water in a soil that is optimum for growing plants.

FACTORS OF SOIL FORMATION

Soils are natural expressions of the environment in which they were formed. They are derived from an infinite variety of materials that have been subjected to a wide spectrum of climatic conditions. Soil development is influenced by the topography on which soils occur, the plant and animal life which they support and the amount of time which they have been exposed to these conditions.

Soi1 scientists recognize five major factors that influence soil formation: 1) parent material, 2) climate, 3) living organisms (especially native vegetation), 4) topography and 5) time. The combined influence of these soil-forming factors determines the properties of a soil and their degree of expression (fig. 2).

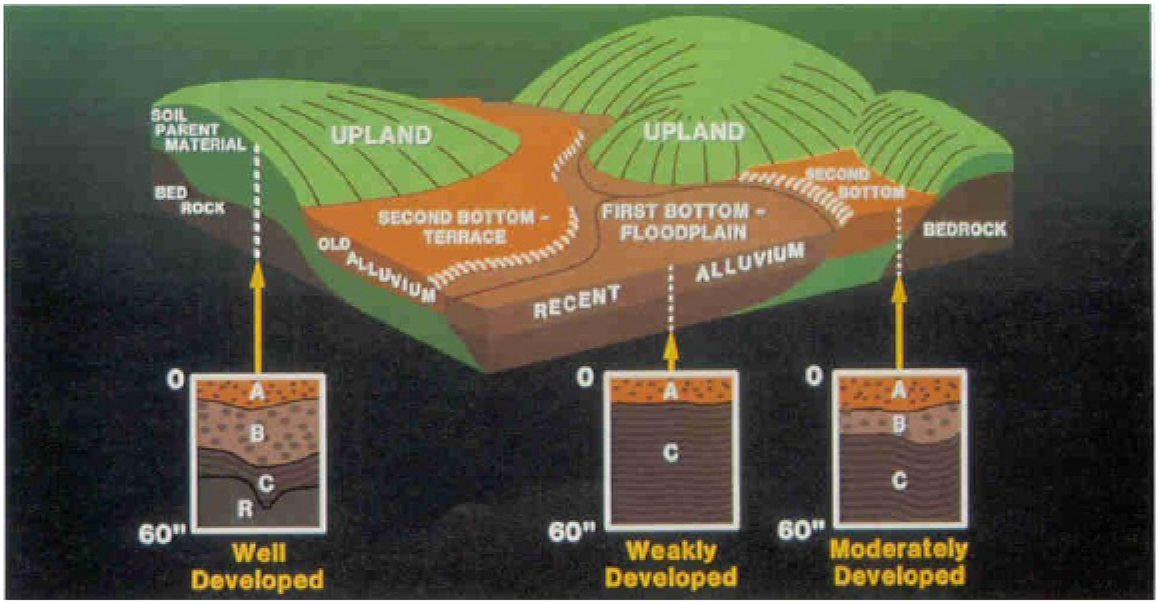

Figure 2. The five factors of soil formation affect the processes that influence soil development.

Parent Material

Parent material refers to organic (such as fresh peat) and mineral material in which soil formation begins. Mineral material includes partially weathered rock, ash from volcanos, sediments moved and deposited by wind and water, or ground up rock deposited by glaciers. The material has a strong effect on the type of soil developed as well as the rate at which development takes place. Soil development may take place quicker in materials that are more permeable to water. Dense, massive, clayey materials can be resistant to soil formation processes.

Bedrock such as limestone, sandstone, shale, granite, gneiss and schist, slate, marble and many others break down into **residuum** (residue) through the weathering process. It is this residuum that becomes the parent material of soil and imparts some of the parent characteristics into the resulting soil profile.

Soil material and rock fragments may fall, roll or slide downslope under the influence of gravity and water. This incoherent mass of material that generally accumulates on the lower portion of slopes and in depressions is called **colluvium**. Rock fragments in colluvium generally are angular in contrast to the rounded waterworn cobbles and stones found in alluvium and glacial outwash.

Streams and rivers commonly overflow their banks and deposit fresh materials on the floodplains. These fresh or recent deposits, commonly topsoil, comprise the parent materials for the soils developed on these floodplains. Since there is new material added almost annually, the soils never have time to form well-developed horizons. Therefore, these young soils have poorly developed profiles, and most of their character is inherited from the parent material. This type of parent material exceeds 0.5 m (20 in.) in depth, and it is referred to on the scorecard as **recent alluvium**.

Soils located on stream terrace positions that contain water worn coarse fragments have parent materials referred to as **old alluvium**. These soils were originally deposited by water and commonly have had time to form well-developed horizons. They never or rarely flood, and thus are not influenced by deposition of fresh materials.

In the Mid-Atlantic region, large areas are underlain by the complex series of water-deposited sediments left by previous geologic events. These older sediments comprise the Coastal Plain along the Atlantic seaboard. In Maryland, these materials occupy half of the land area, and they comprise nearly all the parent material for Delaware soils and large segments of New Jersey. These **Coastal Plain sediments**, although much older than the recent alluvium along streams, have not been cemented and consolidated into bedrock--thus, the name unconsolidated sediments. Often these sediments have been capped or coated with a thin (several cm to several m) veneer or sheet of material consisting mainly of silt (loess). The wind may have carried this material from the glacial outwash areas before the rise in sea level that formed the Chesapeake Bay. The Coastal Plain soils are formed in these sediments and silt-cap parent materials. Therefore, soils occurring on the upland portions of the Coastal Plain are considered to have Coastal Plain sediments as their parent materials on the scorecard. Recent alluvium can and does occur on the Coastal Plain in the same landscape positions (along streams and rivers) as in other sections of the state.

Climate

Climate is a major factor in determining the kind of plant and animal life on and in the soil. It determines the amount of water available for weathering minerals, transporting the minerals and releasing elements. Climate, through its influence on soil temperature, determines the rate of chemical weathering.

Warm, moist climates encourage rapid plant growth and thus high organic matter production. The opposite is true for cold, dry climates. Organic matter decomposition is also accelerated in warm, moist climates. Under the control of climate freezing, thawing, wetting, and drying break parent material apart.

Rainfall causes leaching. Rain dissolves some minerals, such as carbonates, and transports them deeper into the soil. Some acid soils have developed from parent materials that originally contained limestone. Rainfall can also be acid, especially downwind from industrial processes.

Living organisms

Plants affect soil development by supplying upper layers with organic matter, recycling nutrients from lower to upper layers, and helping to prevent erosion. In general, deep rooted plants contribute more to soil development than shallow rooted plants because the passages they create allow greater water movement, which in turn aids in leaching. Leaves, twigs, and bark from large plants fall onto the soil and are broken down by fungi, bacteria, insects, earthworms, and burrowing animals. These organisms eat and break down organic matter releasing plant nutrients. Some change certain elements, such as sulfur and nitrogen, into usable forms for plants.

Microscopic organisms and the humus they produce act as a kind of glue to hold soil particles together in aggregates. Well-aggregated soil is ideal for providing the right combination of air and water to plant roots.

Animals living in the soil affect decomposition of waste materials and how soil materials will be moved around in the soil profile.

Landscape position

Landscape position causes localized changes in moisture and temperature. When rain falls on a landscape, water begins to move downward by the force of gravity, either through the soil or across the surface to a lower elevation. Even though the landscape has the same soil-forming factors of climate, organisms, parent material, and time, drier soils at higher elevations may be quite different from the wetter soils where water accumulates. Wetter areas may have reducing conditions that will inhibit proper root growth for plants that require a balance of soil oxygen, water, and nutrients.

Steepness, shape, and length of slope are important because they influence the rate at which water flows into or off the soil. If unprotected, soils on slopes may erode leaving a thinner surface layer. Eroded soils tend to be less fertile and have less available water than uneroded soils of the same series.

Aspect affects soil temperature. Generally, for most of the continental United States, soils on north-facing slopes tend to be cooler and wetter than soils on south-facing slopes. Soils on north-facing slopes tend to have thicker A and B horizons and tend to be less droughty.

Position

Position generally refers to the point on the landscape where the soil is located. Most soil series have a rather limited range of position and land form. In figure 3, the landscape is divided into (1) upland, (2) upland depression, (3) terrace, and (4) floodplain. Most soils can be classified into one of these landscape positions by observing the general surroundings in respect to streams or natural drainage systems.

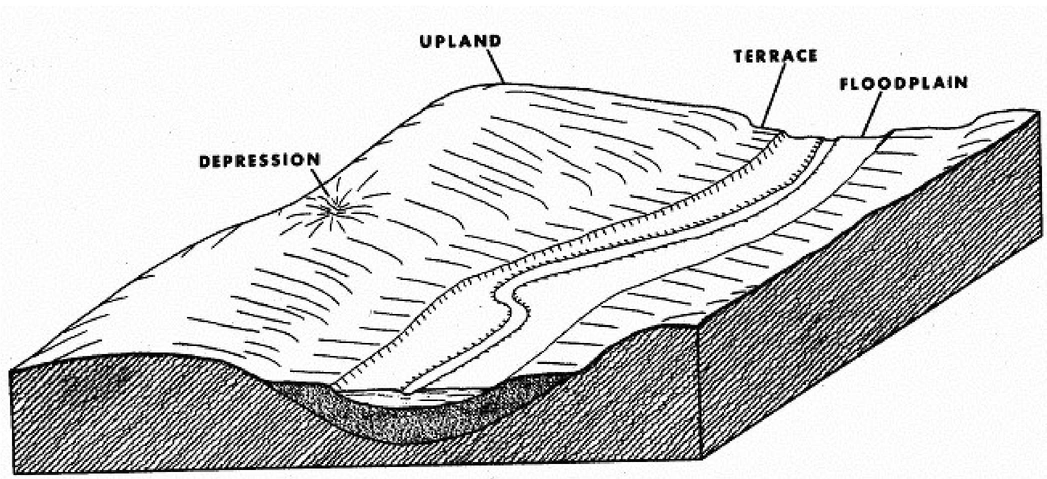

Figure 3. Landscape position can be upland, upland depression, terrace, or floodplain.

The **floodplains** refer to areas near streams that flood periodically. These soils may be quite productive, but they have a flooding hazard that seriously limits their use for urban development or agriculture. **Terrace** refers to soils developed in older alluvial materials above the zone of current flooding. **Upland depressions** or waterways refer to soils developed on concave land forms or at the heads of drainage ways and along waterways where surface drainage is retarded. Water tends to pond in these depressions, and the soils commonly have a darker and thicker surface horizon because of organic matter accumulations. Areas unaffected by stream activity in recent geologic time, and ordinarily lying at higher elevations (than alluvial plains) on rolling and convex positions, are designated **upland**.

Slope Characteristics

Slope generally is expressed as a percentage that is calculated by dividing the difference in elevation between two points by the horizontal distance and multiplying by 100. For example, a 10 percent slope would have a 10-foot drop per 100 horizontal feet.
The percent slope can be estimated visually, but the Abney level, or a similar type of instrument, is used for more precise measurements.

Slope classes are used for interpretive purposes. The classes are nearly level, gently sloping, strongly sloping, moderately steep, steep and very steep. The range in percentages for these classes will vary depending on the topography of the area. Because of contrasting landscapes, two divisions are used in establishing limits for the slope classes in Maryland: (1) the Coastal Plain and (2) a combination formed by the Appalachian and Piedmont provinces. The slope classes and appropriate ranges of percent for the two divisions are shown in table 1.

Table 1. Slope classes for Maryland's Coastal Plain and Piedmont-Appalachian provinces and their corresponding letter designations in the soil survey.

Sloe Class	**Coastal Plain**	**Piedmont-Appalachian**	**Soil Survey**
	Percentage	Percentage	Letter Designation
Nearly level	0-2	0-3	A
Gently sloping	2-5	3-8	B
Moderately sloping	5-10	8-15	C
Moderately steep	10-15	15 25	D
Steep	15-25	25-50	E
Very steep	25+	50+	F

Time

Time is required for horizon formation. The longer a soil surface has been exposed to soil forming agents like rain and growing plants, the greater the development of the soil profile. Soils in recent alluvial or windblown materials or soils on steep slopes where erosion has been active may show very little horizon development.

Soils on older, stable surfaces generally have well defined horizons because the rate of soil formation has exceeded the rate of geologic erosion or deposition. As soils age, many original minerals are destroyed and many new ones are formed. Soils become more leached, more acid, and more clayey. In many well drained soils, the B horizons tend to become redder with time.

SOIL FORMING PROCESSES

The four major processes that change parent material into soil are additions, losses, translocations, and transformations.

Additions

The most obvious addition is organic matter. As soon as plant life begins to grow in fresh parent material, organic matter begins to accumulate. Organic matter gives a black or dark brown color to surface layer. Most organic matter additions to the surface increase the cation exchange capacity and nutrients, which also increase plant nutrient availability.

Other additions may come with rainfall or deposition by wind, such as the wind blown or eolian material. On the average, rainfall adds about 5 pounds of nitrogen per acre per year. By causing rivers to flood, rainfall is indirectly responsible for the addition of new sediment to the soil on a flood plain.

Losses

Most losses occur by leaching. Water moving through the soil dissolves certain minerals and transports them into deeper layers. Some materials, especially sodium salts, gypsum, and calcium carbonate, are relatively soluble. They are removed early in the soil's formation. As a result, soil in humid regions generally does not have carbonates in the upper horizons. Quartz, aluminum, iron oxide, and kaolinitic clay weather slowly. They remain in the soil and become the main components of highly weathered soil.

Fertilizers are relatively soluble, and many, such as nitrogen and potassium, are readily lost by leaching, either by natural rainfall or by irrigation water. Long- term use of fertilizers based on ammonium may cause acidity in the soil and contribute to the loss of carbonates in some areas.

Oxygen, a gas, is released into the atmosphere by growing plants. Carbon dioxide is consumed by growing plants, but lost to the soil as fresh organic matter decays. When soil is wet, nitrogen can be changed to a gas and lost to the atmosphere.

Solid mineral and organic particles are lost by erosion. Such losses can be serious because the material lost is usually the most productive part of the soil profile. On the other hand, the sediment relocated to lower slope positions or deposited on bottom lands has the potential to increase or decrease productive use of soils in those areas.

Translocations

Translocation means movement from one place to another. In low rainfall areas, leaching often is incomplete. Water starts moving down through the soil, dissolving soluble minerals as it goes. There isn't enough water, however, to move all the way through the soil. When the water stops moving, then evaporates, salts are left behind. Soil layers with calcium carbonate or other salt accumulations form this way. If this cycle occurs enough times, a calcareous hardpan can form.

Translocation upward and lateral movement is also possible. Even in dry areas, low-lying soils can have a high water table. Evaporation at the surface causes water to move upward. Salts that are dissolved in solution will move upward with the water and deposit on the surface as the water evaporates.

Transformations

Transformations are changes that take place in the soil. Microorganisms that live in the soil feed on fresh organic matter and change it into humus. Chemical weathering changes parent material. Some minerals are destroyed completely. Others are changed into new minerals. Many of the clay-sized particles in soil are actually new minerals that form during soil development.

Other transformations can change the form of certain materials. Iron oxides (ferric form) usually give soils a yellowish or reddish color. In waterlogged soils, however, iron oxides lose some of their oxygen and are referred to as being reduced. The reduced form of iron (ferrous) is quite easily removed from the soil by leaching. After the iron is gone, generally the leached area has a grayish or whitish color.

Repeated cycles of saturation and drying create a mottled soil (splotches of colored soil in a matrix of different color). Part of the soil is gray because of the loss of iron, and part is a browner color where the iron oxide is not removed. During long periods of saturation, gray lined root channels develop. This may indicate a possible loss of iron or an addition of humus from decayed roots.

SOIL FEATURES

There are many properties or features that describe and characterize soils (fig. 4). Some of these features (such as color, texture and depth) are relatively easy to record while others require very sophisticated equipment and highly technical procedures (such as chemical data and mineralogical analysis).

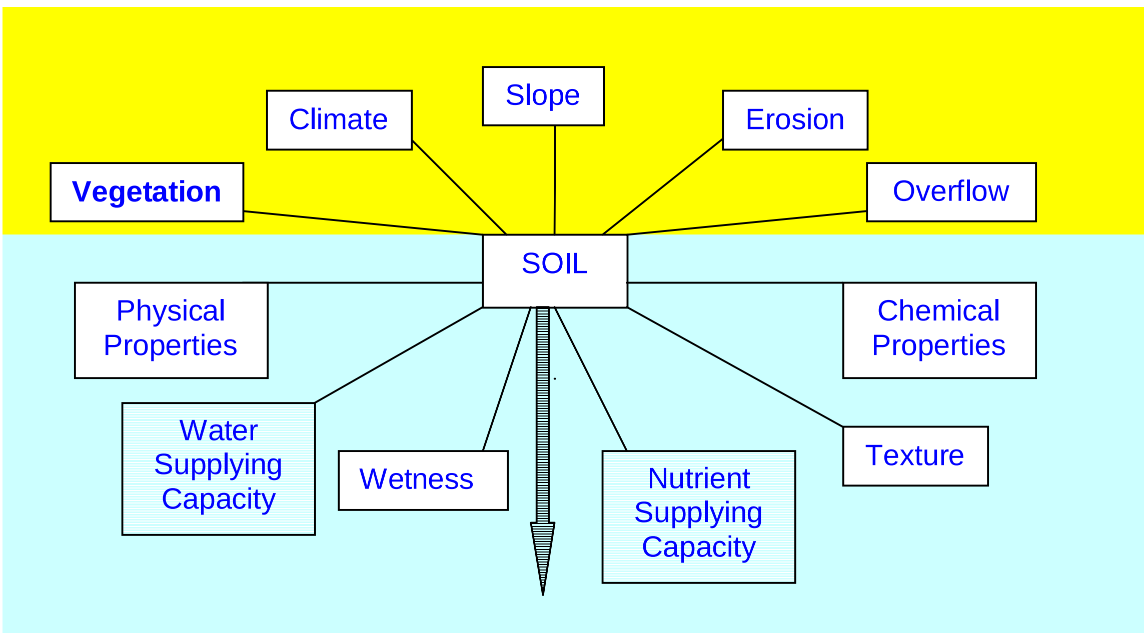

Figure 4. Soil properties that can influence use and management of land.

The Soil Profile

Due to the interactions of the five soil-forming factors, soils differ greatly. Each section of soil on a landscape has its own unique characteristics. The way a soil looks if you cut a section of it out of the ground is called a **soil profile**. When you learn to interpret it, the profile can tell you about the geology and climate history of the landscape over thousands of years, the archeological history of how humans used the soil, what the soil properties are used today, and the best way to use the soil. In a sense, each soil profile tells a story about the location where it was found.

Soil horizons

Soils are deposited in or developed into layers. These layers, called horizons, can be seen where roads have been cut through hills, where streams have scoured through valleys, or in other areas where the soil is exposed.

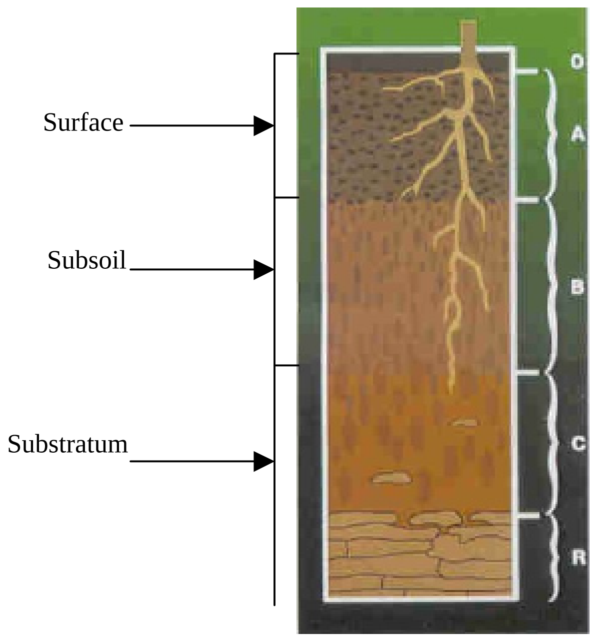

Figure 5. Soil profile separated into horizons.

Where soil forming factors are favorable, five or six master horizons may be in a mineral soil profile (fig. 5). Each master horizon is subdivided into specific layers that have a unique identity. The thickness of each layer varies with location. Under disturbed conditions, such as intensive agriculture, or where erosion is severe, not all horizons will be present.

The uppermost layer generally is an organic horizon, or **O horizon**. It consists of fresh and decaying plant residue from such sources as leaves, needles, twigs, moss, lichens, and other organic material accumulations. Some organic materials were deposited under water (fig. 6). Subdivisions of Oa, Oe, and Oi are used to identify levels of decomposition. The O horizon is dark because decomposition is producing humus.

Figure 6. Profile on the left shows an Oi horizon at the surface; an organic horizon with little decomposition. Profile to the right shows an Oa horizon; an organic horizon that is highly decomposed.

Figure 7. The soil profile to the right shows a well drained soil with an A horizon from the surface to a depth of 5 cm (2 in.). The measuring tape is in feet. The middle soil profile is a somewhat poorly drained soil with the top of the gray due to wetness occurring at 40 cm (16 in.). Tape measure is in meters. The middle soil profile has a buried A horizon starting at 1 m (40 in.). The soil profile to the left is moderately well drained with an Ap horizon from the surface to 20 cm (8 in.).

Below the O horizon is the **A horizon**. The A horizon is mainly mineral material. It is generally darker than the lower horizons because of the varying amounts of humified organic matter (fig. 7). It is the horizon of maximum biological activity. This horizon is where most root activity occurs and is usually the most productive layer of soil. It may be referred to as a surface layer in a soil survey. An A horizon that has been buried beneath more recent deposits is designated as an "Ab" horizon (fig. 7). An A horizon that has been plowed or otherwise manipulated is an Ap horizon (fig. 7).

The **E horizon** generally is bleached or whitish in appearance (fig. 8). As water moves down through this horizon, soluble minerals and nutrients dissolve and some dissolved materials are washed (leached) out. The main feature of this horizon is the loss of silicate clay, iron, aluminum, humus, or some combination of these, leaving a concentration of sand and silt particles.

Figure 8. This profile is a soil found in the Appalachian Plateau showing an E horizon from 20 to 35 cm (8 to 14 in.) and a B horizon from 35 to 55 cm (14 to 22 in.) Measuring tape is in 10 cm increments. Below 55 cm (22 in.) is a C horizon.

Below the A or E horizon is the **B horizon**, or subsoil (fig. 8). The B horizon is usually lighter colored, denser, and lower in organic matter than the A horizon. It commonly is the zone where leached materials accumulate. The B horizon is further defined by the materials that make up the accumulation, such as "t" in the form of "Bt", which identifies that clay has accumulated. Other illuvial concentrations or accumulations include iron, aluminum, humus, carbonates, gypsum, or silica. Soil not having recognizable concentrations within B horizons but show color or structural differences from adjacent horizons is designated "Bw".

Still deeper is the **C horizon** or substratum (fig. 8). The C horizon may consist of less clay, or other less weathered sediments. Partially disintegrated parent material and mineral particles are in this horizon. Some soils have a soft bedrock horizon that is given the designation Cr. C horizons described as "2C" consist of different material, usually of an older age than horizons which overlie it.

The lowest horizon, the **R horizon**, is bedrock (fig. 9). Bedrock can be within a few centimeters of the surface or many meters below the surface. Where bedrock is very deep and below normal depths of observation, an R horizon is not described.

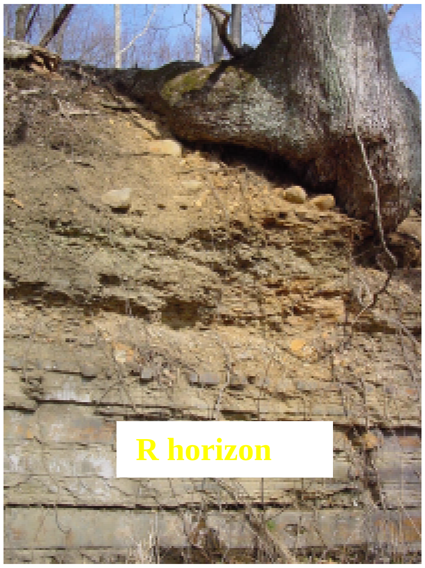

Figure 9. This soil profile has 110 cm (44 in.) of unconsolidated soil material over hard bedrock.

Generally, soil horizons are found in the order presented (fig. 10). However, a soil profile may lack certain horizons or have horizons out of order due to factors that influenced that soil's development. For example, a soil profile may lack E and B horizons if it is a young soil that has not had the time for an E and B horizon to develop. Or, a soil may have a buried A horizon if that soil has had material deposited on top of what was once the soil surface (fig. 7). This may occur on flood plains after a flooding event deposits sediments, because of erosion deposition, or because man has deposited material on top of the soil.

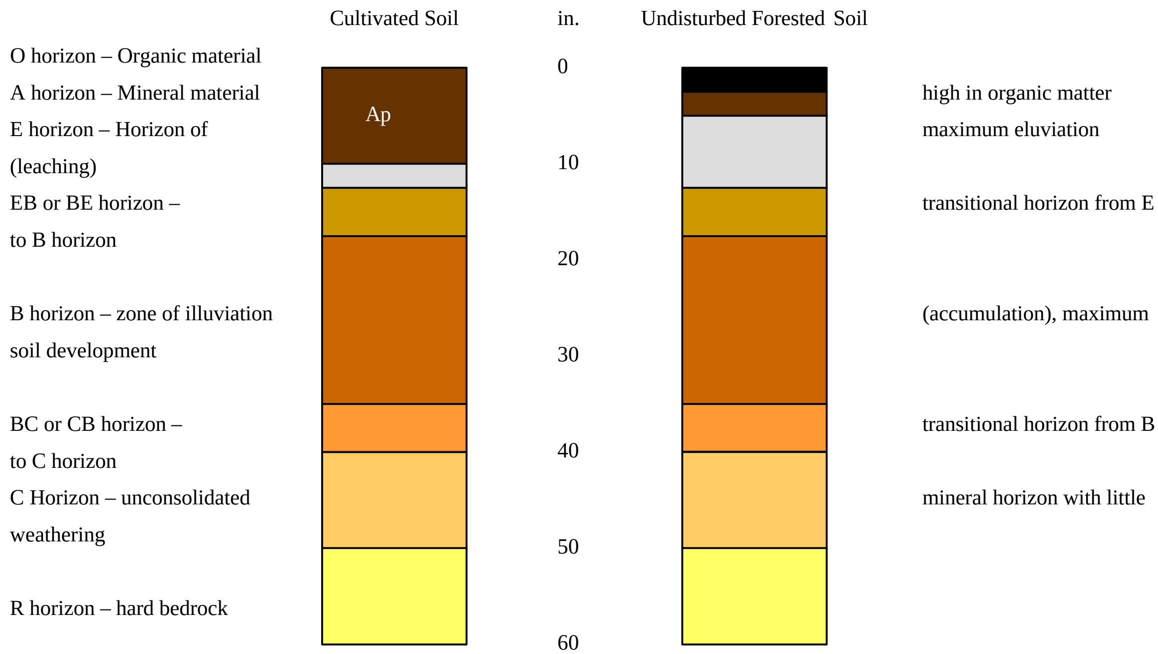

Figure 10. Common horizons designations and the order in which they are most commonly found.

Color

To the casual observer, color is the most noticeable soil property. Maryland soils vary in color from red, yellow and brown to gray in the subsoil (B horizon) and from black to very light gray in the topsoil (A horizon). Color is a significant indicator of several soil properties, including the organic matter content and drainage condition. The three components that have the most affect on soil color are organic compounds (usually black or dark brown), iron oxides (usually red, orange or yellow) and the color of the mineral grains (usually gray).

Black or very dark colors in the A horizon suggest relatively high organic matter contents. Most cultivated Maryland soils have organic matter in their plow layer ranging between 1 and 4 percent by weight. In some poorly drained soils, the organic matter content will reach 10 percent and higher. Generally, the darker the A horizon the higher the organic matter content. In Maryland, this generalization can be taken a step further; a deep, dark colored A horizon indicates the soil was formed under very poorly drained conditions. Organic matter enhances soil tilth (physical condition) or structure and is a natural nitrogen supplier under favorable conditions. As the organic matter content decreases, the color is determined more by the mineral components of the horizon. Pale colors indicate that the horizon has low organic matter content (fig. 11).

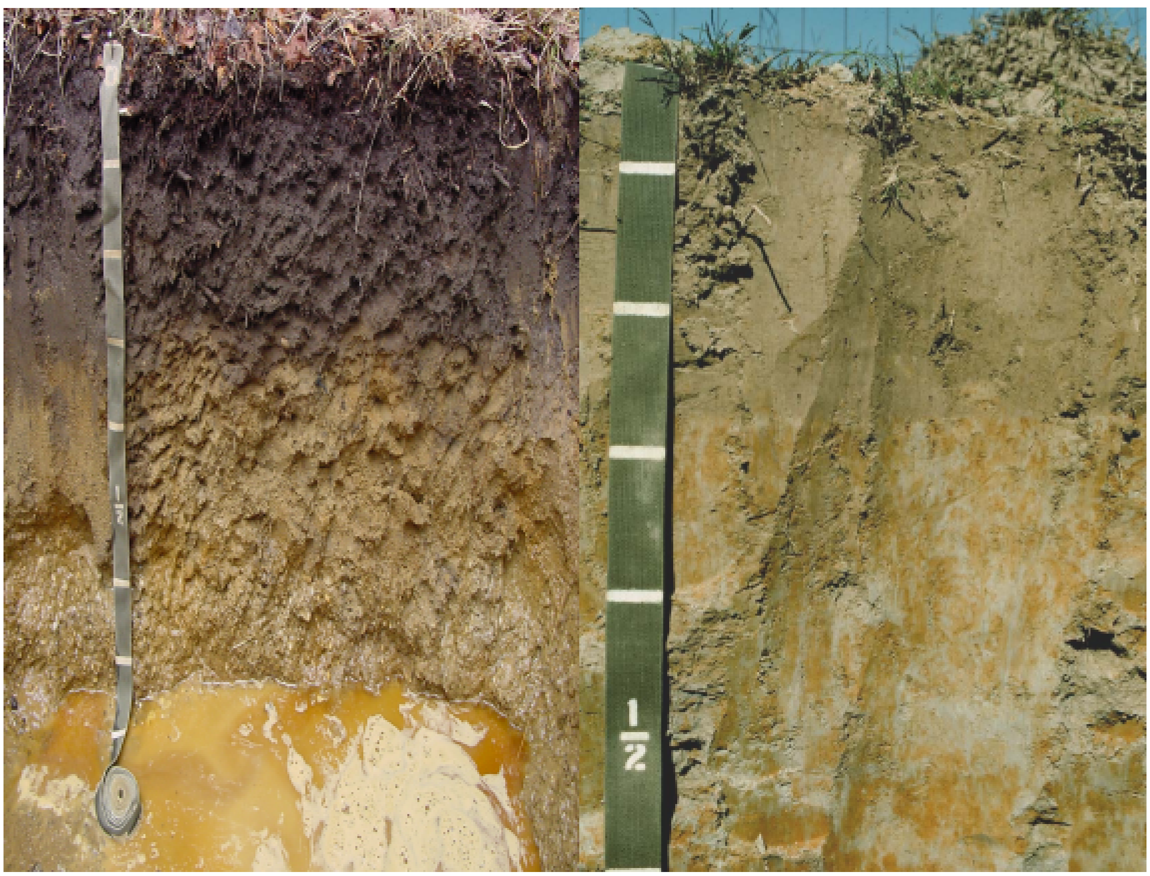

Figure 11. The soil profile on the left has a dark surface high in organic matter, while the soil profile on the right has a pale surface low in organic matter. The measuring tapes are in meters.

Subsoil colors are not greatly influenced by organic matter. Usually, the iron compounds coating the mineral particles are largely responsible for the color of this horizon.
Soils formed under well-drained conditions, where oxygen is readily available, have subsoils with bright colors, usually brown, red or yellow (iron oxide colors). Some grayish tones may occur in these soils, but they are associated with the weathering of rocks and not drainage. Usually, soils formed under well-drained conditions are uniform in color, however, **mottles** (splotches of color), may occur due to weathering of rock fragments or parent material colors, etc (fig. 12). Brown, red or yellow colors can be interpreted as indicating good natural drainage making artificial drainage unnecessary. Septic systems should work in these soils unless they contain too much clay. Also, these soils should provide good dry locations for houses with basements.

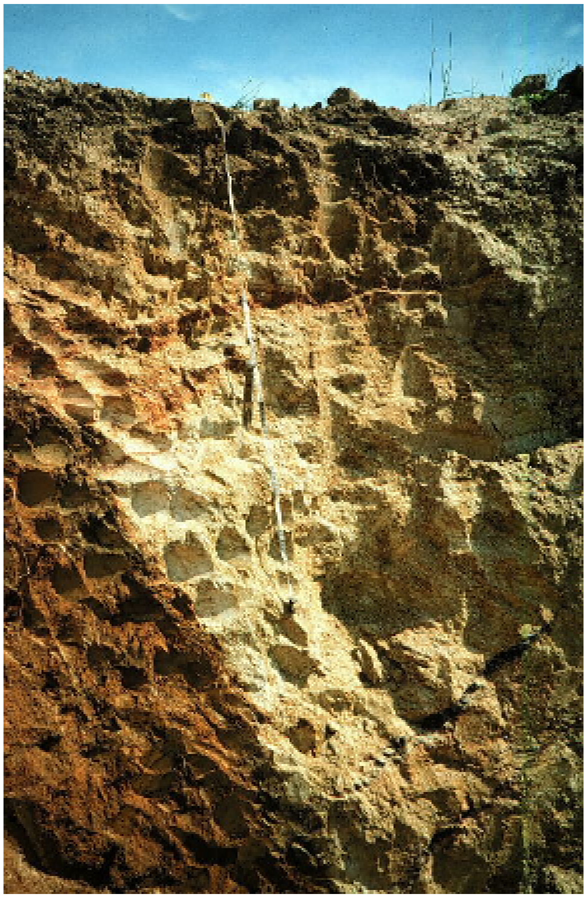

Figure 12. The red and gray colors in this soil profile are inherited from its parent material.

When these bright colors are mixed with areas of gray (color of the mineral grains) the soil developed under conditions of imperfect drainage. The mixed pattern, called **redoximorphic features**, indicates that the soil is saturated with water for significant periods during the year (fig. 13). This pattern is caused when iron is reduced due to wetness and moved leaving splotches where of gray colors where the mineral grains have been stripped of iron. Artificial drainage usually is necessary for good crop production and septic systems are subject to periodic failure when installed in these soils.

Figure 13. The red and gray colors in these soil profiles are due to wetness. These splotches of colors due to wetness are called redoximorphic features. The soil profiled and the left has a predominance of gray due to the loss of iron starting close to the bottom of the spade. The soil on the right has a predominance of red with gray splotches starting at 1 m (40 in.). The measuring tape for the profile on the right is in meters.

When gray (color of the mineral grains) predominates with only streaks and spots of brighter colors (redoximorphic features) the soil was formed under poorly drained conditions. The spots of brighter colors are where the iron has re-oxidized forming spots similar to rust. These soils are called **hydric soils**, soil that have a water table near the surface for significant periods of time. Artificial drainage is necessary for crop production, and these soils are poor building sites, especially where septic systems are needed.

Figure 14. This soil profile is a hydric soil. The predominance of gray colors with splotches of red near the soil surface demonstrates the typical pattern of redoximorphic features found in a hydric soil.

When determining colors, make sure that the soil is moist. Moistened soil better illustrates color variations, making it easier to distinguish one horizon from another. Soil scientists use standard color (Munsell) charts to determine color (fig. 15); this permits uniformity and eliminates some of the human variable. According to the chart, a soil horizon described as yellowish-brown in Maryland has exactly the same color as a yellowish-brown horizon in California.

Figure 15. The Munsell soil color book is used to standardize soil color designations.

Organic vs. mineral soil material

Organic soil contains high amounts of organic matter. Organic soil material will be very dark in color, contain fibers, and will feel greasy when rubbed. Organic soil material is usually found at the soil surface, where leaves, twigs, and other sources of organics accumulate. When observing organic soil material, you may be able to readily identify leaves and twigs and other sources of organics. This is relatively undecomposed and is considered to be peat. If the source of organics is not easily identified the organic matter is more highly decomposed and would be considered mucky-peat (intermediate decomposition) or muck (high decomposition).

Mineral soil texture (USDA)

Texture is determined by the relative proportion of sand, silt, and clay (mineral material <2mm in diameter). Sands range in size from 2 millimeters (very coarse) to 0.05 millimeter (very fine); silts range from 0.05 to 0.002 millimeter and clays are less than 0.002 millimeter. Figure 16 illustrates the relative sizes between the three major particles. Particles larger than 2 millimeters, such as gravel, stones and coarse fragments are considered as modifiers of soil texture, but are not included in the textural class. Coarse-textured (light) soils are composed predominantly of sand particles. Fine-textured (heavy) soils are dominated by clay particles. Medium-textured soils, such as loams, are characterized by having sand, silt and clay in such proportions as to exert nearly equal influence on the character of the soil.

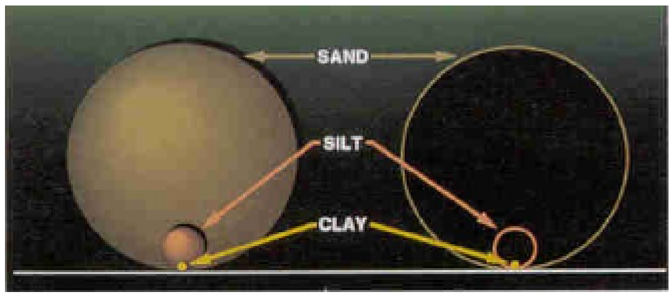

Figure 16. The relative sizes of sand silt and clay.

Soil texture is very important; it influences a soil's available water capacity; tilth; ease of tillage; resistance or susceptibility to erosion; drainage and permeability; and capacity to absorb and release nutrients. Therefore, texture exerts a profound influence on soil productivity and management requirements.

Sand particles can be distinguished by the naked eye. The coarse silt fraction can be seen under a low-power magnifying glass, but individual clay particles are so fine that only electron microscopes can reveal them.

Soil texture can be determined in the lab by measuring the proportion of sand, silt and clay. A textural triangle (fig. 17) is used to determine the texture once the proportion of sand, silt and clay are known. However, soil scientists need a quick method for determining soil texture in the field. This is done by feel. Moistening the soil and rubbing it between the thumb and forefinger permit a close textural class estimate (fig. 18). By employing this method, even the beginning student can acquire the skill of determining several textural classes. (Remember to use only less than the 2-millimeter material.) Usually, the subsoil in most Maryland soils will contain more clay than the surface

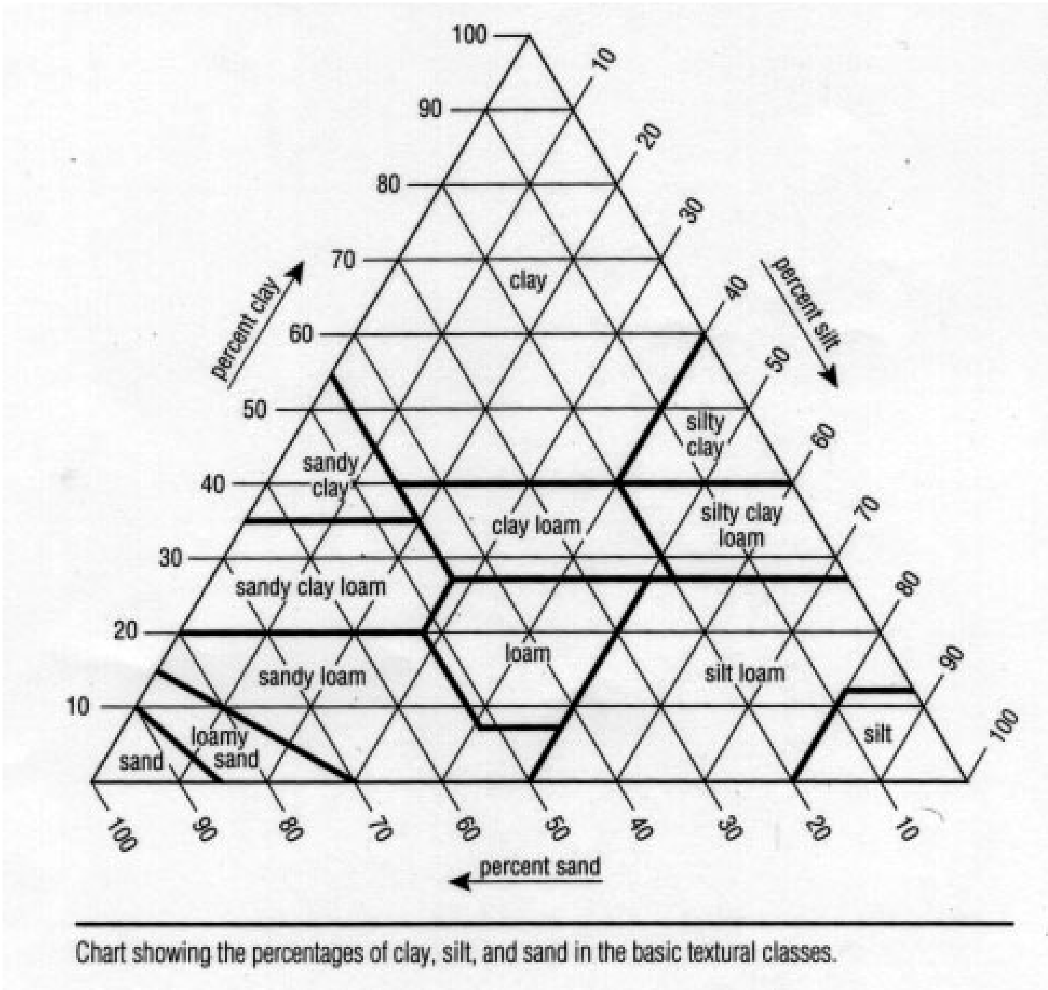

Figure 17. Textural triangle used to determine texture of soil once proportion of sand, silt and clay are known.

soil. Thus, the surface or A horizon may be classed as 'coarse' or 'medium' while the subsoil might be classed as 'medium', 'moderately fine' or 'fine'. Many moderately fine- or fine-textured soils do not allow water to percolate very rapidly, making them poorly suited for septic systems.

Coarse. Coarse-textured soils feel gritty and do not hold together when moist. The sand and loamy sand soils belong in this group. They tend to be droughty and very permeable. However, these soils may contain enough silt and clay to provide some available water and nutrient holding capacity. Thus, under ideal rainfall or irrigation, these soils commonly are used for agriculture. They are preferred for early spring truck crops

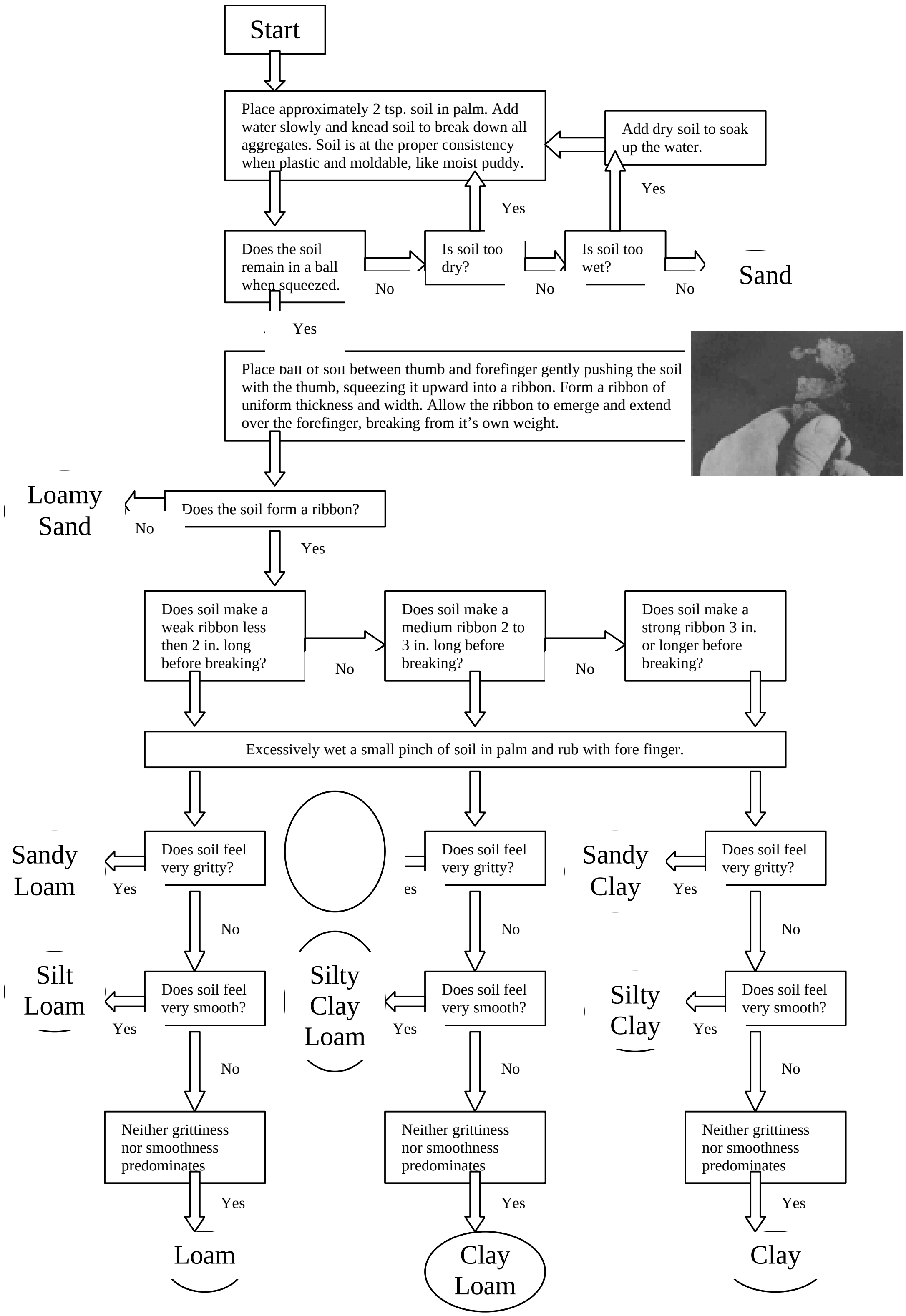

Figure 18. Flow chart for evaluating soil texture by feel.

because they drain quickly (where water tables are not high) and warm rapidly. Irrigation commonly is practiced to ensure timely watering. Where drainage is good, these soils provide adequate sites for septic systems although renovation of the wastewater and ground water contamination may be a problem.

Moderately Coarse. Moderately coarse-textured soils feel gritty but they hold together in a ball or when rolled out under gentle pressure. The sandy loam soils fall into this textural category. These soils hold more water than the coarse-textured soils, but they also are commonly irrigated since they do not have the available water capacity of the medium-textured soils. Moderately coarse-textured soils are highly desirable for crop production, and they also make excellent building sites when well drained.

Medium. Medium-textured soils, such as loams, silt loams and sandy clay loams contain significant proportions of sand, silt and clay. When rubbed between the fingers, medium-textured soils feel smooth but not sticky. A ribbon tends to form when a moistened sample is rubbed out, but this ribbon breaks apart because of insufficient quantities of clay. These textures provide good water and nutrient supplying capacities, and they are usually the most productive agricultural soils. Septic systems usually are long lived if these soils are well drained.

Moderately Fine. Moderately fine-textured soils such as silty clay loams and clay loams contain between 27 to 40 percent clay. When moist, these soils feel slightly sticky and are slightly plastic. When a sample is rubbed between the thumb and forefinger, a ribbon can be formed. The more clay that is present the stickier the sample and the longer and more flexible the ribbons.

Fine. Fine-textured soils are those containing greater than 40 percent clay. When moist samples are rubbed between the forefinger and thumb, a ribbon can be formed. This ribbon will feel stiff and usually has a very shiny appearance. These soils feel sticky or very sticky when moist. Fine-textured soils harden and form clods when dry and are puddled easily if worked when wet. For this reason, they are very difficult to manage and are not the best agricultural soils or best soils for building sites that require septic systems.

Rock fragments

Rock fragment is used as a texture modifier. The size and percentage of rock fragments in the soil are important to land use. Rock fragments within soil layers reduce the amount of water available for plant use and may restrict some tillage operations. Particles larger than 2 millimeters (0.08 in) in diameter are called rock fragments (fig. 19). The following is a list of gravel types.

- Rounded
  - Gravel >2 to 75 mm diameter (0.08 to 3 in.)
  - Cobbles >75 to 250 mm diameter (3 to 10 in.)
  - Stones >250 to 600 mm diameter (10 to 25 in.)
  - Boulders >600 mm diameter (>25 in.)
- Flat
  - Channers >2 to 150 mm long (0.08 to 6 in.)
  - Flagstones >150 to 380 mm long (6 to 15.2 in.)
  - Stones >380 to 600 mm long (15.2 to 25 in.)
  - Boulders >600 mm long (>25 in.)

Figure 19. This soil profile contains cobble size rock fragments in a high enough concentration to put an extremely cobbly modifier on the texture.

If a soil horizon contains more than 15 percent rock fragments a modifier is put on the texture (fig. 19). For example if a soil horizon contains 20 percent gravel size rock fragments and the texture is a sandy loam, the modifier would be gravelly and the texture would be labeled gravelly sandy loam. Table 2 shows modifiers used when the gravel content is greater than 15 percent.

Table 2. Rock fragment texture modifiers.

Fragment Content % by Volume	Rock Fragment Modifier
<15	None
15 to <30	Modifier (i.e. gravelly)
30 to <60	Very + modifier
60 to <90	Extremely + modifier
>= 90	Use noun (i.e. gravel)

Soil Structure

Soil structure is the naturally occurring aggregation of soil particles into units called **peds**. To determine soil structure you must carefully remove soil and shake it gently so that the soil falls apart naturally. Clay and organic compounds are the binding material that creates the peds that form soil structure. The size and type of soil structure is important because it affects water movement in the soil.

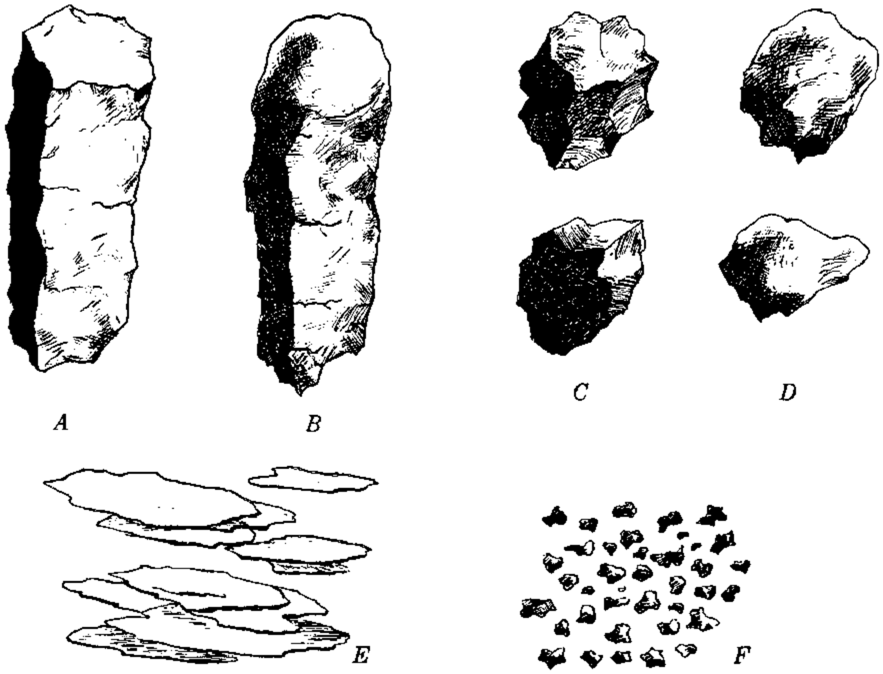

Figure 20. Structures found in Maryland include A. prismatic, C. angular blocky, D. subangular blocky, E. platy, and F. granular. Although not found in Maryland, B. columnar structure is similar to prismatic structure, but is rounded at the top.

Soil structure common to Maryland includes granular, angular blocky, subangular blocky, platy, prismatic, single grain, and massive (fig. 20). Granular structure is small and rounded, usually found in surface horizons. All other structures are usually found in subsurface horizons. Angular blocky has blocky peds that have sharp edges. Subagular blocky has blocky peds with rounded edges. Platy structure is flattened and can impede water movement through the soil. Prismatic is vertically elongated with flat tops. Single grain is found in sands and loamy sands and falls apart into loose grains. Massive is material that is held together, but does not fall apart naturally into any coherent structure.

Permeability

Permeability is the rate at which water and air move through the soil. Permeability is influenced by texture, structure, bulk density, and large pores. Soil structure influences the rate of water movement through saturated soil, in part, by the size and shape of pores. Granular structure readily permits downward water movement, whereas a platy structure requires water to flow over a much longer and slower path (fig. 21). Permeability is used in drainage design, irrigation scheduling, and many conservation practices. Permeability classes are shown in table 3.

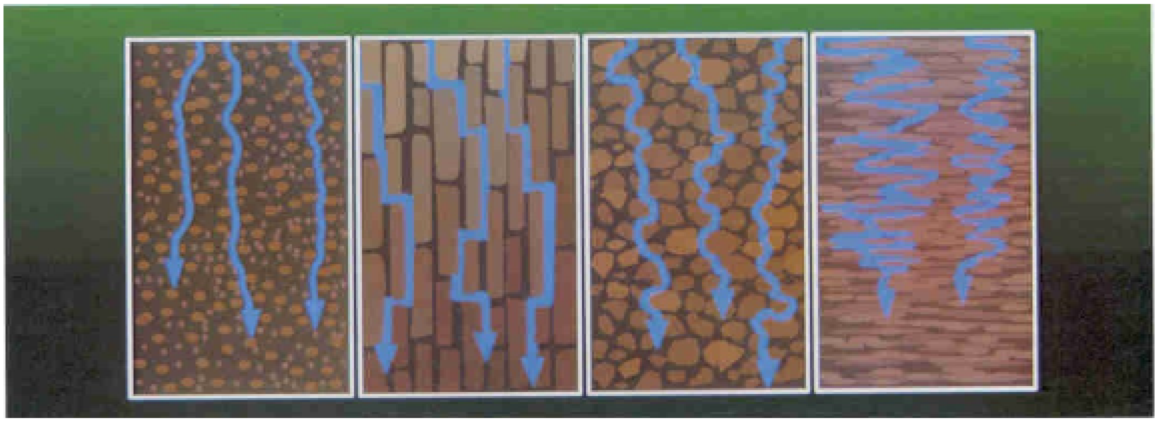

Figure 21. Paths of water flow through soils with granular, prismatic, subangular blocky, and platy structure, respectively

Table 3. Permeability classes

Class	Rate (in/hr)
Very slow	<0.06
Slow	0.06-0.02
Moderately slow	0.02-0.6
Moderate	0.6-2.0
Moderately rapid	2.0-6.0
Rapid	6.0-20
Very rapid	>20

Depth

The depth of a soil is considerably important both for agricultural and nonagricultural uses. A shallow-rooted crop may produce equally well on either a deep or shallow soil. However, deeply rooted plants such as trees or alfalfa require deep soils for best growth. During droughty periods, crops on shallow soils usually are the first to show damage because of the lack of moisture. This results from a soil volume that cannot hold adequate water.

Houses with basements or septic systems should be built on deep, well-drained soils. The lack of deep soil may necessitate a house with a slab or shallow foundation, and a septic system may not be functional or permitted on such soils.

Shallow soils restrict plant growth by impeding root growth and provide only limited water and nutrient re-serves. The processes of soil formation may have been such that only a thin veneer of soil has formed over a very hard or resistant parent material. Erosion may have reduced the thickness of a once-deep soil. Coarse gravel and sand layers also can impede root penetration as can sustain high water tables. In addition, root-restricting horizons or pans may have been formed during soil formation.

Most of the better agricultural soils in Maryland have a thickness of at least 1 m (40 in.). These soils are considered deep for agricultural and judging purposes. A soil that has a thickness of greater than 1.5 m (60 in.) is very deep. Any soil possessing a root-restricting horizon at a depth of less than 0.5 m (20 in.) is considered shallow (fig. 22). Moderately deep soils are those between these two extremes.

In summary, the categories of soil depth are:

Very deep	greater than 1.5 m (greater than 60 in.)
Deep	1 to 1.5 m (40 to 60 in.)
Moderately deep.............	0.5 to 1 m (20 to 40 in.)
Shallow	0.25 to 0.5 m (10 to 20 in.)
Very shallow	less than 0.25 m (less than 10 in.)

Figure 22. The soil on the left is a shallow soil with bedrock starting at 0.35 m (15 in.). The soil on the right is a very deep soil with no bedrock to a depth greater than 1.5 m (60 in.)

Reaction

Soil **pH** is an expression of the degree of acidity or alkalinity of a soil. It influences plant nutrient availability. A very acid soil (pH <5.0) typically has lower levels of nitrogen, phosphorus, calcium, and magnesium available for plants, and higher levels o availability for aluminum, iron, and boron than a net soil at pH 7.0. At the other extreme, if the pH is too high, availability of iron, manganese, copper, zinc, c especially phosphorus and boron may be low. A pH above 8.3 may indicate a significant level of exchangeable sodium.

Drainage

Some soils can be worked soon after heavy rains while others may remain saturated or ponded for long periods. Coarse-textured soils such as sands allow water to drain through the soil very rapidly if outlets are available. Moderately coarse-, medium-, moderately fine-, and fine-textured soils on similar landscape positions usually require correspondingly longer periods before they can be worked. Soils on extensive level areas or those in depressions commonly are poorly drained, and water tables may be at or near the surface for a long time.

Plants require good aeration as well as moisture for optimum growth. Soils that are excessively drained (such as sand) are well aerated but dry out quickly thus restricting crop production. Poorly drained soils that are not artificially drained retard crop production because long periods of water saturation starve roots of required oxygen. Also, these soils do not warm readily in the spring. Thus, the best agricultural soils are those that are deep and allow excess water to readily pass through the profile while retaining enough water to supply crops until the next rain.

Soils that are deep, well drained, moderately coarse and medium textured are preferred for agricultural production because they have a very desirable air-water relationship for many crops. These soils are about half mineral and organic material and half pore space. Ideal conditions exist when approximately half of this pore space is filled with water and half with air. Of course, these proportions fluctuate with the rainfall pattern. Coarse-textured soils (such as sand) contain a much greater proportion of air than water in this pore space, and they must be irrigated for good crop production. On the other hand, fine-textured soils (such as clay) possess a higher proportion of water than air in the pore space.

Well-drained soils also are preferred for many nonagricultural uses. Home sites and housing developments should be located in well-drained soils, especially if basements are to remain dry and septic systems are to function efficiently.

One of the best indicators of drainage class is soil color. The more redoximorphic features (mottling due to wetness) and gray in the subsoil, the poorer the soil drainage, the longer and higher the water tables stand in a soil profile, the more intense is the mottling and the higher it occurs within the profile. Soil scientists recognize six drainage classes in the field. Figure 23 shows the relationship between topography or position on the landscape and the resulting soil drainage. The water table, as indicated on the figure, is shown as it might appear during wet seasons.

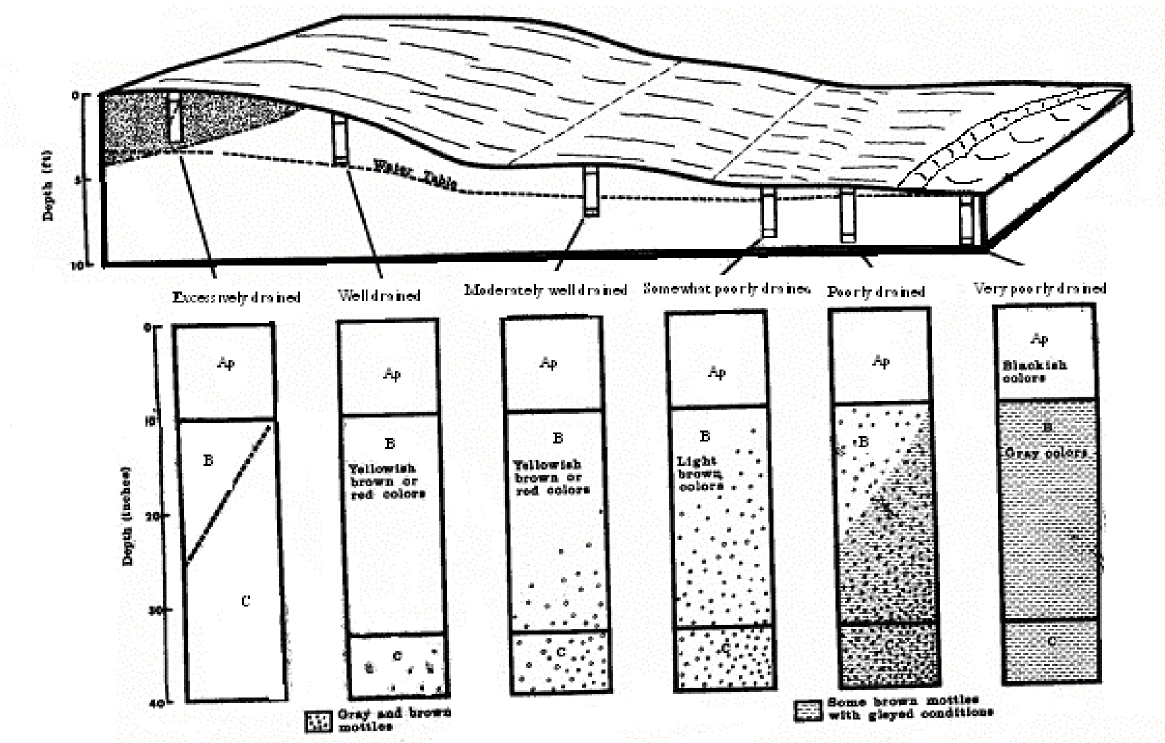

Figure 23. Maryland drainage classes and their location on the landscape.

Excessively drained. Water is removed from the soil very rapidly because of either coarse textures (such as sand and loamy sand) or shallow, porous profiles on steep slopes. Excessively drained soils are suited poorly to agriculture unless irrigation is practiced. No drainage mottles occur in these soils (fig. 24).

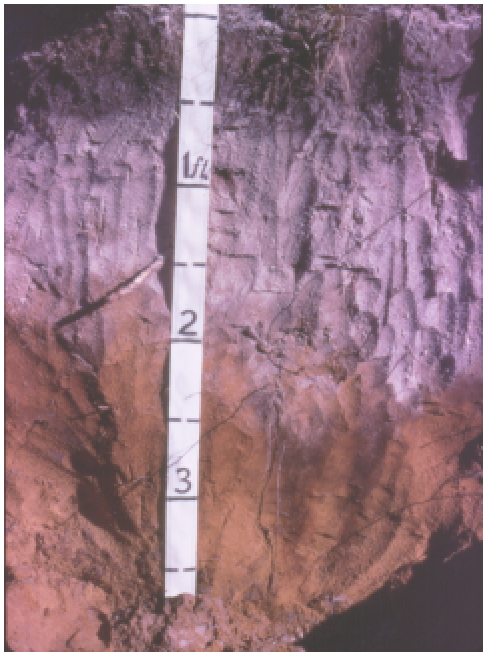

Figure 24. This soil profile shows an excessively drained soil. It is a sandy soil with no redoximorphic features.

Well drained. Good aeration occurs. Subsoil colors are bright and the profile lacks redoximorphic features above 1 m (40 in.) (fig. 25). Brown, yellowish brown and reddish brown colors are common.

Figure 25. This soil is a well drained soil with no redoximorphic features in the upper 1 m (40 in.)

Moderately well drained. In these soils, redoximorphic features are present above 1 m (40 in.) indicating that saturated conditions or water tables occur above this depth at various times during the year (fig. 26). Mottles are restricted to the 0.5 to 1 m (20 to 40 in.) zone for classification in this category. These soils may retard crop growth in wet years, but crops may do very well during drought periods. Artificial drainage may be beneficial during wet periods. Septic systems may experience periodic failure during saturated conditions.

Figure 26. This is a moderately well drained soil with redoximorphic features occurring starting at 0.75 m (30 in.)

Somewhat poorly drained. Redoximorphic features occur within the 10 to 20 in. zone, indicating prolonged periods of saturation or high water tables. Serious crop injury or failure may result during wet years (fig. 27). Unless artificial drainage is provided, crop production is restricted and septic systems commonly fail.

Figure 27. This is a somewhat poorly drained soil with a predominantly gray matrix starting at 0.35 m (15 in.)

Poorly drained. These soils have dark surface horizons and gray subsoils with redoximorphic features occurring above 25 cm (10 in.) (fig. 28). They have high water tables or are ponded for long periods or both. These soils usually occupy level areas or footslope positions and are productive only if they are artificially drained. Development of these soils for home sites should be avoided.

Figure 28. This is a poorly drained soil with a predominantly gray matrix due to wetness occurring at the surface.

Very poorly drained. Water is removed so slowly that the water table remains at or on the surface much of the year (fig. 29). These soils usually occupy low-lying and concave or depressed positions on the landscape. They normally have very dark or black, thick surface horizons with relatively high organic matter contents. The subsoils usually are gray. These soils can be used for agriculture, but only if intensive drainage is practiced.

Figure 29. This is a very poorly drained soil with a black surface due to organic matter accumulation underlain by a predominantly gray matrix due to wetness.

Available Water Capacity

The available water capacity of a soil is closely related to texture. As mentioned previously, air and water occupy the pore space between the particles comprising the soil skeleton. The bigger the soil particles (such as sand or gravel), the larger the pores between them. Thus, water drains first and rapidly from these larger pores. This results in droughty soils because the plants are supplied only from the small amount of remaining moisture. Irrigation is necessary on these soils even in humid climates.

As the particles become smaller, the pores between the grains also are reduced in size. This results in the retention of more water for plant use. Therefore, medium-textured and moderately fine-textured soils, such as loam, silt loam and clay loam have much higher available water capacities than coarse-textured soils. The moderately coarse-textured soils (such as sandy loam) are intermediate in those categories. Fine-textured soils (such as clay) have such small pores that plant roots are unable to obtain much more water from these fine soils than is available from medium-textured soils. Moderately coarse-, medium- and moderately fine-textured soils are, therefore, preferred for agricultural use because they provide good, available water capacity and aeration while being easily worked.

To calculate the water available within the soil profile, consider only the first 1 m (40 in.) or to a root limiting layer if it occurs above 1 m (40 in.). The available water capacity of each horizon down to 1 m (40 in.), when added together, will give the total available water for the profile. A deep silt loam will hold more water than a soil with 0.25 m (10 in.) of silt loam surface soil and the remainder sand. Therefore, both the surface and subsoil must be considered in computing the available water

See Table 4 for a general guide when calculating the amount of available water in a 40 in. profile. The range and average water availability are presented in inches of available water per inch of soil depth.

For example, if a soil consists of 20 in. of silt loam over loamy sand, the available water capacity would be affected by both textural classes. In determining the water in the 20 in. of silt loam or medium-textured material, simply multiply the depth (20 in.) by the amount of available water held by the silt loam textural class (0.23 in. of water per inch of soil). This calculation gives 4.6 in. of available water in the 20 in. zone. Now the remaining 20 in. (to complete the 40 in. profile) is loamy sand or coarse-textured material which holds only 0.05 in. of water per in. of soil. Multiplying 20 in. of loamy sand times 0.05 yields a total of 1.0 in. of available water. Therefore, the 40 in. soil profile has an available water capacity of 4.6 in. (silt loam) plus 1.0 in. (loamy sand) or 5.6 in. of available water.

Table 4. Amount of available water by textural class.

Textural class	Available water (in. water/in. soil	
	Range	Average
Coarse (sand, loamy sand)	.02-.09	0.05
Moderately coarse (sandy loam, fine sandy loam	.09-.19	0.14
Medium (loam, sandy clay loam, silt loam	.19-.27	0.23
Moderately fine (clay loam, silty clay loam)	.10-.19	0.15
Fine (silty clay, sandy clay, clay)	.07-.19	0.13

Available Water Capacity Categories	Range in in. H_20 per 40 in. soil
Very Low	Less then 2.5
Low	2.6 to 4.5
Medium	4.6 to 7.0
High	Greater then 7.0

Erosion

Soils under their natural vegetative cover attain equilibrium with their environment. When this vegetative cover is removed and the soils are cultivated, this equilibrium is changed. At certain times of the year the soils are exposed to heavy rains with little or no vegetative cover to break the impact of the rain drops. As a result, soil particles are dislodged and runoff waters carry these particles downslope and deposit them on other parts of the landscape or carry them into streams. Wind also is an effective carrier of particles on sandy soils. Regardless of the process, the removal of soil is called erosion.

Some soils in Maryland have been cultivated for hundreds of years and many of these soils are severely eroded. Often, the entire original surface horizon has been removed, leaving the subsoil exposed. In some parts of the Piedmont, it is estimated that from 60 to 90 cm (24 to 36 in.) of the soil have been lost. The degree or severity of erosion is an important soil property.

The degree of past erosion can be determined by comparing the original soil depth, observed in virgin forests, with the present soil depth. The less surface soil, or the closer the subsoil is to the surface, the more severe the erosion problem.

The amount of past erosion is estimated as a measure of the soil that remains in relation to the given original thickness. The following categories are used to define the severity or degree of erosion in Maryland.

None to slight. Less than 7.5 cm (3 in.) of the original soil have been lost. No mixing of the subsoil into the plow layer is evident.

Moderate. Between 7.5 to 20 cm (3 to 8 in.) of the original soil have been removed. Subsoil material may be mixed with the plow layer, but the plow layer remains darker than the subsoil.

Severe. More than 20 cm (8 in.) of the original soil have been lost. Commonly, subsoil material is mixed with the plow layer, and the plow layer color closely resembles the subsoil color. Where the subsoil is exposed or gullies occur, the soil is severely eroded.

Erosion Potential

Erosion potential is determined by the steepness of the slope, length of slope, the nature of the soil (soil texture, infiltration rate and tilth) and the type of vegetative cover. A soil's susceptibility to erosion will influence greatly how the soil is used. Erosion potential can be determined primarily by evaluating factors such as slope gradient, slope length and soil texture.

Land Capability Classification

Land capability classes and in most cases, subclasses are assigned to each soil. They suggest the suitability of the soil for field crops or pasture and provide a general indication of the need for conservation treatment and management. There are 8 capability classes. Capability classes are designated by either Arabic or Roman numerals (I through VIII), which represent progressively greater limitations and narrower choices for practical land use (fig. 30). Capability subclasses are noted with an e, w, s, or c following the capability class; for example, IIe. The "e" indicates that the soil is erosive. A "w" signifies a wetness limitation. An "s" denotes a shallow, droughty, or stony soil. A "c" indicates a climatic limitation. No subclasses are shown for capability class I because these soils have few limitations. Figure illustrates some of the capability classes on a landscape.

Of the eight capability classes, only the first four are considered usable for cropland. Class I land has little or no hazard for crop production and is the best agricultural land. Classes II, III and IV need progressively more care and protection when cultivated crops are grown. Soils in classes V, VI and VII are suited for adapted native plants (such as forests), although some soils in classes V and VI are capable of producing specialized crops such as fruit trees and ornamentals. Soils in class VIII do not respond to management without major reclamation since they include the very steep and rocky areas of the mountain regions and the very wet tidal marshes in Maryland.

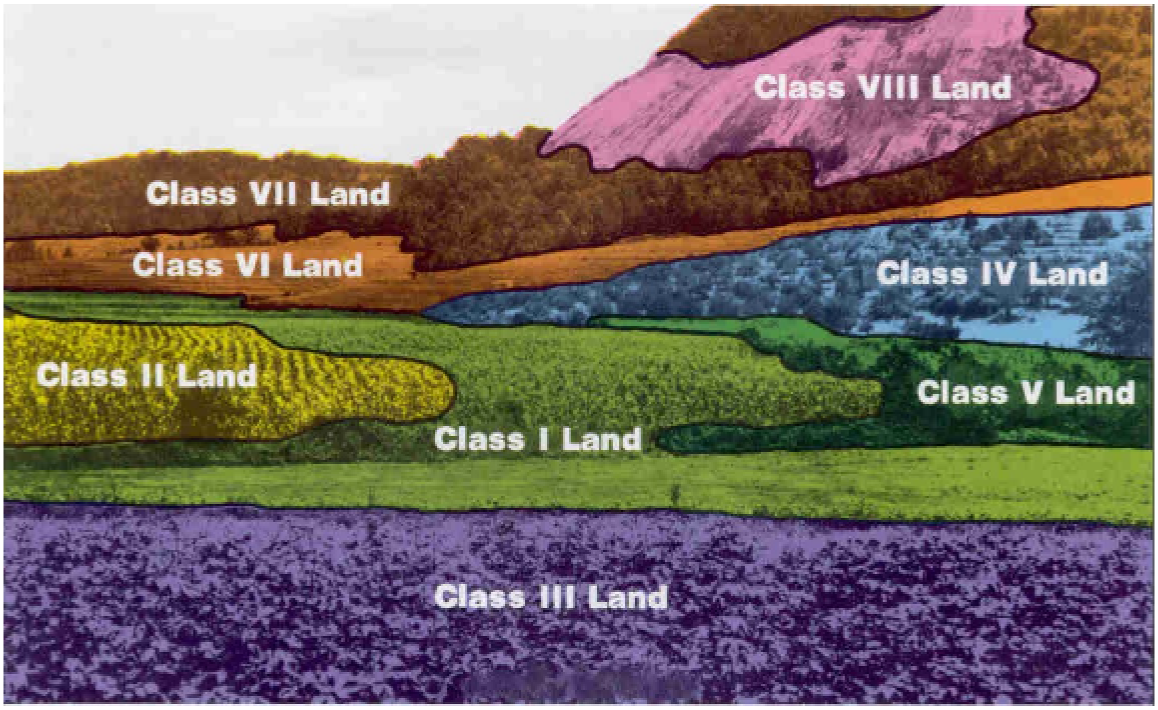

Figure 30. Location of different land capability classes in the landscape.

Capability Classes Suitable for Cultivation of Row Crops

Class I

Soils In this class have few limitations that restrict their use.

These soils are the best in nearly all respects for both agricultural production and nonagricultural uses. They are deep (1 m (40 in. or more)), well drained and medium textured with medium to high available water capacities, moderate permeability and none to moderate erosion. These soils are easily worked and are among the most productive in the state. Slopes should not exceed 2 percent in the Coastal Plain or 3 percent in the Piedmont and Appalachian provinces. Management should include maintenance of proper plant nutrient balance and tilth.

Class II

Soils in this class have some limitations that reduce the choice of plants or require moderate conservation practices.

Although these soils are rated good and usually are productive, some physical conditions render them less desirable than class I land. Likewise, the drainage class, soil depth, permeability or available water capacity maybe less desirable than class I soils. In general, slopes ranging between 2 and 5 percent in the Coastal Plain, and 3 and 8 percent in the remainder of the state would place this soil in class II. Drainage may be the limiting factor with mottling within the 20 to 40 in. zone of the profile. A slow or rapid permeability, low available water capacity or moderate soil depth (0.5 to 1 m (20 to 40 in.)) also could eliminate this soil from class I. Although several limitations may exist, only one is necessary to place this soil in class n. Management practices, in addition to those for class I, should include moderate erosion control (including rotations with sod or cover crops), contour fanning, moisture retention methods or drainage depending on the type of limitation.

Class III

Soils in this class have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Limitations similar to class II soils may be present in these soils, but these limitations are more severe, restricting the use of these soils. Large acreages of class III land are strongly sloping and subject to moderate to severe erosion. Slope limits for this class range between 5 and 10 percent for the Coastal Plain and 8 and 15 percent for the remainder of the state. If drainage is the limiting factor, mottling should occur within the 20 in. zone, indicating that saturated conditions or high water tables are present at some time during the year .Shallow soils (less than 0.5 m (20 in.)), coarse-textured surface layers, fine- textured subsoils with slow permeability or very low available water capacity also can limit the use of soils to the extent that they are placed in this class. The very coarse soils with very low available water capacities also fit into this class and require irrigation to realize production.

The soils in this class require more intense management than the previous classes. Management practices should include intensive erosion control measures such as terracing and strip-cropping. Where excessive water is limiting, drainage practices are necessary to make these soils productive.

Class IV

Soils In this class have very severe limitations that restrict the choice of plants or require very careful management, or both.

Where erosion is limiting, this land is good for only occasional cultivation under careful management. Sod crops should occupy a large portion of the rotation be- cause of the severe erosion hazard. Slope limits for this class range between 10 and 15 percent in the Coastal Plain, and 15 and 25 percent in the Piedmont and Appalachian sections of the state. Very poorly drained soils in depressions have such high water tables, or are saturated for such long periods, that only very intensive drainage management can make these soils productive.

Soils that are severely eroded or gullied with little or no surface soil must be placed in this capability class, even though these soils may occur on slopes similar to those required for class III soils (see note on Figure 9).

Very intensive management practices are required for production on these soils. Where erosion is the hazard, cultivated crops may be grown only once in several sea- sons. Sod crops such as hay, pasture or cover crops are necessary to minimize the erosion loss. Even under excel- lent management, crop failures or severe yield reductions can be expected occasionally.

Capability Classes Unsuited for Cultivation

Class V

Soils in this class are nearly level and not subject to erosion, but because of excessive wetness resulting from frequent flooding or some permanent obstruction like rock outcrops, they are not suited for cultivation.

Streams that overflow frequently, excessive seepage, very stony soils or numerous outcroppings of bedrock make these soils unsuited for cultivation. Many of these soils are deep, however, and they have few limitations for pasture or forestry. These soils respond to good management, which is necessary for satisfactory production.

Class VI

Soils in this class have severe limitations that make them generally unsuited for cultivation, and that limit their use largely to pasture, woodland, or wildlife food and cover.

These soils have continuing limitations that cannot be corrected economically such as steep slopes (15 to 25 percent in the Coastal Plain and 25 to 50 percent in the Piedmont and Appalachian provinces), a severe erosion hazard, effects of past erosion, or stoniness. These factors produce some limitation for pasture and forestry .It should be pointed out that even for most of these uses, the better classes are preferred for maximum protection.

Class VII

Soils in this class have very severe limitations that make them unsuited for cultivation and that restrict their use largely to grazing, woodland or wildlife.

Although not suited for cultivation, intensive management can make productive pasture and woodland possible. Even in rough, timbered areas, special care is required to prevent excessive erosion. Soils on very steep slopes, very shallow soils and very stony soils that occur on slopes greater than 25 percent in the Coastal Plain and greater than 50 percent in the Piedmont are the most common members of this class. This class includes the least capable soils with regard to pasture and woodland.

Class VIII

Soils and landforms in this class have limitations that preclude their use for commercial production of plants and restrict their use to recreation, water supply, wildlife or esthetic purposes.

Tidal marshes that are flooded daily, continuously ponded areas (areas containing water for more than 6 months of a year), and areas with greater than 90 percent rock outcrop, stones or boulders are included in this class as well as borrow pits, barren mine dumps and sandy beaches. These land areas have few or none of the physical soil features (found in class I soils) necessary to support any type of agriculture.

Other management interpretations

Some soil surveys, or addenda to the surveys, have special tables on important agronomic soil interpretations. A few tables may be in the form of a soil's potential for a specified use, such as its potential for cropland. Other tables group soils for specific programs; such as prime or unique farmland, land capability classification, highly erodible lands, and hydric soils.

Hydric soils are wet soils defined as a group for the purpose of implementation of legislation for preserving wetlands and for assessing the potential habitat for wildlife. The soils considered to be hydric were selected on the basis of flooding, water table, and drainage class criteria. Hydric soils developed under wet conditions (anaerobic within 30 cm (12 in.)) and can support the growth and regeneration of hydrophytic vegetation. Indicators we look for in the field to identify hydric soils include organic soils, 40 cm (16 in.) of organic soil material in the upper 80 cm (32 in.); histic epipedon, 20 cm (8 in.) of organic soil material in the upper 40 cm (16 in.); gleyed or low chroma colors, a predominance of gray colors due to wetness; high organic matter in sandy soils; and organic streaking in sandy soils.

You can also identify the soil series and look to see if it is listed on the county hydric soils list. The hydric soils list, developed for the 1982 Farm Bill, is included in the Soil Conservation Service Field Office Technical Guide, Section II. Some map units that have inclusions of soils that meet the hydric soil criteria are added to the field office listing.

Highly erodible soil and potentially highly erodible soil are also listed in Section II of the Soil Conservation Service Field Office Technical Guide. The criteria used to group highly erodible soils were formulated using the Universal Soil Loss Equation and the wind erosion equation. The criteria are in the National Food Security Act Manual. Soil use, including tillage practices, is not a consideration.

Areas defined as highly erodible can be held to an acceptable level of erosion by following approved practices in a conservation plan. Various conservation practices, such as residue management, reseeding to grasses, contour farming, and terraces, are used in conservation planning to reduce soil loss, maintain productivity, and improve water quality.

Prime farmland soils are listed by map unit name in the tables or the "Prime Farmland" section of the soil survey. These soils have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops. Unique farmland is land other than prime farmland that is used for the production of specific high value crops, such as citrus, tree nuts, olives, cranberries, fruit, and vegetables.

SOIL SURVEYS

Like snowflakes, no two soils are exactly the same. Surface as well as below the surface soil features change across landscapes. A grouping of soils having similar properties and similar behavior is called a series. A series generally is named for a town or local landmark. For example, the Elkton series is named for a town in Cecil County, Maryland. More than 17,000 soil series have been named and described in the United States, and more are being defined each year.

In mapping, a soil series is further divided into a phase of a series by properties that are important to soil use, such as surface texture and slope. These phases of soil series, once identified, all have a characteristic behavior. The behavior for that kind of soil and individual phase is applicable no matter where the soil is observed.

One of the main references available to help land users determine the potentials and limitations of soils is a soil survey. Copies of a soil survey for a specific county are available from the Soil Conservation Service office responsible for that county. Reference copies are also available in the county or depository libraries. A soil survey is prepared by soil scientists who determine the properties of soil and predict soil behavior for a host of uses. These predictions, often called soil interpretations, are developed to help users of soils manage the resource.

A soil survey generally contains soils data for one county, parish, or other geographic area, such as a major land resource area. During a soil survey, soil scientists walk over the landscapes, bore holes with soil augers, and examine cross sections of soil profiles. They determine the texture, color, structure, and reaction of the soil and the relationship and thickness of the different soil horizons. Some soils are sampled and tested at soil survey laboratories for certain soil property determinations, such as cation-exchange capacity and bulk density. To be proficient in using soil survey data, a basic understanding of the concepts of soil development and of soil-landscape relationships is imperative.

General soil information

The general soil map is near the back of the soil survey publication. This generalized map of the soils for the soil survey area is color coded to show major soil associations (or groupings) of the major soils. Soils within a soil association may vary greatly in slope, depth, drainage, and other characteristics that affect management. Descriptions of each of the soil associations are near the front of the soil survey report immediately following the short introductions to cultural and natural features of the area. This section is labeled "General soil map units" in the Contents.

The general soil map can be used to compare the suitability of large areas for general land uses. Because of the scale, it is not intended to be used to make management decisions on specific sites. Each color-coded area on the map has a corresponding description. For example, on the general soil map illustrated by figure 9 areas coded 1 and shaded light yellow designate the Lamoni-Shelby soil association. As the name of the unit implies, Lamoni and Shelby soils are the major soils that occupy the landscape in this area. Likewise, the description of association 1 gives general information about this section of the county.

Some soil surveys include three-dimensional drawings depicting the relationships of soils, parent material, and landscape position for the major soils. Figure 10 illustrates the dominant Lamoni and Shelby soils and the minor Colo soils as they occur in association 1. Note the relationship of parent material and landscape positions to the different soils. Please refer to Section II "How is Soil Formed?" and to figure 3 for additional insights on these relationships.

Detailed soil information

To obtain information about a particular plot of land from a soil survey, locate the general area on the "Index to Map Sheets", and select the appropriate map sheet number. The sheets are in numerical order in the soil survey. After selecting the correct sheet, a specific parcel of land is located on the aerial map by using section numbers, roads, streams and drainage- ways, towns, or the imagery on the map sheet. Areas on the aerial photograph are delineated for individual soil map units and each contains a unique map unit symbol.

The symbols on the detailed maps are listed on the back of the "Index to Map Sheets" with the names of each soil they represent. Some soil names include terms for the surface texture, slope range, and erosion. Detailed information can be obtained about each unit by referring to the map unit description or soil interpretive tables. Each unit is easily located by using the Index to Map Units or Summary of Tables in the front of the publication. Both the map unit descriptions and soil survey interpretive tables have information about the soils.

In each map unit description, soil information is given for the common uses. Major limitations or hazards affecting these uses are stated. Also listed are possible alternatives to help overcome each major limitation or hazard.

Areas delineated on the soil maps are not necessarily made up of just one soil, but include smaller areas of similar or different soils. The composition of soils in the map unit is explained in each map unit description.

REFERENCES

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Maryland Envirothon SOILS Exam

Objective: To test students' knowledge and awareness of basic soil science and its application in wise land-use planning and therefore conserving, protecting and enhancing the soil resource base. This is accomplished through a practical hands-on type of exam requiring the ability to make basic soil property observations, apply these observations to make suitability interpretations and the ability to use soil survey reports.

Soils Exam Outline:

Part 1: Soil and Surrounding Features (65 points)

A. Landscape Features (8 pts.)

1. Position (2 pts.)
2. Parent Material (2 pts.)
3. Slope Characteristics (2 pts.)
4. Surface Stoniness or Rockiness (2 pts.)

B. Soil Profile Features (31 pts.)

1. Major Soil Horizons (3 pts.)
2. Topsoil Layer (A-horizon) thickness (2 pts.)
3. Soil Color (2 pts.)
4. Soil Drainage (6 pts.)
5. Soil Depth (4 pts.)
6. Soil Texture (6 pts.)
7. Soil Permeability (2 pts.)
8. Soil Reaction - pH (4 pts.)
9. Soil Erosion (2 pts.)

C. Soil and Site Interpretations (26 pts.)

1. Agricultural Suitability (20 pts.)

a. Major Limiting Factors (3 pts.)

b. Land capability Class (2 pts.)

c. Prime Farmland (2 pts.)

d. Hydric Soil (2 pts.)

e. Potential Future Erosion (2 pts.)

f. Best Management Practices (4 pts.)

g. Nutrient Management (5 pts.)

2. Suitability for Septic tank Absorption Field (2pts.)

3. Suitability for Lawns and Golf Fairways (2 pts.)

4. Suitability for Playgrounds (2 pts.)

Part II. Soil Survey Uses (20 pts.)

Part III. Soil Conservation in Maryland (15 pts.)

Guidance to Soils Exam

Part I. Soil and Surrounding Features - This section pertains to the exposed soil profile and the area to be evaluated as provided by a sign or the pit proctor.

A. Landscape Features

1. Position - requires understanding of kinds of landscape positions and the ability to differentiate in field.

2. Parent Material - requires knowledge of characteristics of 5 major types and ability to differentiate in field. Soil profiles may contain multiple types.

3. Slope Characteristics - requires the ability to use clinometers or Abney levels to determine slope percentage and place in appropriate class based on physiographic province of the State. Guidance to appropriate physiographic province will be provided in training and/or by site proctor.

4. Surface Stoniness or Rockiness - Must be able to recognize stoniness or rock outcrops and assess quantities present to determine significance.

   Very Stony - stones exposed on soil surface that are $\geq$ 10 inches in diameter and are less than 30 feet apart.

   Rock Outcrop - two or more bedrock exposures within 100 feet within designated area to be judged.

B. Soil Profile Features - based on exposed soil profile

1. Major soil horizons - requires knowledge of characteristics of major soil horizon and ability to differentiate in field.

2. Topsoil layer thickness - requires measurement to nearest inch of the A-horizon(s) or of any O horizons plus A-horizon(s) in forested areas.

3. Soil Color - requires assessment of color of both the A-horizon and subsoil and substratum horizons. (Munsell color books may be used in some contests).

4. Soil Drainage - requires ability to recognize gray soil colors attributable to wetness, measure the depth these colors first appear below the surface, place in appropriate depth class and place the profile into its appropriate natural drainage class. (Caution - depth classes to gray due to wetness do not correlate to drainage class which appears to be on same line.)

5. Soil Depth - both effective rooting depth and depth to bedrock must be given. Criteria for both depth classes are given on exam. Effective rooting depth is the same as depth to bedrock unless a fragipan, sustained high water table, or significant layer of coarse gravel or sand (greater than 60% gravel) occurs above bedrock.
   Information sign and/or proctor will provide guidance as to depth to these restrictions.

6. Soil Texture - requires the ability to determine texture by feel on both topsoil and subsoil horizons and place in one of the 5 broad textural groups. Basic textural classes are provided on exam for further guidance. Texture samples may be provided or a depth increment may be designated for extraction of texture samples from the profile.

7. Soil Permeability - is required on both the topsoil and subsoil layers and is primarily dependent upon textural group of each of these layers (on quiz). Textural groups are given on exam correlated to respective permeability rates. (Caution - textural group defines permeability unless the soil contains a fragipan or it is formed in a

limestone or similar parent material where structure is strongly expressed. Soils with fragipans have slow permeability in subsoil regardless of texture and soils developed from limestone have moderate permeability although subsoil texture may be in the "fine" textural group).

8. Soil Reaction - requires the ability to properly use Hellige-Truog or other test kits as demonstrated in training session to determine pH on both topsoil and subsoil layers. More precise information may or may not be provided by proctor for sampling locations. pH should be estimated to the nearest tenth, i.e. 5.7. In most cases, a one to 1 1/2 pH range, bracketing the measured pH, is allowed for full credit.

9. Past Soil Erosion - The appropriate class is determined by measuring the thickness of existing topsoil layer (A-horizon or O horizon plus A-horizon(s) in forested areas) and comparing this measured thickness to the original topsoil thickness given on the information sign. Class criteria are included on the exam.

C. Soil and Site Interpretations - these responses are based on landscape features and soil property decisions made in the preceding subparts A and B.

1. Agriculture Suitability

    a. Major limiting factors - check all that apply based on previous determinations and information provided on the sign pertaining to flooding.

Limiting criteria for each factor are given on the exam.

b. Land Capability Class - while technical criteria for Land Capability Class and subclass as provided in soil survey reports can be quite complex, only the major Land Capability Class is requested based upon criteria listed on the exam. (Caution - carefully heed the meaning of the words, "and" and "or" in these criteria.)

c. Prime Farmland - based on land capability classification as Class I or II from above.

d. Hydric Soil - is included to illustrate relationship between poorly drained soils as identified in question #B.4. and identification as Hydric Soil and possible wetland implications.

e. Potential Future Erosion - is included to emphasize the significance of future erosion potential on the site if cultivated for agricultural purposes or otherwise disturbed in timber harvest operations or in other urban related uses. For this test it is based strictly on slope class determined in question #A.3.

f. Best Management Practices - while there are numerous BMP available for erosion control and water quality improvement this test is linked to identification of needed BMP's that can be tired to measurable soil features or interpretations from previous sections of the test. Criteria are given on the exam.

g. Nutrient Management - requires basic knowledge of types of crops (legumes vs. non-legumes), soil test results and when nutrients as well as lime should be applied. Legume crops such as soybeans, alfalfa and clovers do not require nitrogen. All other crops such as corn, small grains and grasses for hay or pasture require supplemental nitrogen for optimum productivity.

Recommendations are given for the crop indicated on information sheet irrespective of what might actually be growing on the site. Soil tests for Magnesium, phosphorus and potassium will be given on information sheet as VL = Very low, L = Low, M = Medium, H - High or VH = Very high. These nutrients are needed or recommended if the soil test is VL, L or M. The need for lime is dictated by soil reaction or pH of the topsoil layer as determined by the participant in question # B.8. Lime is recommended if the pH or the topsoil layer is less than 6.5.

2. Suitability for Septic Tank Absorption Fields - requires the ability to apply soil features determined from exposed soil profile and site in previous

sections of the exam to arrive at a suitability rating for this use. The most limiting level of any of the four soil properties dictates the overall degree of suitability. Example, if the site were nearly level with bedrock > 72 inches, depth to gray due to wetness in the 40 - 72 inch range and slow permeability, the suitability would be SEVERE.

(Caution - since many soil pits, for safety purposes are seldom excavated to a depth of 72 inches or more, it is presumed that conditions evident at the bottom o the exposed profile, i.e. at 60 inches for example, also represent conditions at >? 72 inches unless specific guidance to the contrary is provided on information sign or by the proctor.)

3. Suitability for Lawns and Golf Fairways - is similar in format to suitability for septic absorption fields except that key soil features are different as are some criteria depth ranges, i.e. depth to gray. This suitability rating also requires the estimation of % rock fragment (gravel) by volume in the surface layer. Representative samples of varying gravel contents should be carefully evaluated during training sessions for reference.

4. Suitability for Playgrounds - is similar to later suitability matrices except soil features and criteria change. Again, soil features determined in earlier portion of exam along with rock fragment content are used to arrive at an overall suitability.

Part II. Soil Survey Use - this portion of exam is provided as guidance to the type of questions to be expected. In most cases, the questions will be the same but responses will change depending upon soil survey area.

Part III. Soil Conservation in Maryland - this portion of the exam consists of general knowledge questions taken from the "Soil Conservation in Maryland" Section of your Maryland Envirothon Soils Study Guide.

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Name ____

Maryland Envirothon SOILS Scorecard

Check the best answer in each question or fill in the blank.

Part I: Soil and Surrounding Features (65 points)

A. Landscape Features. From the site of the Soils Station (where you are standing right now), please answer the following questions: (8 points)

1. Position (2 points)

___Upland
___Upland depression or drainageway
___Terrace
___Floodplain

2. Parent Material (2 points)

___Residual
___Colluvium
___Recent alluvium
___Old alluvium
___Coastal plain sediments

3. Slope Characteristics (2 points)

		Percentages
Class	Coastal Plain	Piedmont/Appalachian
___A - Nearly level	0 - 2	0 - 3
___B - Gently sloping	2 - 5	3 - 8
___C - Strongly sloping	5 - 10	8 - 15
___D - Moderately steep	10 - 15	15 - 25
___E - Steep	15 - 25	25 - 50
___F - Very steep	25+	50+

4. Surface Stoniness or Rockiness (2 points)

___None
___Very stony
___Rock outcrop

B. Soil Profile Features: (31 points)

1. Circle the major soil horizons visible in this profile: (3 points)

O A E B C R

2. How thick is the topsoil layer (A-horizon(s))? (2 points)

________ inches

3. Soil Color: (2 points)

Topsoil (A-horizon)	**Subsoil and Substratum (B&C horizons)**
___Brown or dark brown	___Yellowish brown or red, no gray mottling (wetness)
___Reddish brown	___Yellowish brown or red, some gray mottling (wetness)
___Gray or grayish brown	___Light brown with gray mottling (wetness)
___Black	___Gray, some brown mottling (wetness)

4. Soil Drainage: (6 points)

Depth to gray due to wetness:	**Natural soil drainage class:**
___ 0 - 10 inches	___Excessively well drained
___ 10 - 20 inches	___Well drained
___ 20 - 40 inches	___Moderately well drained
___ 40 - 72 inches	___Somewhat poorly drained
___ More than 72 inches	___Poorly drained

5. Soil Depth: (4 points)

Effective Rooting Depth	Depth to Bedrock	
________	________	Very shallow (less than 10 inches)
________	________	Shallow (10 to 20 inches)
________	________	Moderately deep (20 to 40 inches)
________	________	Deep (40 to 60 inches)
________	________	Very deep (greater than 60 inches)

6. Soil Texture: (6 points)

Topsoil (A-horizon)	Subsoil (B-horizon)	
________	________	Coarse - sand, loamy sand
________	________	Moderately coarse - sandy loam, fine sandy loam
________	________	Medium - loam, silt loam, sandy clay loam
________	________	Moderately fine - silty clay loam, clay loam
________	________	Fine - clay, silty clay, sandy clay

Tie breaker: % Clay in subsoil __________

7. Soil Permeability: (2 points)

Topsoil Subsoil
( )

_______________ Rapid (>6.0 in./hr.)
(Coarse texture)

_______________ Moderately rapid (2.0-6.0 in./hr.)
(Moderately coarse texture)

_______________ Moderate (0.6-2.0 in./hr.)
(Medium texture)

_______________ Moderately slow (0.2-0.6 in./hr.)
(Moderately fine texture)

_______________ Slow (<0.2 in./hr.)
(Fine texture)

8. Soil Reaction - using the pH test kit, give the pH of: (4 points)

Topsoil (A-horizon) ________________________

Subsoil (B-horizon) ________________________

9. Past Soil Erosion (Original topsoil thickness = ___________) (2 points)

_____ Slight (less than 3" of original soil lost)

_____ Moderate (3-8" of original soil lost)

_____ Severe (>8" of original soil lost)

C. Soil and Site Interpretations (26 points)

1. Agricultural Suitability

(a) Major limiting factors (Check all that apply) (3 points)

_____ None
_____ Flooding or ponding (Occasional or Frequent)
_____ Slope (Gently sloping or greater)
_____ Past erosion (Severe)
_____ Effective rooting depth (<40" deep)
_____ Drainage (<40" to gray mottles)
_____ Permeability (Slow or rapid)
_____ Available water capacity (coarse textures)
_____ Stoniness or rockiness (>1%)

(b) Land Capability Class (Check one) (2 points)

_____ I No limiting factors, nearly level
_____ II Gently sloping, or moderately well drained,or moderately deep
_____ III Strongly sloping, or somewhat poorly drained, or shallow
_____ IV Moderately steep, or poorly drained, or occasionally flooded
_____ V Nearly level and stony or rocky, or frequently flooded
_____ VI Moderately steep, or gently sloping through moderately steep and stony or rocky
_____ VII Steep, or very steep with or without stones, or very shallow
_____ VIII Swamp, tidal marsh, coastal beach or rock outcrop

(c) Is this Prime Farmland, i.e. Land Capability Class I or II? (2 points)

_____ Yes _____ No

(d) Is this a Hydric Soil, i.e. poorly drained? (2 points)

_____ Yes _____ No

(e) Potential future erosion if cultivated or disturbed: (2 points)

_____ Slight (nearly level)
_____ Moderate (gently sloping)
_____ Severe (strongly sloping - very steep)

C. Soil and Site Interpretations (Continued)

(f) Best management practice(s) needed at this site (Check all that apply: (4 points)

_____ Drainage (moderately well, somewhat poor or poorly drained)
_____ Irrigation (excessively well drained)
_____ Contour farming (gently sloping)
_____ Contour strip-cropping (strongly sloping or moderately steep)
_____ Grassed waterway (drainageway or swale which conveys concentrated runoff)
_____ No-till farming (gently sloping, strongly sloping or moderately steep)
_____ Permanent vegetation (Land Capability Class V, VI, VII or VIII)
_____ None

(g) Nutrient Management (5 points)

Crop to be grown (from information on sign) = ________________

Soil test results (from information on sign):

Magnesium ________
Phosphorus ________
Potassium ________

Check the following if needed:

_____ Lime (Topsoil pH from question #8)
_____ Nitrogen
_____ Magnesium
_____ Phosphorus
_____ Potassium

2. Suitability for Septic Tank Absorption Fields: (2 points)

	Slope	Depth to Bedrock	Depth to Gray (wetness)	Permeability
___SLIGHT	Nearly level, gently sloping	> 72"	> 72"	Moderately rapid or moderate
___MODERATE	Strongly sloping	40-72"	40-72"	Moderately slow
___SEVERE	Moderately steep to very steep	< 40"	< 40"	Slow or rapid

C. Soil and Site Interpretations (Continued)

3. Suitability for Lawns and Golf Fairways: (2 points)

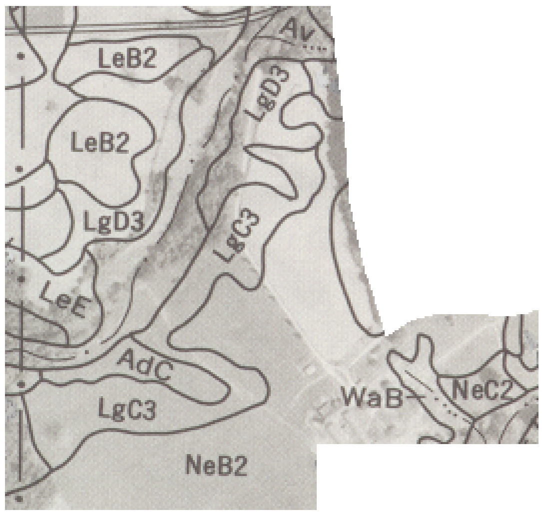
	Surface Soil Texture	Slope	Past Erosion	Surface Rock Fragment	Depth to Gray (wetness)
___SLIGHT	Mod. coarse, medium	Nearly level, gently sloping	Slight	< 15% gravel	> 24"
___MODERATE	Mod. fine, coarse	Strongly sloping	Moderate	15-35% gravel	12-24"
___SEVERE	Fine	Mod. steep, very steep	Severe	> 35% gravel or very stony, rock outcrops	< 12"

4. Suitability for Playgrounds: (2 points)

	Slope	Surface Soil Texture	Surface Rock Fragment	Depth to Gray (wetness)	Depth to Bedrock
___SLIGHT	Nearly level	Mod. coarse, medium, mod. fine	< 15% gravel	> 30"	> 40"
___MODERATE	Gently sloping	- - -	15-35% gravel	18-30"	20-40"
___SEVERE	Strongly sloping to v. steep	Fine, coarse	> 35% gravel or v. stony, rock outcrop	< 18"	< 20"

Part II: Soil Survey Use (20 points)

1. **You have just purchased a piece of property in Harford County. The following is the soils map for the property you just purchased. You would like to build a house on the property as well as do some farming and develop some areas to attract wildlife. Answer the following questions to help you decide where the most appropriate places are to do these things on your property. (A through I totals 12 points)**



A.) You would like to have a basement. What mapping unit is best for houses with basements? (1 point) ***(See table 9.)***

A. Av B. LgC3 C. LeE D. NeB2 E. WaB

B.) The area does not have a public sewer system so you will need a septic system. What mapping unit is best for filter field? (1 point) ***(See table 9.)***

A. AdC B. LeB2 C. LgD3 D. NeB2 E. WaB

C.) Preventing soil erosion is one way of limiting non-point source pollution. What mapping units on your property need protection due to the hazard of erosion? (Circle all that apply)? (3 points) (See mapping unit descriptions.)

A. Av B. LgC3 C. LgD3 D. NeB2 E. WaB

D.) You would like to plant corn. What mapping unit is going to yield the most corn?
(1 point) ***(See table 4.)***

A. AdC   B. LeB2 C. LgC3 D. NeB2 E. NeC2

E.) What is the capability unit of the NeB2 mapping unit? (1 point) ***(Listed in mapping unit description)***

F.) The capability unit of Av mapping unit is VIw-1. What does the VI tell you? What does the VIw tell you? (2 points) ***(See pages 50 and 51.)***

G.) Because of the steep slopes and erosion hazard, you would like to take the LgC3 and LgD3 mapping units out of crop production and plant the area for wildlife habitat. What kind of wildlife habitat are these areas good for? (1 point)
(***See table 6.)***

H.) You thought about donating part of the area mapped as NeC2 to the local government so they can build an playground, however, after checking with the soil survey you decide the area has severe limitations for playground and, therefore, this is not the best use for this land. What factor gives this mapping unit a severe limitation for athletic fields? (1 point) ***(See table 11.)***

I.) What recreational use would the NeC2 map unit be suitable for? (1 point)
(See table 11.)