HYDROGEOLOGIC ATLAS　　BEL AIR QUADRANGLE　　HARFORD COUNTY, MARYLAND

MAP 1. DEPTH TO WATER TABLE

Maryland Geological Survey　　Quadrangle Atlas No. 6

DEPTH TO WATER TABLE

EXPLANATION

This map shows the approximate depth to the zone of saturation (water table). It was prepared using available well and spring records (Nutter and Smigaj, 1975; Dingman and Ferguson, 1956); however, the perennial stream network, as shown on the quadrangle map, supplemented by fairly extensive field reconnaissance, was the principal basis for delineating the area underlain by a shallow water table (0 to 10 ft, or 0 to 3 m). The area underlain by a fairly deep water table (greater than 35 ft or 11 m) was based mainly on well records, consideration of the topographic relief, and the distribution of the area underlain by a shallow water table. Locally, temporary zones of perched water may occur above the main water table in the spring or after periods of heavy precipitation; no attempt was made to delineate such areas of perched-water conditions.

The water table fluctuates seasonally in response to recharge from precipitation and to evaporation and transpiration. The water table is highest during the late winter or early spring; in general, it declines throughout the late spring and summer as a result of decreases in recharge and large increases in use of water by plants. Water infiltrates through the soil, moves laterally after reaching the water table, and is discharged through numerous springs and seeps. The smaller springs, normally located at the heads of small valleys, may flow only during the spring, but many larger springs flow throughout the year. Some springs may go dry during the late summer or during dry years. The seasonal decrease in the flow of springs and in the "fair-weather" flow of streams is caused by the seasonal decline of the water table. The magnitude of water-table fluctuations is greatest under hilltops and least under valleys. On the basis of the above discussion of water-table fluctuations, it is clear that the areas delineated on this map are not static, but will change from season to season and from year to year. This map shows the generalized water-table conditions and is suitable for use on a reconnaissance basis only.

The following hydrograph shows the water-level fluctuations in a typical shallow water-table well in the Maryland Piedmont.

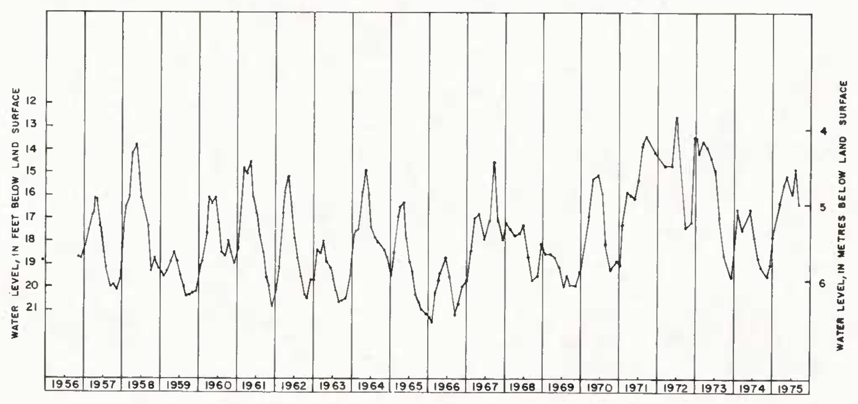


Figure 1.—Hydrograph of a well near Jacksonville, Baltimore County

Ground-water levels also fluctuate in response to withdrawals from wells, but pumping by domestic wells probably does not signficantly affect water levels except in areas in the immediate vicinity of pumped wells. Some lowering of water levels has occurred in the vicinity of the Gatch Quarry south of Churchville due to dewatering for quarry operations.

Approximate depth to water, in feet (meters), below land surface:

0-10 feet (0-3 meters)	10-35 feet (3-11 meters)	Greater than 35 feet (Greater than 11 meters)

Base Map from U.S. Geological Survey, 1956
(photorevised, 1974)

MN　GN
8½°
151 MILS
0°50'
15 MILS

UTM GRID AND 1974 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24000

1　½　0　1 MILE

1000　0　1000　2000　3000　4000　5000　6000　7000 FEET

1　.5　0　1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MARYLAND
QUADRANGLE LOCATION

MAP 2. SLOPE OF THE LAND SURFACE

Maryland Geological Survey

Quadrangle Atlas No. 6

SLOPE OF THE LAND SURFACE

EXPLANATION

Areas on this map shown by solid color identify those areas in the Bel Air quadrangle where the slope exceeds 20 percent, which is the maximum land slope permitted for the installation of domestic septic systems by the Harford County Health Department. This map was prepared by the U.S. Geological Survey, Topographic Division, using a semiautomated photomechanical process, which translates the distance between adjacent contours into slope data. The slope zones on the map are unedited. Proximity of the same contour or absence of adjacent contours may produce false slope information at small tops and depressions, on cuts and fills, in saddles and drains, along shores of open water, and at the edges of the map.

Base Map from U.S. Geological Survey, 1956 (photorevised, 1974)

MN GN 8½° 151 MILS 0°50' 15 MILS

UTM GRID AND 1974 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MARYLAND
QUADRANGLE LOCATION

MAP 3. GROUND-WATER AVAILABILITY

Maryland Geological Survey
Quadrangle Atlas No. 6

GROUND-WATER AVAILABILITY

INTRODUCTION

Ground water in the Bel Air quadrangle occurs primarily in joints, faults, and other fractures in metamorphic-rock aquifers and in the saturated part of the weathered overburden (saprolite); unfractured and unweathered metamorphic rock is virtually impermeable. Wells penetrating rock that contains closely spaced, intersecting fractures will likely yield abundant quantities of water, whereas wells penetrating poorly fractured rock will yield little water. Therefore, the distribution of fractures in the rock is the most important factor governing the availability of water in metamorphic-rock aquifers.

Selecting sites where wells are likely to intersect fractures is difficult. Probably the most effective method of determining the ground-water availability at specific sites involves a detailed analysis of the topography and the mapping of straight stream reaches or other linear features on aerial photographs. The orientation of many valleys, draws, and stream channels seems to be controlled by joints and faults. For example, it was found by statistical analysis of well data (Nutter and Otton, 1969) that the average yield of wells in valleys is substantially more than the average yield of wells on hilltops, apparently because wells drilled in valleys are more likely to intersect fractures than wells drilled on hilltops or slopes. Although analysis of the topography and mapping of linear features on aerial photographs are probably the most useful methods for selecting specific well sites, these methods do not readily lend themselves to regional mapping of ground-water availability.

A map based on contrast in the water-bearing properties between principal geologic formations provides a useful way of showing generalized ground-water availability. Accordingly, the rocks in the quadrangle are subdivided into three hydrogeologic units based on differences in water-bearing properties, as indicated by available well records. The variability of well yields and specific capacities within each hydrogeologic unit is substantial; nevertheless, there seems to be a valid basis for subdividing the rocks into three generalized hydrogeologic units.

SELECTION OF UNITS

Figure 1 shows cumulative frequency graphs of specific capacities of wells penetrating the principal metamorphic-rock aquifers in the Bel Air quadrangle. Graphs of the minor aquifers are omitted because of insufficient well data and to avoid cluttering the illustration.

The Baltimore Gabbro (as used in Southwick and Owens, 1968) is clearly the most productive aquifer shown in figure 1 based on the position of its graph with respect to the graphs of the other aquifers; the Cockeysville Marble and the upper pelitic schist of the Wissahickon Formation, which do not occur in the Bel Air quadrangle, are the only metamorphic-rock aquifers in Harford County with higher average yields and specific capacities.

The lower pelitic schist of the Wissahickon Formation is the least productive aquifer based on the position of the graphs in figure 1. The ultramafic rocks (chiefly serpentinite) and the James Run Gneiss are also included in this hydrogeologic unit.

The boulder gneiss of the Wissahickon Formation, the muscovite quartz monzonite gneiss, the Port Deposit Gneiss, and the metagabbro and amphibolite are placed in an intermediate hydrogeologic unit.

These three hydrogeologic units are listed in the following explanation along with the corresponding symbols used on the maps and some pertinent data.

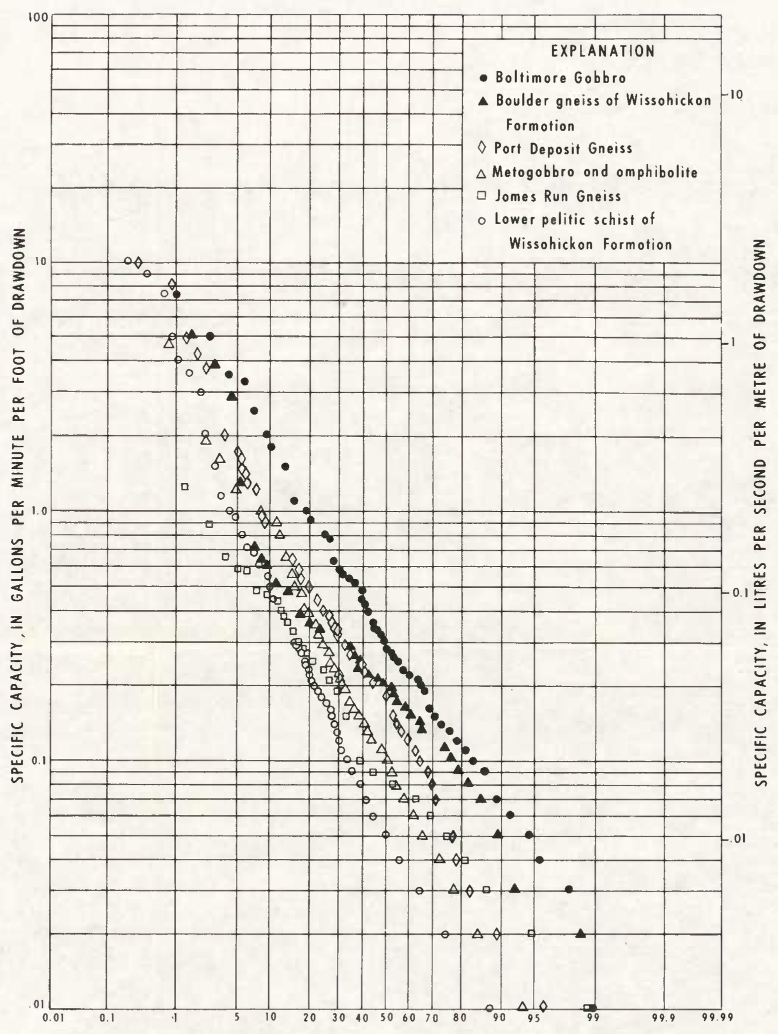


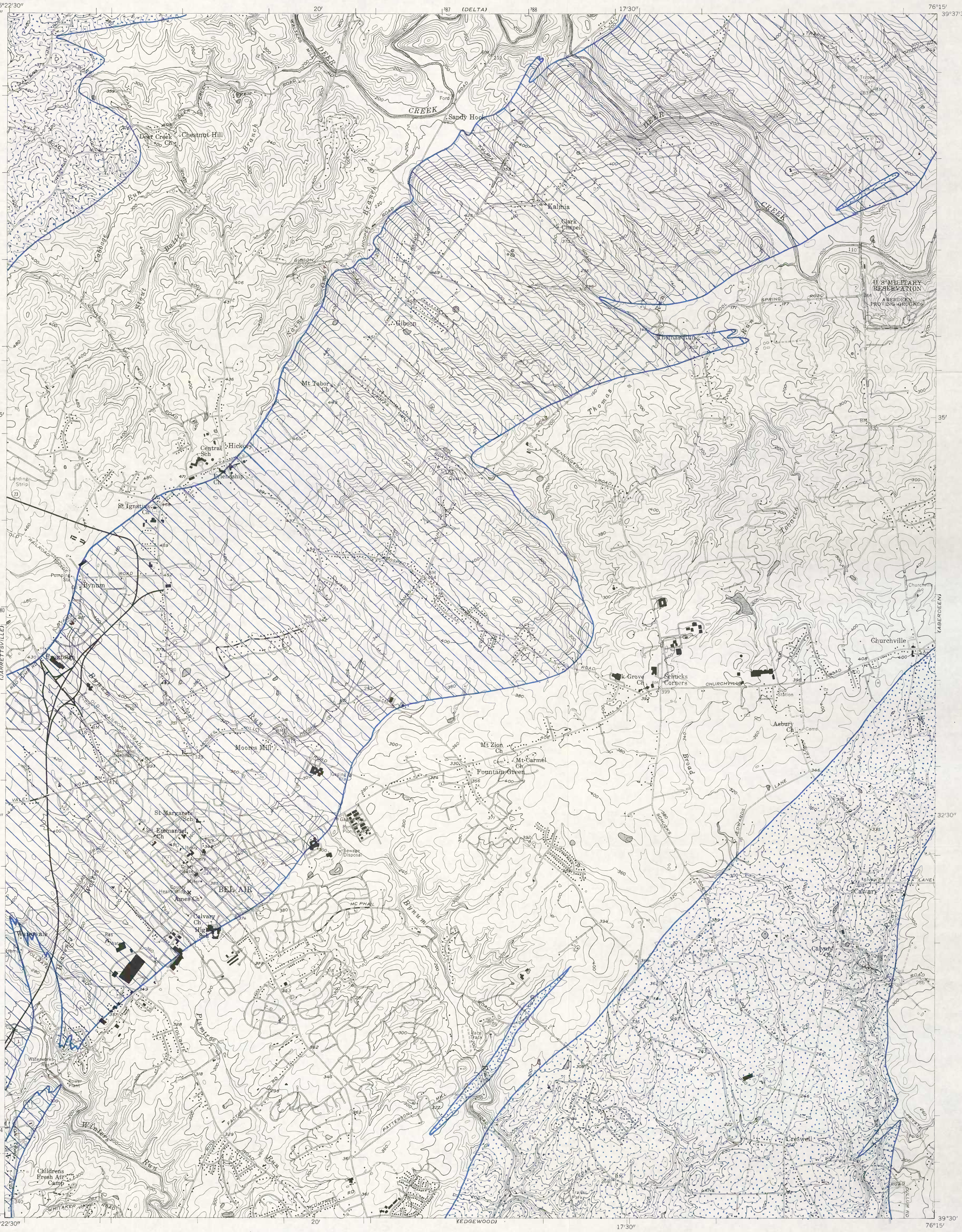
Figure 1.—Cumulative frequency graph of specific capacities of wells penetrating the principal metamorphic-rock aquifers.

EXPLANATION

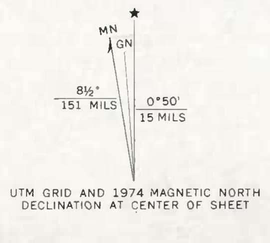
HYDROGEOLOGIC UNIT 1. This unit includes the Baltimore Gabbro, median specific capacity 0.31 (gal/min)/ft. Well yields in this unit range from 2 to 65 gal/min and average 13 gal/min and average 13 gal/min (95 wells).

HYDROGEOLOGIC UNIT 2. This unit includes the boulder gneiss of the Wissahickon Formation (67 wells), median specific capacity 0.20 (gal/min)/ft; the muscovite quartz monzonite gneiss (5 wells), median specific capacity 0.26 (gal/min)/ft; the Port Deposit Gneiss (202 wells), median specific capacity 0.19 (gal/min)/ft; and the metagabbro and amphibolite (121 wells), median specific capacity 0.11 (gal/min)/ft. Well yields in this unit range from 1 to 125 gal/min and average 12 gal/min (395 wells).

HYDROGEOLOGIC UNIT 3. This unit includes the lower pelitic schist of the Wissahickon Formation (230 wells), median specific capacity 0.05 (gal/min)/ft; the ultramafic rocks (18 wells), median specific capacity 0.10 (gal/min)/ft; and the James Run Gneiss (76 wells), median specific capacity 0.08 (gal/min)/ft. Well yields in this unit range from less than 1 to 100 gal/min and average 8 gal/min (324 wells).



Base Map from U.S. Geological Survey, 1956 (photorevised, 1974)



UTM GRID AND 1974 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

MAP 4. CONSTRAINTS TO INSTALLATION OF SEPTIC SYSTEMS

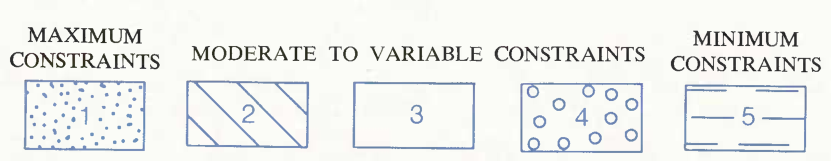
Maryland Geological Survey Quadrangle Atlas No. 6

CONSTRAINTS TO INSTALLATION OF SEPTIC SYSTEMS

SELECTION OF UNITS

For the purpose of evaluating the degree of constraint to the disposal of liquid wastes, such as domestic septic-tank effluent, the Bel Air quadrangle was divided into five units based on land slope, depth to the water table, the presence of thin soil and subsoil (saprolite), and differences in infiltration rates in the saprolite. These units were selected in a manner similar to the methods developed by Otton and others (1975).

The following diagram shows the relationship between the five units selected with regard to the relative constraint to the disposal of liquid wastes.



FACTORS CONSIDERED IN SELECTION OF UNITS

The following factors were considered in selection of the units mapped:

1. Land slopes were obtained from a slope map prepared by the U.S. Geological Survey (map 2). Harford County Health Department regulations as of 1975 prohibit the installation of septic systems where the land slope exceeds 20 percent. Steep slopes are considered to be a major cause of failure of underground sewage-disposal systems (U.S. Public Health Service, 1967, p. 18; U.S. Department of Agriculture, 1971, p. 8).

2. The depth to the water table is a major constraint to the construction of liquid waste-disposal systems. Areas where the depth to the water table is less than 10 ft (3 m) have a fairly high risk of failure of the system, and the potential for pollution of the ground-water supply is greater in areas of shallow water table than where the water table is fairly deep. A depth of 10 ft (3 m) was chosen because (a) the recommended depth to the tile field is 3 ft (0.9 m) (U.S. Department of Agriculture, 1971; (b) a minimum distance of 4 ft (1.2 m) between the tile field and the water table is recommended (U.S. Public Health Service, 1967); and (c) a 3-ft (0.9-m) additional depth is suggested to allow for seasonal fluctuation of the water table.

3. Saprolite infiltration rates are another major factor constraining the installation of liquid-waste disposal systems. Where the saprolite has low permeability, it may not accept the effluent produced by a normal household, and the system may fail; where the saprolite is extremely permeable, the effluent may not be adequately renovated. Infiltration rates were determined principally on the basis of percolation-test data collected by Harford County sanitarians under standardized procedures established by the Maryland Department of Health.[1]

In addition to the three factors listed above, two additional factors constrain the installation of liquid-waste disposal systems—flood-prone areas and areas having thin saprolite. However, these factors were not directly considered in preparing this map because in the Bel Air quadrangle, the flood-prone areas lie entirely within the areas having shallow water table (map 1), and areas having thin saprolite nearly always lie within the areas having steep slopes (map 2).

[1] The percolation test conducted in Harford County is performed as follows: a 2- or 3-ft (0.6- or 0.9-m)-wide short trench or pit is dug to the depth to be tested and a 1-ft (0.3-m)-deep hole is hand-dug on the floor of the trench. The hand-dug hole is filled with water, and the time required for the water to drop the second inch of a 2-in (51-mm) decline is measured. The test is rated "passing" if the time required to drop the second inch is between 1 and 30 minutes.

EXPLANATION

UNIT 1 includes areas where the depth to the permanent water table ranges from 0 to 10 ft (0 to 3 m) (map 1) and areas where the land slope exceeds 20 percent (map 2). This unit includes valley areas subject to periodic flooding and most of the areas having thin saprolite.

Few percolation tests have been run in unit 1 because it is seldom considered for building sites.

UNIT 2 includes areas underlain by crystalline mafic rock that characteristically develops fairly impermeable clayey saprolite. In addition, some of the areas underlain by serpentinite in the northeastern part of the quadrangle have fairly thin saprolite. The geologic units that underlie unit 1 include the Baltimore Gabbro, ultramafic rocks, and ultramafic and gabbroic rocks (Southwick and Owens, 1968).

Percolation-test data from unit 2 show a fairly high incidence of failures, and the average percolation rate is greater than 12 min/in (4.7 min/cm).

UNIT 3 includes areas underlain mostly by gneissic metamorphic rocks having moderately to variably permeable saprolite. The geologic units underlying unit 3 include the boulder gneiss of the Wissahickon Formation, the muscovite quartz monzonite gneiss, and the Port Deposit Gneiss (Southwick and Owens, 1968).

The average percolation rate for the formations that comprise unit 3 ranges between 6 and 12 min/in (2.4 and 4.7 min/cm), and the incidence of failures is fairly low.

UNIT 4 includes areas underlain by upland gravel deposits having widely variable permeability. The upland gravel deposits tend to be fairly permeable (average percolation rate about 6 min/in), but in some areas the gravel contains substantial silt and clay, and the incidence of failures exceeds that of unit 5. Relatively few percolation-test data were available from this unit.

UNIT 5 includes areas underlain by schistose metamorphic rocks having moderately permeable saprolite. Unit 5 is underlain entirely by the lower pelitic schist of the Wissahickon Formation in the Bel Air quadrangle (Southwick and Owens, 1968).

The average percolation rate for unit 5 is less than 6 min/in (2.4 min/cm) and the incidence of failures is low.

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

QUADRANGLE ATLAS NO. 6
BEL AIR QUADRANGLE
HYDROGEOLOGY

By

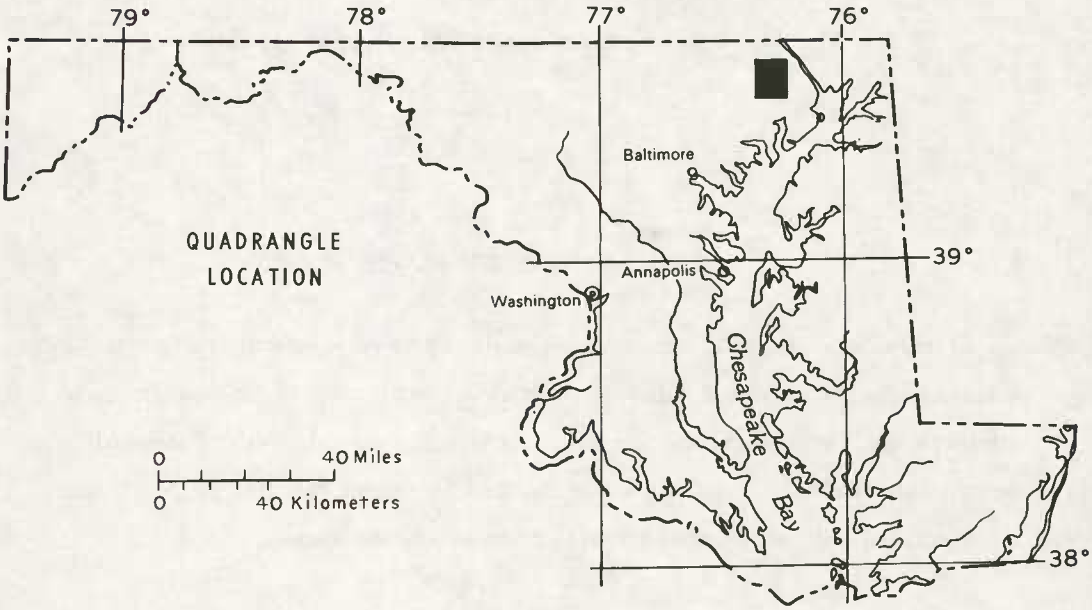
Larry J. Nutter

U.S. Geological Survey

INTRODUCTION

This atlas describes the hydrogeology of the Bel Air 7½-minute quadrangle, in central Harford County, Maryland. It is intended for use by planners, health officials, consulting engineers, developers, and the general public who are concerned with potential environmental problems and land-use planning.

The land use in much of the quadrangle is agricultural and woodland, but fairly extensive suburban areas have developed, especially around Bel Air, the county seat of Harford County.



GEOLOGY

The Bel Air quadrangle lies within the Piedmont physiographic province. It is underlain by metamorphosed sedimentary and igneous rocks. The reader is referred to Southwick (1969) for a detailed description of the geology.

The crystalline rocks of the quadrangle are mantled by soil and weathered rock (saprolite) that vary in thickness, depending on the topographic position and the type of rock (Otton and others, 1975). In some places the saprolite is thin or absent, and in other places it is more than 50 feet (16 meters) thick; it tends to be thin beneath steep slopes and thick beneath many broad upland areas.

MAPS INCLUDED IN THE ATLAS

The information presented in this atlas is in the form of four numbered maps on a standard topographic quadrangle base. The titles of the maps are as follows:

Map 1. Depth to water table.
Map 2. Slope of the land surface.
Map 3. Ground-water availability.
Map 4. Constraints on installation of septic systems.

LIMITATIONS OF MAPS

The maps in this atlas are based on some degree of judgment and interpretation; in many places, where data were restricted, construction of the maps required interpolation. The boundaries shown on these maps should not be construed as being final. The maps are designed to be used for broad planning purposes, and more detailed data are needed for evaluation of specific sites.

CONVERSION OF MEASUREMENT UNITS

English Unit	*Multiply By*	*Metric Unit*
inches (in)	25.4	millimeters (mm)
feet (ft)	.305	meters (m)
miles (mi)	1.609	kilometers (km)
gallons (gal)	3.785	liters (l)
gallons per minute (gal/min)	.0631	liters per second (l/s)
gallons per day (gal/d)	.0438	cubic meters per second (m^3/s)

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[1] The name of this agency was changed to the Maryland Geological Survey in June 1964.

Department of Natural Resources

MARYLAND GEOLOGICAL SURVEY

Kenneth N. Weaver, Director

QUADRANGLE ATLAS NO. 6

BEL AIR QUADRANGLE HYDROGEOLOGY

By

Larry J. Nutter

1977

Prepared in cooperation with
the Geological Survey
United States Department of the Interior
and the
Harford County Department of Planning and Zoning