Maryland Geological Survey
Quadrangle Atlas No. 26

MAP 1. SLOPE OF THE LAND SURFACE

EXPLANATION

This map shows the slope of the land surface of the Clarksville quadrangle and the Howard County portion of the Sandy Spring quadrangle. The slopes are grouped into five categories. The map was prepared using ARC-INFO, a Geographic Information System product of Environmental Systems Research Institute, Inc. (trade names are used here for information only) and Digital Elevation Models (DEM) of the Clarksville and Sandy Spring 7.5-minute quadrangles obtained from the U.S. Geological Survey. The DEM consists of elevation data arranged in a square grid having a 30-meter (approximately 98 feet) spacing. The square grid results in a checkerboard or jagged appearance when detailed areas are examined; the smallest area shown is about one-quarter acre.

Base from U.S. Geological Survey, 1957 (Clarksville Quadrangle), photorevised 1979; and 1945 (Sandy Spring Quadrangle), photorevised 1979; scale 1:24,000.

UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

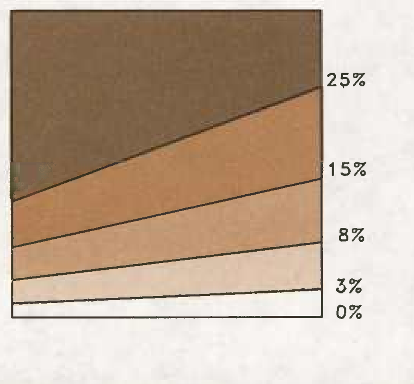
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

1993

Prepared in cooperation with the
Howard County Department of Public Works

MARYLAND
QUADRANGLE LOCATION

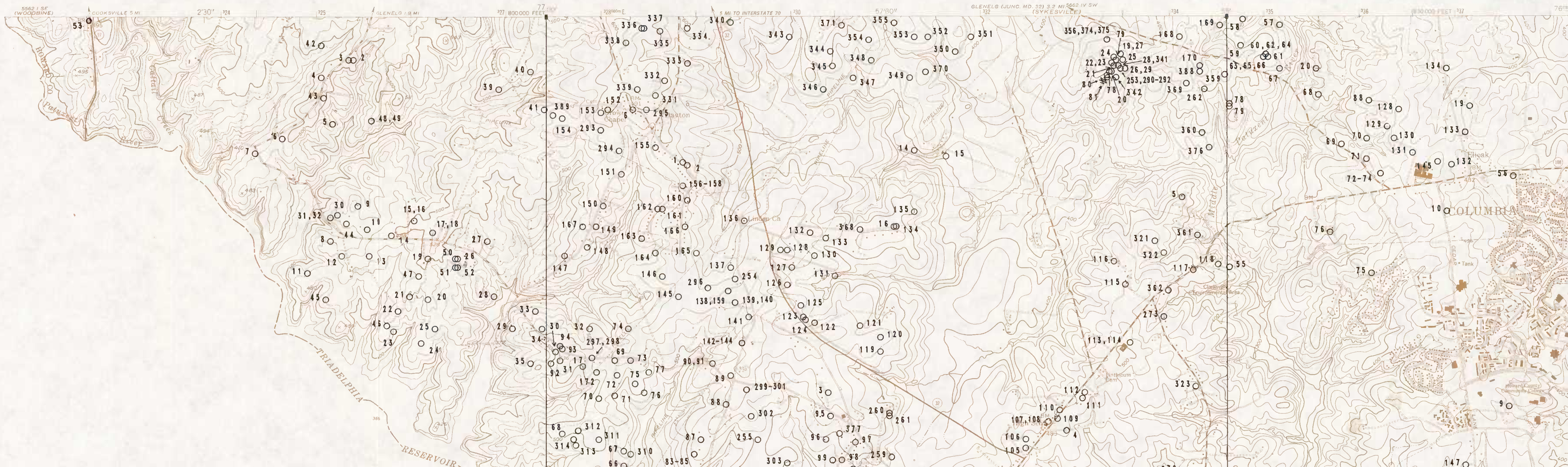
Prepared by **Daft-McCune-Walker, Inc.**, Towson, Maryland using Digital Elevation Models produced by the United States Geological Survey.



MAP 2. LOCATIONS OF WELLS AND SPRINGS

Maryland Geological Survey

Quadrangle Atlas No. 26



LOCATIONS OF WELLS AND SPRINGS

By Michael D. Tompkins and Mark T. Duigon

The wells and springs shown on this map have been visited as they were inventoried. Records of wells and springs inventoried in Howard County over the years were recently compiled and placed into a computer data base (Dine, et al., 1992). One additional well in the northwestern corner of the mapped area was inventoried and data describing it are tabulated herein. The data base, known as the Ground-Water Site Inventory (GWSI) is operated by the U.S. Geological Survey and is part of a national hydrologic data base, the National Water Data Storage and Retrieval System (WATSTORE). Within WATSTORE, site-location, water-quality, and daily water-level-measurement data are related and indexed.

The State of Maryland has required a permit for drilling water wells since 1945. The permit requires that the driller furnish construction and yield information for each well completed. Wells drilled since 1973 have attached metal tags stamped with the permit numbers, which facilitates matching up completion reports and wells. These numbers are included in the well tables.

Wells and springs are identified using a State-wide numbering system. The first pair of letters of an identifying number is the county abbreviation. A grid is superimposed on each county, with a 5-minute by 5-minute spacing based on latitude and longitude. The second pair of letters in the identifier refers to the 5-minute quadrangle in which the well or spring is located; the first of these, upper-case, identifies the tier (with A being northernmost) and the second identifies the column (with a being westernmost). The remaining numbers are the sequential numbers assigned to sites in that quadrangle. Thus, for example, well HO Ce 38 is the 38th site inventoried in the second tier from the north, fourth column from the west, in Howard County.

REFERENCE

Dine, J.R., Adamski, J.C., and Tompkins, M.D., 1992, Hydrologic data for Howard County, Maryland: Maryland Geological Survey, Basic Data Report No. 19, 240 p.

EXPLANATION

27 ○ Water well and number

28 ⊕ Spring and number

SUPPLEMENTAL RECORDS OF WELLS IN THE CLARKSVILLE-SANDY SPRING QUADRANGLES

Well number	Well permit number	Owner	Driller	Date of construction	Altitude of land surface (ft)	Topo-graphic setting	Depth drilled (ft)	Use of water	Geologic unit	Casing: Depth (ft)	Casing: Diameter (in)	Fin-ish	Water level (ft)	Data measured	Pumping test: Yield (gpm)	Pumping test: Drawdown (ft)	Pumping test: Specific capacity (gpm/ft)	Pumping test: Hours pumped	Pumping test: Data	Well number
HO Cc 53	HO-73-2466	Madden, John	L F Easterday	02-16-1978	495	H	80	H	300SKVL	21	6	X	__	02-16-1978	40	__	__	3	02-16-1978	HO Cc 53

EXPLANATION OF CODES

Topographic setting	Use of water	Geologic unit	Finish
H Hilltop	H Domestic	300SKVL Sykesville Formation	X Open hole

Base from U.S. Geological Survey, 1957 (Clarksville Quadrangle), photorevised 1979; and 1945 (Sandy Spring Quadrangle), photorevised 1979; scale 1:24,000.

UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MARYLAND
QUADRANGLE LOCATION

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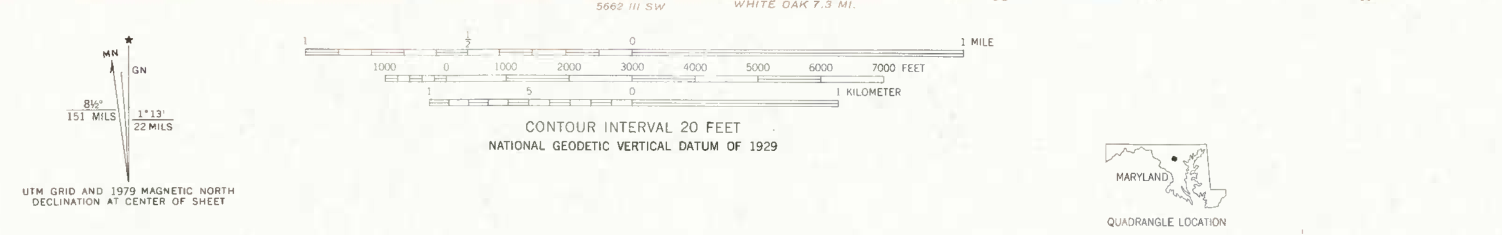
Maryland Geological Survey

MAP 3. DEPTH TO THE WATER TABLE

Quadrangle Atlas No. 26

Base from U.S. Geological Survey, 1957 (Clarksville Quadrangle), photorevised 1979; and 1945 (Sandy Spring Quadrangle), photorevised 1979; scale 1:24,000.



CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

DEPTH TO THE WATER TABLE

By Mark T. Duigon

EXPLANATION

This map shows the depth from land surface to the water table. It is generalized, showing three depth zones where the water table, on average, may be encountered. Water-level data were obtained mostly from completion reports submitted by drillers and were supplemented by soil survey information (Matthews and Hershberger, 1968), topographic analysis, and observation of springs, swamps, and other natural features. Water-level data from completion reports and from monitoring programs have been compiled by Dine *et al.* (1992). Static water levels (not affected by pumping) reported by drillers for 674 wells in the area shown on this map range from 1 ft to 245 ft below land surface; the median water level is 35 ft (fig. 1).

The reported levels from which figure 1 was derived are from one-time measurements. However, ground-water levels fluctuate seasonally and, to a lesser magnitude, over longer periods (fig. 2) in response to climatic variations. Analysis of water-level data from observation wells in Howard County revealed that extreme water levels occurred most commonly during January (lowest levels) and May—June (highest levels) (fig. 3). Consequently, water levels measured during these months were excluded from the set used to construct this map.

The water table is the surface of the zone of saturation where ground water is not confined by an overlying impermeable zone. This surface has a configuration similar to that of the land surface, although its relief is less. Because of this similarity, the shallowest zone shown on the map generally follows the drainage network and the deepest zone generally occurs beneath hills and interfluves. The water level in well HO Cd 26, shown in figure 2, is about 2 feet deeper than that in well HO Cd 29, even though the wells are close to each other and within about half a foot in altitude. The difference is a consequence of downward flow: HO Cd 29 is open in the interval 63 to 68 ft, whereas HO Cd 26 is open in the interval 106 to 150 ft.

Certain soils contain low-permeability horizons that can impede the downward percolation of water (such as rainfall infiltrating during a storm), thereby allowing an additional zone of saturation to grow, perched above the impermeable zone. These perched zones are generally temporary, shallow, and of limited extent and are not indicated on this map. Local areas where the water table is temporarily depressed because of pumping are likewise not indicated.

REFERENCES

Dine, J. R., Adamski, J. C., and Tompkins, M. D., 1992, Hydrologic data for Howard County, Maryland: Maryland Geological Survey, Basic Data Report No. 19, 240 p.

Matthews, E.D., and Hershberger, M.F., 1968, Soil survey of Howard County, Maryland: U.S. Department of Agriculture, Soil Conservation Service, 104 p.

U.S. National Oceanic and Atmospheric Administration, 1970-90, Climatological data annual summary (published annually).

APPROXIMATE DEPTH TO WATER TABLE FEET BELOW LAND SURFACE

Less than 10 feet — 10 to 35 feet — Greater than 35 feet

HO Dd 25 ○ Observation well and number

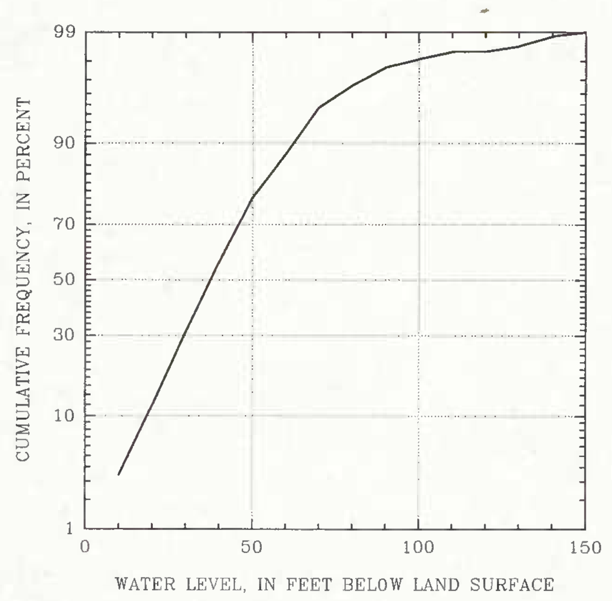


Figure 1.—Cumulative frequency curve of water levels measured in 674 wells in map area.

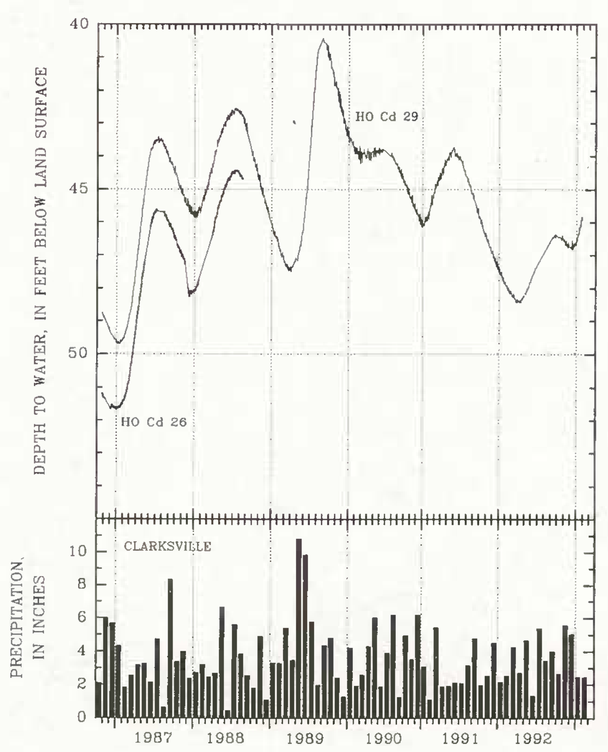


Figure 2.—Water-level fluctuations in adjacent wells during the period October, 1986-January, 1993, and October, 1986-August, 1988. HO Cd 29 is open over the interval 63—68 ft, and HO Cd 26 is open over the interval 106—150 ft. Precipitation data at Clarksville from U.S. National Oceanic and Atmospheric Administration.

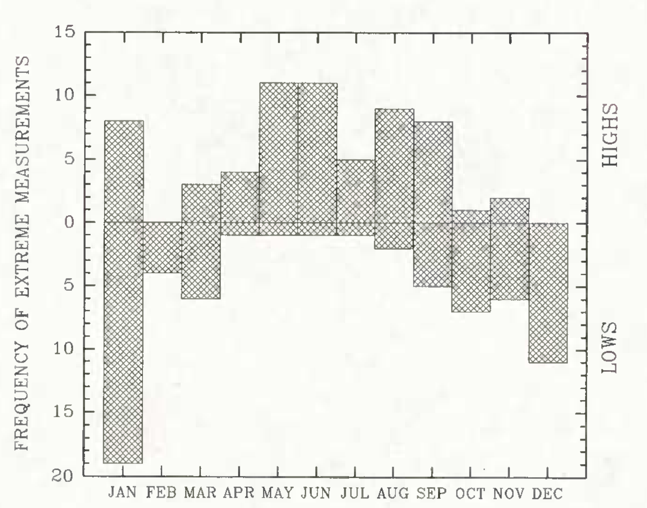


Figure 3.—Monthly distribution of extreme water-level measurements at Howard County observation wells.

1994

Prepared in cooperation with the Howard County Department of Public Works

MAP 4. AVAILABILITY OF GROUND WATER

Maryland Geological Survey
Quadrangle Atlas No. 26

AVAILABILITY OF GROUND WATER

By Mark T. Duigon

INTRODUCTION

Ground water in the Piedmont physiographic province occupies and moves through rock fractures. These fractures are not uniformly distributed throughout the rocks, and individual water-bearing fractures cannot be detected without drilling. Consequently, well yields in this region are highly variable across short distances and cannot be predicted with much certainty. The extent of fracturing varies somewhat among geologic formations owing to lithologic differences and differences in the stresses to which they have been subjected, and this allows them to be assigned to three geohydrologic units based on well-yield and construction data (fig. 1). This map was developed from a statistical analysis (multiway analysis of variance) of specific-capacity data with wells grouped by geologic unit and topographic setting. (Topographic setting was not a significant factor affecting specific capacity.) The geologic units are those of Edwards (1993, written communication).

Domestic water demand is typically 50 to 75 gallons per day per resident of single-family homes (Whitsell, 1982, p. 15), but minimum acceptable well yield is specified by the State. Most domestic well sites are chosen to meet regulations dealing with property lines, septic systems, and structures, as well as for convenience. If greater yields are required, more consideration should be given to site selection and well construction and development. Location of fracture traces (linear zones of concentrated rock fractures), which can be seen on aerial photographs, is a suitable technique for well site selection in fractured-rock terrane. Fractures may also be more numerous beneath stream valleys and upland draws, making these sites more favorable than hilltop sites.

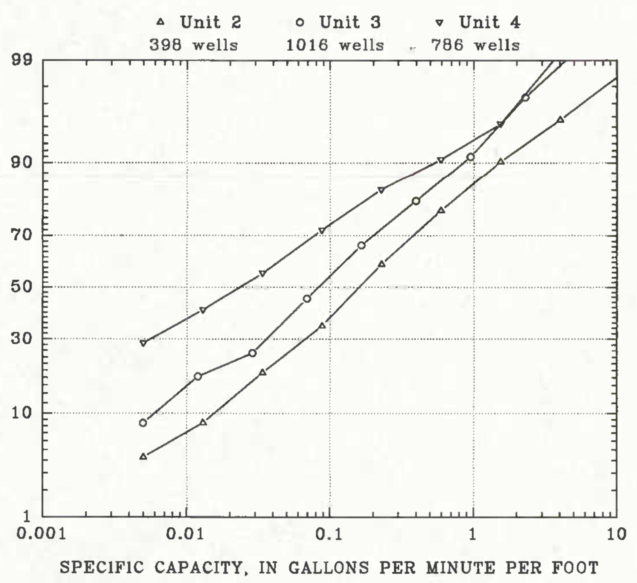


Figure 1.—Cumulative-frequency distributions of specific capacities of wells in the three geohydrologic units.

EXPLANATION

○ Well having reported yield less than 2 gallons per minute

● Well having reported yield greater than 15 gallons per minute

GEOHYDROLOGIC UNIT 1, not present in the Clarksville-Sandy Spring area, is underlain by Coastal Plain sediments and is located elsewhere in Maryland.

GEOHYDROLOGIC UNIT 2: Geohydrologic Unit 2 comprises areas underlain by the Sykesville Formation, a fine- to medium-grained gneiss or fels, and the Cockeysville Formation, a marble interlayered with calc-schist. Reported yields of 67 wells in the Clarksville and the Howard County portion of the Sandy Spring quadrangles range from 0 ("dry hole") to 75 gallons per minute, with a median yield of 7 gallons per minute. Mean yield is 11.3 gallons per minute. The distribution of well yields among four yield classes related to adequacy for various uses is shown in figure 2. Specific capacities of 60 wells range from 0.000 to 3.75 gallons per minute per foot of drawdown, with a median of 0.08 (gal/min)/ft. Mean specific capacity is 0.302 (gal/min)/ft. Well depths range from 35 to 400 feet for 70 wells, with a median of 165 ft and a mean of 177.3 ft. Water levels measured in 68 wells range from 4 to 84 ft below land surface, with a median of 40 ft and a mean of 37.9 ft.

Wells drilled in Geohydrologic Unit 2 will be adequate for domestic use in most cases, and in many cases can meet the needs of limited commercial, municipal, and industrial uses.

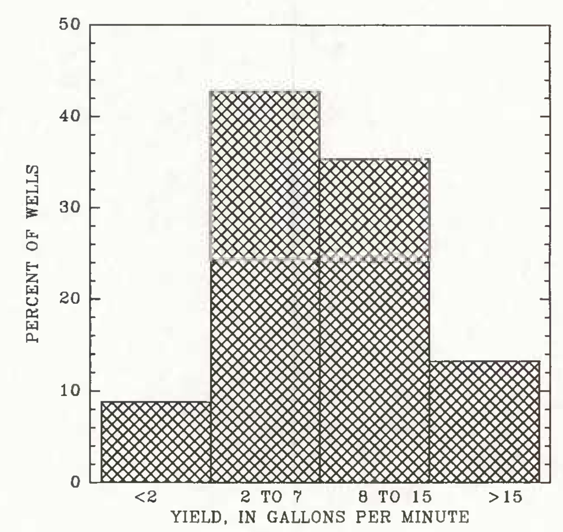


Figure 2.—Distribution of well yields, Geohydrologic Unit 2 (68 wells).

GEOHYDROLOGIC UNIT 3: In the Clarksville and Sandy Spring quadrangles this unit includes areas underlain by the Baltimore Gneiss (gneiss and fels), Morgan Run Formation (fine- to medium-grained schist with some separately mapped layers or pods of mafic and ultramafic rocks), Setters Formation (quartzite, gneiss, and schist), Guilford Granite (fine- to medium-grained granite), and coarse- to very coarse-grained pegmatite. Geohydrologic Unit 3 also includes areas underlain by the Oella Formation where that formation has been injected by pegmatite and/or granite at a scale too small to map the intrusive bodies separably. Reported yields of 253 wells in the mapped area range from 0 to 100 gal/min; the median is 6 gal/min and the mean is 8.7 gal/min. Specific capacities of 226 wells range from 0.000 to 6 (gal/min)/ft, with a median of 0.06 (gal/min)/ft and a mean of 0.312 (gal/min)/ft. Depths of 266 wells range from 26.5 to 600 ft. Median well depth is 200 ft and mean depth is 215.7 ft. Water levels measured in 245 wells range from 1 to 185 ft below land surface, with a median of 31 ft and a mean of 35.2 ft.

About 6 percent of the wells in Geohydrologic Unit 3 were dry holes, and about 13 percent yield less than 2 gal/min (fig. 3). Household demands can generally be met, as can some other uses if the demand is not very high.

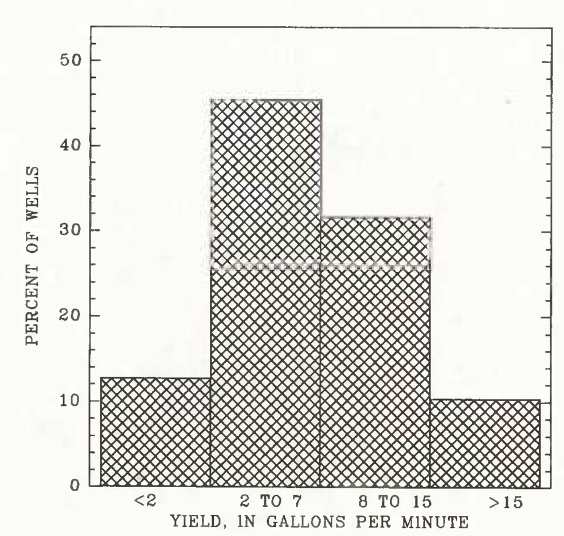


Figure 3.—Distribution of well yields, Geohydrologic Unit 3 (253 wells).

GEOHYDROLOGIC UNIT 4: Geohydrologic Unit 4 is underlain by the Loch Raven and Oella Formations, which consist mostly of medium-grained schist with some gneiss and minor quartzite. In much of this area they are interlayered and not mapped separately, hence they are considered together as one unit. Reported yields of 352 wells range from 0 to 100 gal/min, and have a median yield of 3 gal/min and a mean yield of 5.8 gal/min. Specific capacities of 331 wells range from 0.000 to 50 (gal/min)/ft, with a median of 0.02 (gal/min)/ft and a mean of 0.324 (gal/min)/ft. Depths of 366 wells range from 22 to 600 ft, with a median of 240 ft and a mean of 238.4 ft. Water levels measured in 306 wells range from 5 to 245 ft below land surface. Median water level is 40 ft and mean water level is 42.0 ft below land surface. Obtaining an adequate well yield in this unit can be a serious problem (fig. 4).

About 18 percent of the wells were dry holes, and 32 percent yield less than 2 gal/min. The chances of obtaining a yield sufficient for municipal or certain industrial or commercial uses are fairly low; only about 5 percent of the inventoried wells yield more than 15 gal/min.

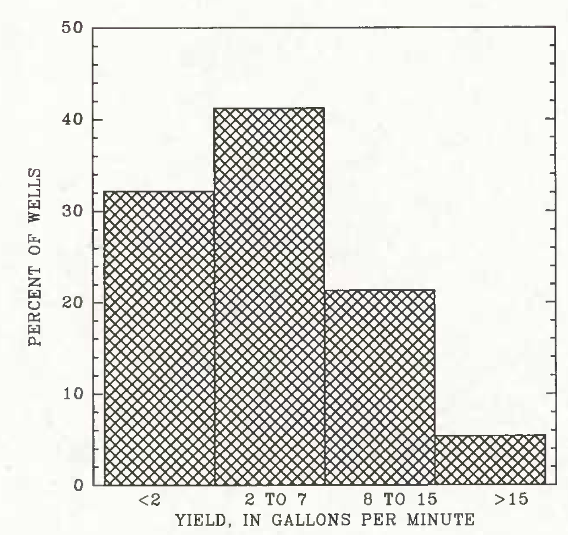


Figure 4.—Distribution of well yields, Geohydrologic Unit 4 (352 wells).

SUMMARY

Reported yields of 677 wells in the Clarksville and the Howard County portion of the Sandy Spring quadrangles range from 0 to 100 gal/min, with a median of 5 gal/min. Mean yield is 7.5 gal/min. Nearly 12 percent of the wells inventoried in the map area were dry holes, and about 22 percent yield less than 2 gal/min. Approximately 8 percent of the wells yield more than 15 gal/min. Specific capacities of 622 wells range from 0.000 to 50 (gal/min)/ft, have a median of 0.04 (gal/min)/ft and a mean of 0.330 (gal/min)/ft. Depths of 715 wells range from 17.6 to 600 ft, with a median of 200 ft and a mean of 221.2 ft. Water levels measured in 632 wells range from 1 to 245 ft below land surface, with a median of 35 ft and a mean of 38.6 ft.

REFERENCE

Whitsell, W.J. (Committee Chairman), 1982, Manual of individual water supply systems: U.S. Environmental Protection Agency, EPA-570/9-82-004, 155 p.

Base from U.S. Geological Survey, 1957 (Clarksville Quadrangle), photorevised 1979; and 1945 (Sandy Spring Quadrangle), photorevised 1979; scale 1:24,000.

UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

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1994

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Howard County Department of Public Works

GROUND-WATER QUALITY

By Mark T. Duigon

INTRODUCTION

Ground-water quality data for Howard County were compiled by Dine, Adamski, and Tompkins (1992) and discussed by Dine, Adamski, and Duigon (1995). Additionally, 11 wells and 2 springs located in a cluster in the northern part of the Clarksville quadrangle were sampled periodically for several years as part of an investigation of nitrogen transport (McFarland, 1989). Geographic variation of basic ground-water chemistry in the mapped area is shown on this map using Stiff diagrams (Stiff, 1951). For sites sampled more than once, median values are shown. Diagrams are provided for four stream-sampling stations, which are included because samples were collected under base-flow conditions (when all of the streamflow consisted of ground-water discharge) and the quality is indicative of ground water in the basin. Ground-water chemistry varies considerably and non-systematically in the mapped area. The diagram shapes are not indicative of the geologic units from which the samples were obtained; some of the variation may be due to the mineralogy of the aquifer, but anthropogenic sources likely affect the chemistry of some of the samples. Chloride has the greatest variation among the major ions (fig. 1). Sewage effluent, from treatment plants or from septic systems, and other wastes are possible sources of chloride and sodium. Deicing salt may be in the form of calcium chloride as well as sodium chloride.

Basic chemical data for the wells are shown in table 1. Most of the samples may be classified either as calcium-sodium—bicarbonate-chloride-sulfate or as calcium-sodium—chloride-sulfate-bicarbonate water types, depending on whether the chloride content is relatively low or high (fig. 1). Some trace metals were detected at all sites (table 2); molybdenum and vanadium are the only trace metals that were undetected at all sites. Radon concentrations in ground water in the mapped area range from 1,900 to 23,000 picocuries per liter (pCi/L). The U.S. Environmental Protection Agency had proposed a Maximum Contaminant Level for radon of 300 pCi/L (1991); uncertainties involved in assessing health risks of waterborne radon have delayed implementation of a MCL (Stone, 1993), and a value of 3,000 pCi/L has been proposed (reauthorization of the Safe Drinking Water Act, S. 1316, 1995). Radon concentrations at all of the sites sampled are greater than 300 pCi/L, and concentrations at 14 of those 22 sites exceeded 3,000 pCi/L. Of the carbamate-group pesticides, carbofuran was detected at one site (HO Cd 387). Atrazine, metolachlor, and prometone, members of the triazine group of pesticides, were each detected at one site each (table 3).

REFERENCES

Dine, J.R., Adamski, J.C., and Duigon, M.T., 1995, Water resources of Howard County, Maryland: Maryland Geological Survey, Bulletin 38, 128 p.

Dine, J.R., Adamski, J.C., and Tompkins, M.D., 1992, Hydrologic data for Howard County, Maryland: Maryland Geological Survey, Basic Data Report No. 19, 240 p.

McFarland, E.R., 1989, Nitrogen transport in ground water in two geologic settings, Patuxent River basin, Maryland: Proceedings of the Conference on Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region, March 14-16, 1989, George Washington University, Washington, D.C., p. 105-124.

S. 1316, 104th Congress, § 8 (1995).

Stiff, H.A., 1951, The interpretation of chemical water analysis by means of patterns: Journal of Petroleum Technology, vol. 3, no. 10, section 1, p. 15-16; section 2, p. 3.

Stone, Richard, 1993, EPA analysis of radon in water is hard to swallow: Science, vol. 261, no. 5128, p. 1514-1516.

U.S. Environmental Protection Agency, 1991, Notice of proposed rulemaking, national primary drinking water regulation—radionuclides: U.S. Federal Register, vol. 56, no. 13 (July 18, 1991), p. 33,050-33,124.

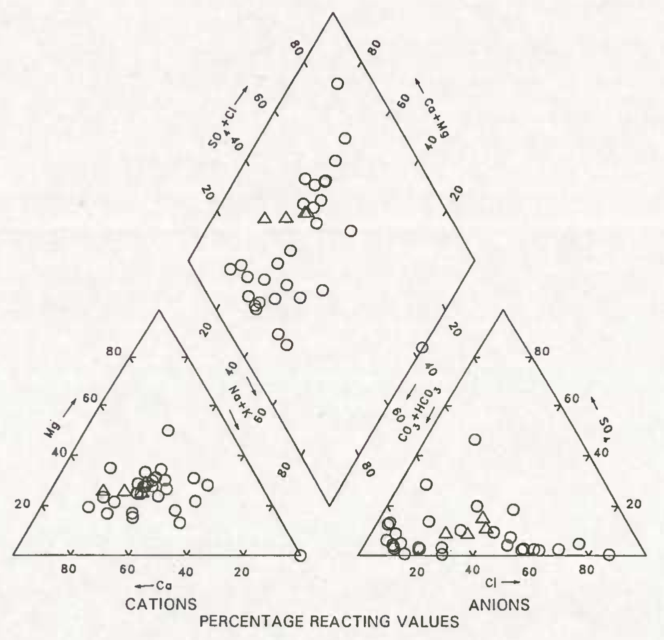

Figure 1.—Major-ion percentages in ground water in the Clarksville and the Howard County portion of the Sandy Spring quadrangles (32 sites). Ground-water samples are shown by circles; the triangles are base-flow samples. Percentages are computed from concentrations expressed in milliequivalents per liter. For sites sampled more than once, median values are shown.

TABLE 1. BASIC GROUND-WATER CHEMISTRY
[Concentrations are for dissolved forms; B, stream base flow; W, well; S, spring]

Site	Site type	Geologic unit	Open interval (ft below land surface)	Date sampled	Specific conductance (μS/cm at 25°C)	pH	Hardness (mg/L as $CaCO_3$)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate + Nitrite (total, mg/L as N)	Silica (mg/L)	Total dissolved solids (residue at 180°C, mg/L)	Site
01591000	B	—	—	12-20-88	91	6.8	28	6.4	2.9	5.1	1.2	15	11	10	<0.1	2.4	7.2	52	01591000
				04-26-89	94	7.0	29	6.6	3.1	5.3	1.2	20	3.8	10	.1	2.3	5.7	60	
				09-11-89	89	6.7	29	6.8	2.9	5.2	1.5	18	2.0	9.3	.1	2.5	8.4	67	
01593675	B	—	—	12-19-88	240	7.3	96	26	7.6	7.9	1.6	67	19	19	.10	3.1	13	143	01593675
				04-25-89	271	8.3	87	23	7.1	8.9	2.0	63	19	19	.10	2.2	8.7	132	
				09-12-89	232	7.7	95	26	7.2	8.6	2.4	75	19	19	.10	2.8	13	139	
01593700	B	—	—	12-19-88	134	7.0	43	11	3.7	7.1	1.6	27	8.0	13	.10	2.0	18	79	01593700
				04-25-89	180	7.3	44	11	3.9	8.6	2.0	25	8.8	17	.10	1.3	13	94	
				10-16-89	142	7.2	46	12	3.9	8.2	2.8	32	8.0	14	.10	1.4	18	72	
01593710	B	—	—	12-21-88	181	7.0	61	16	5.2	8.3	2.0	38	6.9	17	<.10	2.7	12	114	01593710
				04-26-89	187	8.7	65	17	5.4	9.1	1.8	53	8.5	20	.10	2.1	6.7	111	
				09-11-89	188	7.1	70	19	5.4	9.3	2.4	48	7.0	34	.10	3.0	14	127	
HO Cc 1	W	L-O	?-100	12-19-52	113	6.1	23	6.7	1.5	10	1.5	15	1.0	17	<.1	—	15	66	HO Cc 1
HO Cc 12	W	SKVLG	48-140	04-24-90	84	6.2	29	6.8	2.8	5.5	1.1	21	<1.0	5.9	<.1	2.8	21	55	HO Cc 12
HO Cc 38	W	L-O	20-280	01-18-89	276	7.2	98	28	6.7	12	4.1	54	9.1	44	.1	<.10	25	169	HO Cc 38
HO Cd 102	W	BLMR	51-150	10-25-89	245	5.8	69	16	7.0	14	4.1	36	2.0	34	<.1	5.3	32	155	HO Cd 102
HO Cd 206	W	L-O	36-205	06-06-89	111	5.9	33	8.0	3.2	5.9	1.7	12	<1.0	20	.1	1.8	14	67	HO Cd 206
HO Cd 240	S	BLMR	—	05-08-89	77	5.4	20	4.2	2.4	4.5	2.2	13	2.0	6.4	.1	3.5	14	65	HO Cd 240
				10-25-89	78	5.7	21	4.4	2.4	4.2	2.1	8	2.0	6.8	<.1	4.1	15	36	
HO Cd 249	W	BLMR	61-205	05-24-90	192	6.7	30	3.6	5.0	4.7	1.2	66	2.1	6.0	<.1	2.6	15	51	HO Cd 249
HO Cd 334	W	L-O	62-200	06-27-89	28	5.5	6	.90	.82	2.4	.85	6	<1.0	2.2	<.1	.80	9.2	26	HO Cd 334
HO Cd 344	W	STRS	45-245	05-22-90	179	5.7	51	13	4.4	8.6	2.4	12	2.6	30	<.1	5.0	21	123	HO Cd 344
HO Cd 384	W	BLMR	43-305	11-20-89	204	7.4	81	23	5.7	6.4	4.5	90	14	3.3	.1	<.1	30	133	HO Cd 384
HO Cd 385	W	BLMR	19-100	11-29-89	181	5.9	57	13	5.8	11	1.9	26	32	8.8	.1	2.0	28	122	HO Cd 385
HO Cd 386	W	L-O	47-125	02-13-90	47	6.3	16	4.7	.96	2.8	1.2	23	1.0	2.0	.1	—	13	40	HOCd 386
HO Cd 387	W	BLMR	46-400	05-17-90	637	5.5	230	53	23	17	5.4	33	1.3	160	.2	7.5	27	446	HO Cd 387
HO Cd 388	W	BLMR	33-400	05-08-90	286	6.2	80	17	9.0	13	3.1	37	2.5	36	.1	7.3	28	190	HO Cd 388
HO Cd 389	W	MRGR	53-165	05-24-90	88	5.8	59	14	5.7	8.1	4.6	24	9.4	11	<.1	1.5	23	115	HO Cd 389
HO Ce 76	W	BLMR	78-120	06-06-89	78	6.7	24	5.9	2.2	6.1	1.1	24	<1.0	4.3	.1	2.2	28	58	HO Ce 76
HO Ce 83	W	OELL	68-165	11-08-89	42	6.0	14	2.6	1.7	2.7	.80	20	<1.0	1.6	.1	.90	20	32	HO Ce 83
HO Ce 102	W	OELL	30-160	06-19-89	239	6.3	77	20	6.6	15	2.8	43	21	37	.2	<.10	28	158	HO Ce 102
HO Ce 117	W	OELL	28-500	11-01-89	245	7.6	81	25	4.5	18	1.5	75	33	7.8	.4	<.10	25	151	HO Ce 117
HO Ce 126	W	GLFD	62-120	04-05-90	90	6.4	31	7.9	2.7	5.5	1.3	28	<1.0	5.2	<.1	2.5	29	79	HO Ce 126
HO Ce 132	W	OELL	56-85	06-26-89	54	5.8	13	2.8	1.4	5.6	1.3	17	<1.0	1.8	.1	1.3	26	50	HO Ce 132
HO Ce 183	W	OELL	71-340	04-17-90	115	6.9	39	8.2	4.4	7.7	2.2	48	7.0	1.6	<.1	<.10	26	85	HO Ce 183
HO Dd 40	W	L-O	29-240	05-29-90	77	5.8	28	8.7	1.5	3.2	1.5	27	2.8	2.0	.1	1.0	18	56	HO Dd 40
HO Dd 94	W	L-O	53-300	07-03-89	216	5.3	0	.04	.02	44	.25	16	<1.0	20	<.1	13.0	8.7	137	HO Dd 94
HO Dd 97	W	L-O	?-300	01-09-90	161	6.5	55	17	3.1	4.2	1.4	57	4.0	3.1	<.1	1.1	15	86	HO Dd 97
HO De 16	W	SKVLS	51-62	02-05-53	25	6.4	5	1.2	.50	2.2	.8	8	.20	2.3	.1	—	9.6	25	HO De 16
				01-03-55	38	6.3	7	2.0	.50	2.1	.20	15	.10	1.7	.1	—	8.6	28	
HO De 17	W	SKVLS	22-100	01-03-55	31	6.1	9	2.1	1.0	2.7	.20	10	.10	2.9	.1	—	11	26	HO De 17
HO De 85	W	OELL	61-225	05-22-90	78	5.7	22	4.9	2.4	4.3	1.2	11	<1.0	8.5	<.1	3.5	15	50	HO De 85
MO Dh 1	W	L-O	?-40	12-16-52	36	6.0	8	1.3	1.1	2.5	1.1	8	1.6	1.5	.2	—	11	—	MO Dh 1

Geologic unit codes

BLMR	Baltimore Gneiss
GLFD	Guilford Granite
L-O	Loch Raven-Oella Formations (interlayered/undifferentiated)
MRGR	Morgan Run Formation
OELL	Oella Formation
SKVLG	Sykesville Formation (gneiss)
SKVLS	Sykesville Formation (Sykesville Schist Member)
STRS	Setters Formation

TABLE 2. DISSOLVED TRACE METALS AND RADON
[Concentrations in micrograms per liter except radon, in picocuries per liter]

Site	Date sampled	Aluminum	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Silver	Strontium	Vanadium	Zinc	Radon	Site
HO Cc 12	04-24-90	<10	10	<.5	<1	<5	<3	20	6	20	<4	1	<10	<10	<1.0	53	<6	4	2,600	HO Cc 12
HO Cc 38	01-18-89	<10	53	<.5	2	<5	<3	<10	10	<10	18	40	<10	10	<1.0	220	<6	3	2,800	HO Cc 38
HO Cd 102	10-25-89	<10	110	<.5	<1	<5	<3	40	55	20	9	4	<10	<10	<1.0	170	<6	49	13,000	HO Cd 102
HO Cd 206	06-06-89	10	21	<.5	<1	<5	<3	60	7	<10	<4	<1	<10	<10	<1.0	74	<6	32	20,000	HO Cd 206
HO Cd 240	05-08-89	10	49	1		6	<3	<10	12	<10	<4	<1	<10	<10	<1.0	35	<6	<3	—	HO Cd 240
	10-25-89	20	53	<.5	<1	<5	<3	20	5	<10	<4	3	<10	<10	<1.0	34	<6	4	—	
HO Cd 249	05-24-90	<10	10	<.5	<1	5	<3	10	5	<10	<4	1	<10	<10	<1.0	23	<6	<3	5,000	HO Cd 249
HO Cd 334	06-27-89	<10	10	<.5	<1	<5	<3	55	7	<10	<4	5	<10	<10	<1.0	10	<6	12	1,900	HO Cd 334
HO Cd 344	05-22-90	<10	81	<.5	<1	<5	<3	30	11	<10	<4	3	<10	<10	<1.0	110	<6	8	15,000	HO Cd 344
HO Cd 384	11-20-89	<10	29	<.5	<1	<5	<3	<10	120	<10	4	110	<10	<10	<1.0	93	<6	5	19,000	HO Cd 384
HO Cd 385	11-29-89	<10	71	<.5	<1	<5	<3	20	14	<10	<4	<1	<10	<10	<1.0	140	<6	4	—	HO Cd 385
HO Cd 386	02-13-90	<10	11	<.5	<1	<5	<3	30	12	<10	<4	3	<10	<10	1.0	21	<6	8	—	HO Cd 386
HO Cd 387	05-17-90	<10	380	<.5	2	<5	<3	20	12	10	13	9	<10	20	<1.0	490	<6	10	9,900	HO Cd 387
HO Cd 388	05-08-90	<10	96	<.5	<1	<5	<3	20	7	<10	8	13	<10	<10	<1.0	270	<6	<3	9,300	HO Cd 388
HO Cd 389	05-24-90	<10	28	<.5	1	<5	<3	<10	19	<10	9	92	<10	<10	2.0	61	<6	47	2,900	HO Cd 389
HO Ce 76	06-06-89	<10	41	<.5	<1	<5	<3	20	8	<10	<4	2	<10	<10	<1.0	39	<6	<5	7,300	HO Ce 76
HO Ce 83	11-08-89	<10	17	<.5	<1	20	<3	20	31	10	<4	8	<10	<10	<1.0	21	<6	8	1,900	HO Ce 83
HO Ce 102	06-19-89	<10	15	<.5	<1	<5	7	40	870	<10	26	390	<10	<10	<2.0	115	<6	10	8,300	HO Ce 102
HO Ce 117	11-01-89	10	27	<.5	<1	<5	<3	<10	9	<10	17	14	<10	<10	<1.0	150	<6	<3	7,100	HO Ce 117
HO Ce 126	04-05-90	<10	3	<.5	<1	<5	<3	20	8	10	<4	24	<10	<10	<1.0	44	<6	<4	3,600	HO Ce 126
HO Ce 132	06-26-89	<10	17	<.5	<1	7	<3	20	11	<10	6	15	<10	<10	2.0	54	<6	14	23,000	HO Ce 132
HO Ce 183	04-17-90	<10	36	<.5	1	<5	<3	20	19	<10	26	14	<10	<10	1.0	84	<6	11	5,100	HO Ce 183
HO Dd 40	05-29-90	<10	8	<.5	<1	<5	<3	<10	57	<10	5	2	<10	<10	<1.0	32	<6	6	2,400	HO Dd 40
HO Dd 94	07-03-89	<10	<2	<.5	<1	<5	<3	30	5	<15	<4	<1	<10	<10	<1.0	<1	<6	<5	1,900	HO Dd 94
HO Dd 97	01-09-90	<10	29	<.5	<1	<5	<3	60	24	<10	<4	15	<10	<10	<1.0	92	<6	9	2,100	HO Dd 97
HO De 85	05-22-90	<10	29	<.5	<1	<5	<3	20	44	<10	<4	16	<10	<10	<1.0	40	<6	21	6,300	HO De 85

MAP 5. GROUND-WATER QUALITY

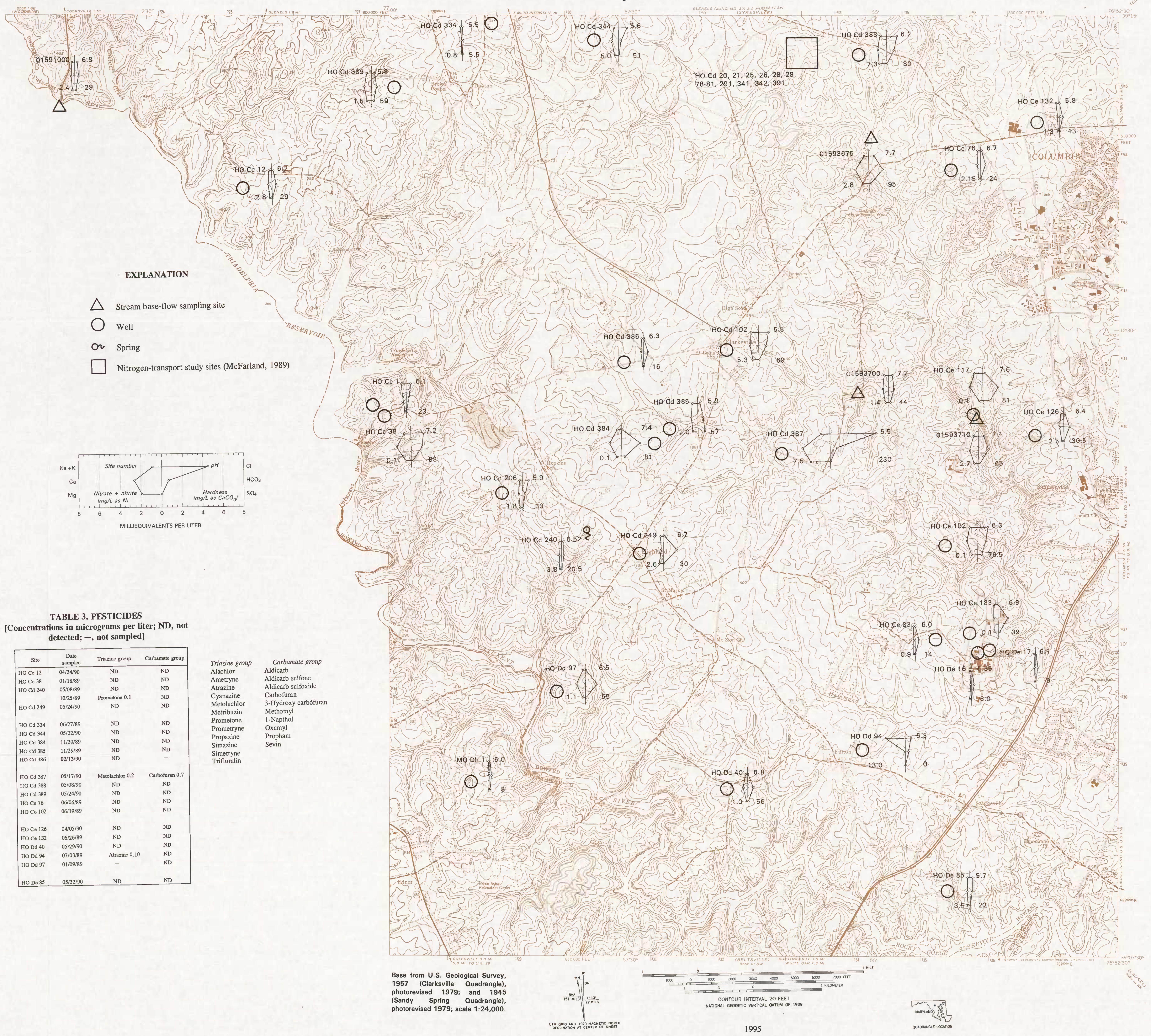

TABLE 3. PESTICIDES
[Concentrations in micrograms per liter; ND, not detected; —, not sampled]

Site	Date sampled	Triazine group	Carbamate group
HO Cc 12	04/24/90	ND	ND
HO Cc 38	01/18/89	ND	ND
HO Cd 240	05/08/89	ND	ND
	10/25/89	Prometone 0.1	ND
HO Cd 249	05/24/90	ND	ND
HO Cd 334	06/27/89	ND	ND
HO Cd 344	05/22/90	ND	ND
HO Cd 384	11/20/89	ND	ND
HO Cd 385	11/29/89	ND	ND
HO Cd 386	02/13/90	ND	—
HO Cd 387	05/17/90	Metolachlor 0.2	Carbofuran 0.7
HO Cd 388	05/08/90	ND	ND
HO Cd 389	05/24/90	ND	ND
HO Ce 76	06/06/89	ND	ND
HO Ce 102	06/19/89	ND	ND
HO Ce 126	04/05/90	ND	ND
HO Ce 132	06/26/89	ND	ND
HO Dd 40	05/29/90	ND	ND
HO Dd 94	07/03/89	Atrazine 0.10	ND
HO Dd 97	01/09/89	—	ND
HO De 85	05/22/90	ND	ND

Triazine group
Alachlor
Ametryne
Atrazine
Cyanazine
Metolachlor
Metribuzin
Prometone
Prometryne
Propazine
Simazine
Simetryne
Trifluralin

Carbamate group
Aldicarb
Aldicarb sulfone
Aldicarb sulfoxide
Carbofuran
3-Hydroxy carbofuran
Methomyl
1-Napthol
Oxamyl
Propham
Sevin

Base from U.S. Geological Survey, 1957 (Clarksville Quadrangle), photorevised 1979; and 1945 (Sandy Spring Quadrangle), photorevised 1979; scale 1:24,000.

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

1995
Prepared in cooperation with the
Howard County Department of Public Works

GEOHYDROLOGIC CONSTRAINTS ON SEPTIC SYSTEMS

By Mark T. Duigon and Barbara F. Cooper

INTRODUCTION

The septic-tank-soil-absorption system ("septic system") is an effective means of disposing of wastewater and sewage in many areas not served by public treatment systems. General descriptions of designs and principles of waste-disposal systems are provided by Bernhart, 1975; Leich, 1977; Johnson, 1978; American Society of Agricultural Engineers, 1978; Purdin, 1979; and Warshall, 1979. Site evaluation is discussed by Huddleston and Olson, 1967; Bouma, 1971 and 1974; Healy and Laak, 1973 and 1974; American Society of Agricultural Engineers, 1978; and Baker, 1978. Romero (1970), Allen and Morrison (1973), Yates and Yates (1989), Pell, Nyberg, and Ljunggren (1990), Keswick and Gerba (1980), and Gross and Mitchell (1990) describe movement of bacteria and viruses through soil and bedrock. Other water-quality aspects may be found in Viraraghavan and Warnock (1976), Scalf, Dunlap, and Kreissl (1977), DeWalle and Schaff (1980), Rea and Upchurch (1980), Hagedorn, McCoy, and Rahe (1981), Yates (1985), Alhajjar, Chesters, and Harkin (1990), Tinker (1991), Foster and Alexander (1992), Hantzsche and Finnemore (1992), and Wilhelm, Schiff, and Cherry (1994).

Materials in the household waste stream include excrement, food scraps, laundry detergents, bleach, and cleaning compounds, and usually are mixed with large quantities of water for transport out of the house. Inside the septic tank, solids are separated from the waste slurry by settling and are broken down by anaerobic decomposition. Liquids flow out of the septic tank and are piped to a distribution field or seepage pit for distribution into the soil. As the water used to transport the wastes percolates through the soil it is depurated by the processes of filtration, adsorption on minerals (particularly clays), microbial action, and dilution. The cleansed water may subsequently recharge the local ground water.

Septic systems must be properly sited, constructed, and maintained to be efficacious. This map identifies areas where geohydrologic features impose maximum, moderate, and minimum constraints on the installation of typical septic systems consisting of septic tank and seepage field. Certain geohydrologic limitations can be overcome through alternative system designs such as mounding of the seepage field, aerobic tanks, sand filters, and other methods; some of these require more intensive maintenance, although some, such as mounding, have come into routine use (mound systems are now included under conventional systems—COMAR 26.04.02.05.Q). Various alternatives to the septic tank and drainfield disposal system are described by Duff (1979), Plews and Lenning (1979), and Bernhart (1979), and Cogger and Carlile (1984).

CONSTRAINT FACTORS

Certain geohydrologic conditions must be considered in order to determine the suitability of a site for installation of a septic system. Specific requirements are specified in the Code of Maryland Regulations (COMAR—see pamphlet for summary of regulations). The dimensions of the absorption field (and, in some cases, other system design aspects) are determined from the results of a percolation test. The percolation test consists of digging a number of holes deep enough to determine whether there is a sufficient thickness of unsaturated, unconsolidated material for effluent treatment, and an indication of the rate at which the soil can accept effluent (percolation rate). A small hole dug at the intended level of the disposal trenches is filled with water to a measured depth; the water level is allowed to drop one inch (pre-wetting), and then timed as it drops another inch. For conventional systems, the percolation rate must be within 2 to 30 minutes per inch after pre-wetting.

1. ***Flood hazard:*** Soil-absorption systems do not drain properly when flooded, and may be damaged. Flood waters can mix with sewage, spreading contamination to surface water and ground water. Areas prone to flooding were obtained from the Soil Surveys (Matthews and Hershberger, 1968; Soil Conservation Service, 1994).

2. ***Depth to water table:*** Water flows more slowly under unsaturated than under saturated conditions, thereby allowing longer contact with soil and more thorough purification, and unsaturated soil is better suited for the growth of the aerobic soil bacteria that break down wastes. Schwartz and Bendixen (1970) noted that nearly all removal of chemical oxygen demand (COD) and methylene-blue active substances (MBAS, which are surfactants contained in detergents) occurred within 2 ft of unsaturated soil, and nearly all ammonia was removed within 4 ft. The actual unsaturated thickness necessary for contaminant removal depends on the particular contaminant, as well as the soil environment. Areas of shallow depth to the water table were obtained from the Soil Surveys and from Map 3 of this atlas.

3. ***Depth to bedrock:*** Bedrock in the area mapped consists of crystalline metamorphic rocks having negligible primary, or intergranular, permeability. Ground water flows through fractures which are variably spaced throughout the rock and which have variable apertures; the fractured rock does not treat wastewater as effectively as soil, which has a much greater mineral surface area (per unit volume) than does the bedrock. Areas of very shallow depth to bedrock were obtained from the Soil Surveys.

4. ***Slope of the land surface:*** There may be a lateral component to the movement of septic-system effluent, resulting in surface discharge in steep areas having shallow soils. Land slopes were obtained from Map 1 of this atlas.

5. ***Distance to surface-water bodies:*** Streams and lakes are commonly areas of ground-water discharge. A septic system should be located at a sufficient distance from surface water to allow adequate treatment underground. Buffers were determined automatically from digital hydrography.

6. ***Geologic unit:*** Ground water in the marble aquifers tends to be more susceptible to contamination than ground water in the other rock units, owing to the solutional enlargement of fractures which allows rapid ground-water flow. Ground-water availability is a problem in some of the other geologic units, and the presence of septic systems in a neighborhood could preclude installation or replacement of an on-site potable water supply. Geologic units were obtained from Edwards (1993).

MAP UNITS

UNIT I: Septic-tank–soil-adsorption systems constructed in this unit face a high probability of failure. This unit mostly occurs adjacent to streams, where flooding is an occasional hazard, the water table comes within 4 ft of land surface (at least seasonally), and the slope of valley walls exceeds 25 percent in some areas. Unit I includes a 300-ft buffer zone around the Triadelphia and T. Howard Duckett Reservoirs, a 200-ft buffer along streams tributary to the reservoirs, and a 100-ft buffer along other streams (the regulation was amended in 1994, limiting the 200-ft buffer requirement to streams within 3,000 ft upstream from a water-supply intake [Maryland Register, 1994]; at the scale of this map, the difference is not discernable). It also includes areas where bedrock is less than 3 ft from land surface, mostly in the northern part of the quadrangle (where Mt. Airy soils occur).

UNIT II: Conditions in this unit are less severe or more variable than in Unit I. A large part of Unit II comprises areas not served by public water (Howard County Master Plan for Water and Sewerage, 1985) that are underlain by marble or by rocks included in Geohydrologic Unit 4 (Map 4 of this atlas). Ground water in the marble is more susceptible to contamination than ground water in the other rocks, and obtaining an adequate potable water supply can be problematic in the area of Geohydrologic Unit 4. This unit also includes areas where the high water table is between 3 and 10 ft below land surface, and areas underlain by soils having a fragipan (a low-permeability horizon that impedes percolation).

UNIT III: Conditions in Unit III, which comprises those areas not included in Unit I or Unit II, generally pose only slight limitations on the operation of septic systems. Onsite inspection is still required to verify site suitability and to estimate drainfield size.

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Maryland Geological Survey

MAP 6. GEOHYDROLOGIC CONSTRAINTS ON SEPTIC SYSTEMS

Quadrangle Atlas No. 26

Base from U.S. Geological Survey, 1957 (Clarksville Quadrangle), photorevised 1979; and 1945 (Sandy Spring Quadrangle), photorevised 1979; scale 1:24,000.

UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MARYLAND
QUADRANGLE LOCATION

1995

Prepared in cooperation with the
Howard County Department of Public Works

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Emery T. Cleaves, Director

QUADRANGLE ATLAS NO. 26
CLARKSVILLE QUADRANGLE AND PART OF SANDY SPRING QUADRANGLE: HYDROGEOLOGY

By Mark T. Duigon, Barbara F. Cooper, and Michael D. Tompkins

INTRODUCTION

This atlas presents hydrogeologic information for the Clarksville 7½-minute quadrangle and the Howard County portion of the Sandy Spring 7½-minute quadrangle (fig. 1). The information contained herein is intended for use by planners, developers, environmental consultants, and other persons interested in hydrogeologic factors pertaining to land use in this area.

The map area lies within the eastern division of the Piedmont physiographic province, about 15 miles

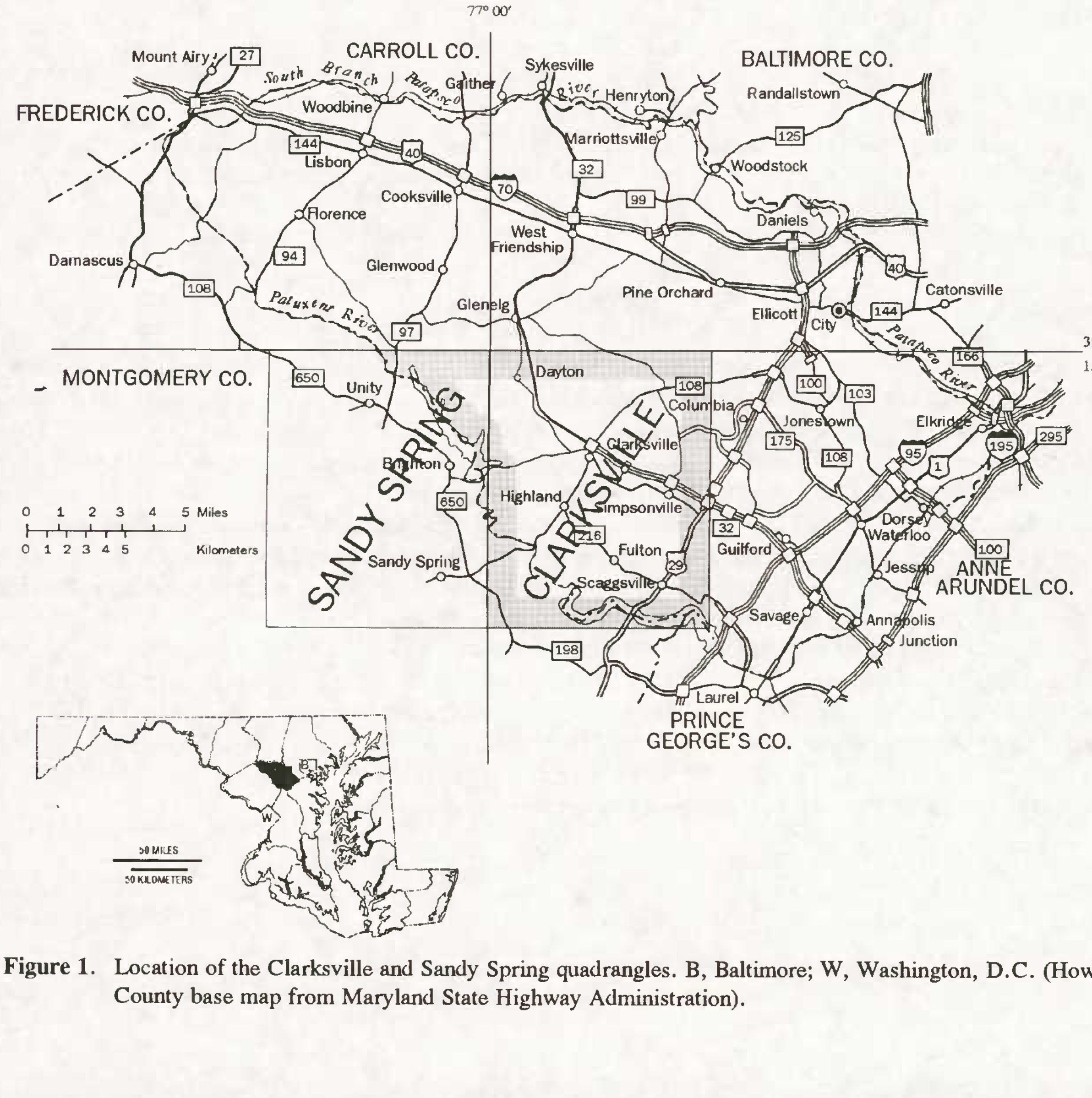

Figure 1. Location of the Clarksville and Sandy Spring quadrangles. B, Baltimore; W, Washington, D.C. (Howard County base map from Maryland State Highway Administration).

southwest of Baltimore and about 20 miles northeast of Washington, D.C. The area is characterized by rolling hills, although the Patuxent River and some of its tributaries have cut steep valleys with over 100 feet of local relief. Maryland Route 216 and its county road extension to the northwest approximately follow a drainage divide which separates the Patuxent River watershed on the south from the Middle Patuxent River and Hammond Branch watersheds on the north.

The climate of this area is humid-temperate, with an annual precipitation of approximately 42 inches. Monthly precipitation is slightly greater during May-September than during the rest of the year (Dine and others, 1995, p. 7-9).

Major roads passing through the map area include U.S. Route 29, and Maryland Routes 216, 108, and 32. There are no incorporated towns in the map area. Numerous residential developments are scattered around the map area, but are most dense in the east; Columbia, Howard County's most populous community, straddles the eastern edge of the map area. Two reservoirs on the Patuxent River, Triadelphia Reservoir and T. Howard Duckett (formerly Rocky Gorge) Reservoir, are maintained for public supply. Some land remains in agricultural use, and there is some commercial development.

Additional atlases covering most of Howard County have been published (Duigon, 1983; Duigon and others, 1995a, 1995b). The hydrologic analyses presented herein are largely based on data compiled by Dine and others (1992); additional discussions of the hydrogeology of Howard County may be found in Dingman and Meyer (1954) and Dine and others (1995).

ACKNOWLEDGMENTS

This atlas was prepared in cooperation with the Howard County Department of Public Works. Evelyn Tomlin of the Division of Environmental Management provided valuable assistance in communicating the needs of the county to the Maryland Geological Survey.

GEOLOGY AND SOILS

The geology used in the hydrogeological analyses for this atlas is based on the Howard County compilation by Edwards (1993). The rocks underlying the map area (fig. 2) have undergone a good deal of deformation, displacement, and metamorphism as a consequence of being located near an orogenic continental margin. Precambrian (Proterozoic Y) Baltimore Gneiss is the basement rock underlying the map area, and is exposed in the cores of a set of domes. Clastic and carbonate rocks of the Glenarm Supergroup lie unconformably upon the Baltimore Gneiss and are exposed in discontinuous concentric bands around the domes. The Glenarm Supergroup comprises the Setters Formation (chiefly quartzite), the Cockeysville Marble, and the Wissahickon Group (schists, which include the Loch Raven and Oella Formations). In the northwestern part of the quadrangle, the Morgan Run Formation (mostly schist) and Sykesville Formation (mostly gneiss) make up the Liberty Complex, a polygenetic mélange that was thrust into its present location (Muller and others, 1989). A younger (Silurian) granite is exposed in the eastern edge of the map area. Adjacent to the south side of the pluton the granite is present in the rocks of the Wissahickon Group and Sykesville Formation as an injection complex, making up as much as 50 percent of the rock. Pods and dikes of pegmatite occur in the north-central part of the map area, and also as an injection complex in the eastern part (making up to 50 percent of the rock). Steeply-dipping dikes of Jurassic diabase cut the rocks of the eastern part of the map area, trending approximately north-south.

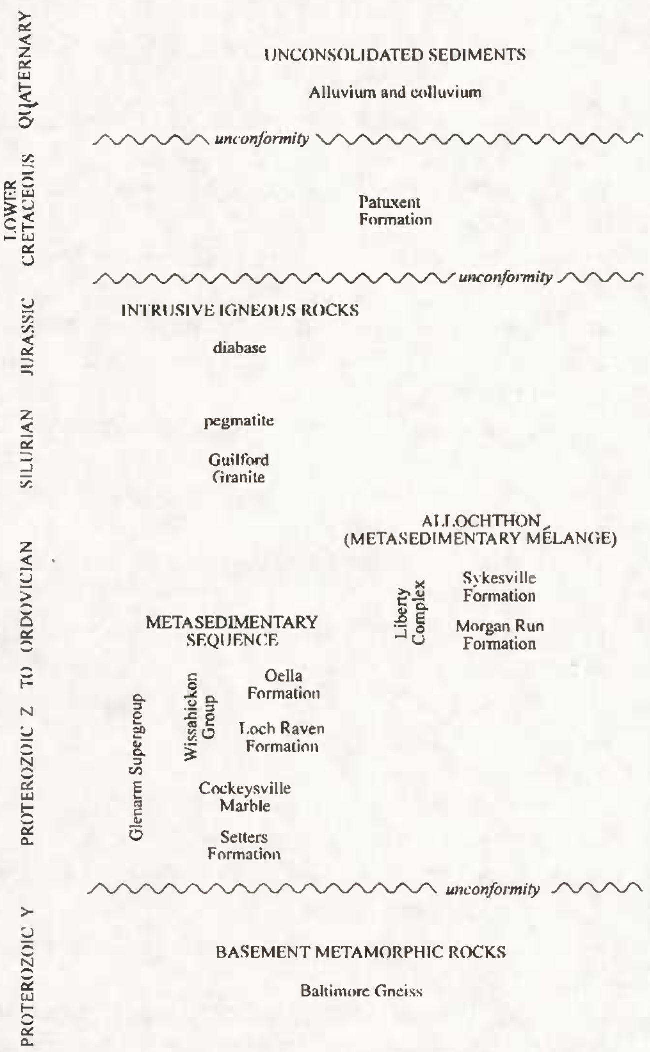

Figure 2. Generalized geologic column for the map area (based on Edwards, 1993 and Muller, 1994).

The sand and gravel facies of the Cretaceous Patuxent Formation extends into the Clarksville quadrangle along an interfluve in the southeastern corner of the map area, just north of the T. Howard Duckett Reservoir. Unconsolidated alluvium underlies floodplains of some of the streams and may interfinger with colluvium at the bases of hillslopes.

Unweathered bedrock is exposed in limited areas in the map area. In most places it is covered by overburden, which includes an assortment of earth materials such as alluvium, colluvium, saprolite, loess, and artificial fill. Alluvium and colluvium are unconsolidated sediments deposited by streams and mass wasting; saprolite is soft, earthy material formed in place by chemical weathering of the crystalline bedrock. A discontinuous deposit of loess, or windblown silt, was deposited on saprolite. The loess eventually was incorporated in the Chester soil where the loess was thick (Darmody and Foss, 1982). Overburden is generally more than 20 ft thick; it is more than 50 ft thick beneath many of the hilltops and uplands, and less than 20 ft thick along the higher-order streams, as well as above certain lithologies such as ultramafic rock. Roen and Froelich (1978) mapped overburden thickness in Howard County.

The geographic distribution of soils is due in part to the parent material that the soil formed in (alluvium along streams or saprolite in interfluvial areas) as well as topographic position and other, interrelated, factors. Most of the map area is underlain by the Glenelg-Chester-Manor and the Glenelg-Manor-Chester soil associations. The Soil Survey of Howard County, Maryland (Matthews and Hershberger, 1968) shows the soils, describes them, and tabulates their properties and the suitabilities of the soils for various purposes.

HYDROLOGY

The hydrology of Howard County is discussed in detail by Dine and others (1995). The crystalline rocks that underlie the Clarksville and the Sandy Spring quadrangles have negligible intergranular, or primary, porosity and permeability. Ground water is stored in and moves through fractures in the rocks, and ground-water flow rates depend upon the openness of the fractures and their degree of interconnection. Unconsolidated overburden above the crystalline rock frequently has much greater primary porosity and permeability than the rock has, allowing additional ground water to be stored (depending on the position of the water table).

The water table is the upper surface of the zone of saturation, and has a shape that approximately corresponds to the shape of the land surface, but with less relief. The water table is high (but deeper below land surface) under hilltops and low (but closer to land surface) along streams. Ground-water flow thus is directed along the hydrologic gradient, parallel to the land-surface gradient, and discharges to the streams. At some localities, rock fractures may have a preferred orientation and not be very well interconnected; in such cases ground water flows at an angle to the hydrologic gradient.

The generalized pattern of water circulation through the earth and atmosphere is known as the hydrologic cycle. The elements of the hydrologic cycle can be quantified for a particular region using a budget equation:

$$P = R_G + R_S + ET + \Delta S$$

where

P = Precipitation,
RG = Ground-water runoff,
RS = Surface or overland runoff,
ET = Combined evaporation and transpiration from plants (evapotranspiration), and
ΔS = Change in storage.

Precipitation is the source, or inflow, of water in the Piedmont and is balanced by outflows as runoff and release back into the atmosphere as water vapor (evapotranspiration), and changes in the amount of water stored in or on the ground. Runoff, commonly measured at a stream-gaging station, is the total streamflow out of a basin. The total flow can be decomposed into contributions from ground-water discharge and overland flow. The amount of water in storage changes considerably seasonally, but net changes generally are smaller over longer periods, and this factor can often be assumed to be negligible. Evapotranspiration can then be estimated as the residual of the equation, or it can be estimated empirically (Thornthwaite and Mather, 1957), from climatological energy budget equations, or from hydrograph separation techniques (Daniel, 1976; this estimates evapotranspiration from the saturated zone, not total evapotranspiration). For the basin measured on Cattail Creek near Roxbury Mills (about 1.5 miles upstream from the confluence with the Patuxent River), the average hydrologic budget for the period 1945-56 is (Dine and others, 1995):

$$43 \text{ in.} = 10 \text{ in.} + 4 \text{ in.} + 29 \text{ in.} + 0 \text{ in.}$$

(Change in storage was assumed negligible and evapotranspiration was calculated as the residual).

The chemical characteristics of ground water affect its suitability for various uses, and these characteristics are determined by geologic controls such as aquifer mineralogy and flow rates, as well as by certain human activities such as agriculture and road salting. Ground-water quality in the map area is generally good, notwithstanding the water is commonly somewhat acidic (except water from the Cockeysville Marble, which generally is hard). Ground-water quality in Howard County is discussed in more detail by Dine and others (1995).

MAPS INCLUDED IN THIS ATLAS

The information in this atlas is presented on six maps, each with a standard U.S. Geological Survey topographic base:

1. Slope of the Land Surface
2. Locations of Wells and Springs
3. Depth to the Water Table
4. Availability of Ground Water
5. Ground-Water Quality
6. Geohydrologic Constraints on Septic Systems

All of the maps were prepared at a scale of 1:24,000; Maps 2—6 have been reduced to a scale of 1:36,000. Computer-automated methods were used to some extent to prepare each map; artifacts of the procedures are most evident in Map 1, owing to the manner in which irregularly spaced elevation-data points were transformed into a regularly-spaced orthogonal grid, from which a lattice of land-slope values was computed.

These maps are designed for broad planning purposes and general hydrologic evaluations, and are not intended to substitute for detailed onsite investigations where required.

CONVERSION FACTORS, ABBREVIATIONS, AND WATER-QUALITY UNITS

Multiply	By	To obtain
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon (gal)	3.785	liter (L)
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
picocurie per liter (pCi/L)	0.03700	Becquerel per liter (Bq/L)

Chemical concentration is expressed in milligrams per liter (mg/L) or micrograms per liter (μg/L). Radionuclide concentration is expressed in picocuries per liter, regardless of radionuclide species [1 picocurie per liter (pCi/L) = 3.7×10^{-2} disintegrations per second per liter]. Specific electrical conductance of water is expressed in microsiemens per centimeter at 25°C (μS/cm). Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) using the following equation:

$$°F = 1.8(°C) + 32.$$

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Department of Natural Resources

MARYLAND GEOLOGICAL SURVEY

Emery T. Cleaves, Director

QUADRANGLE ATLAS NO. 26

CLARKSVILLE AND SANDY SPRING QUADRANGLES

By

Mark T. Duigon

Prepared in cooperation with the
Howard County Department of Public Works

1994