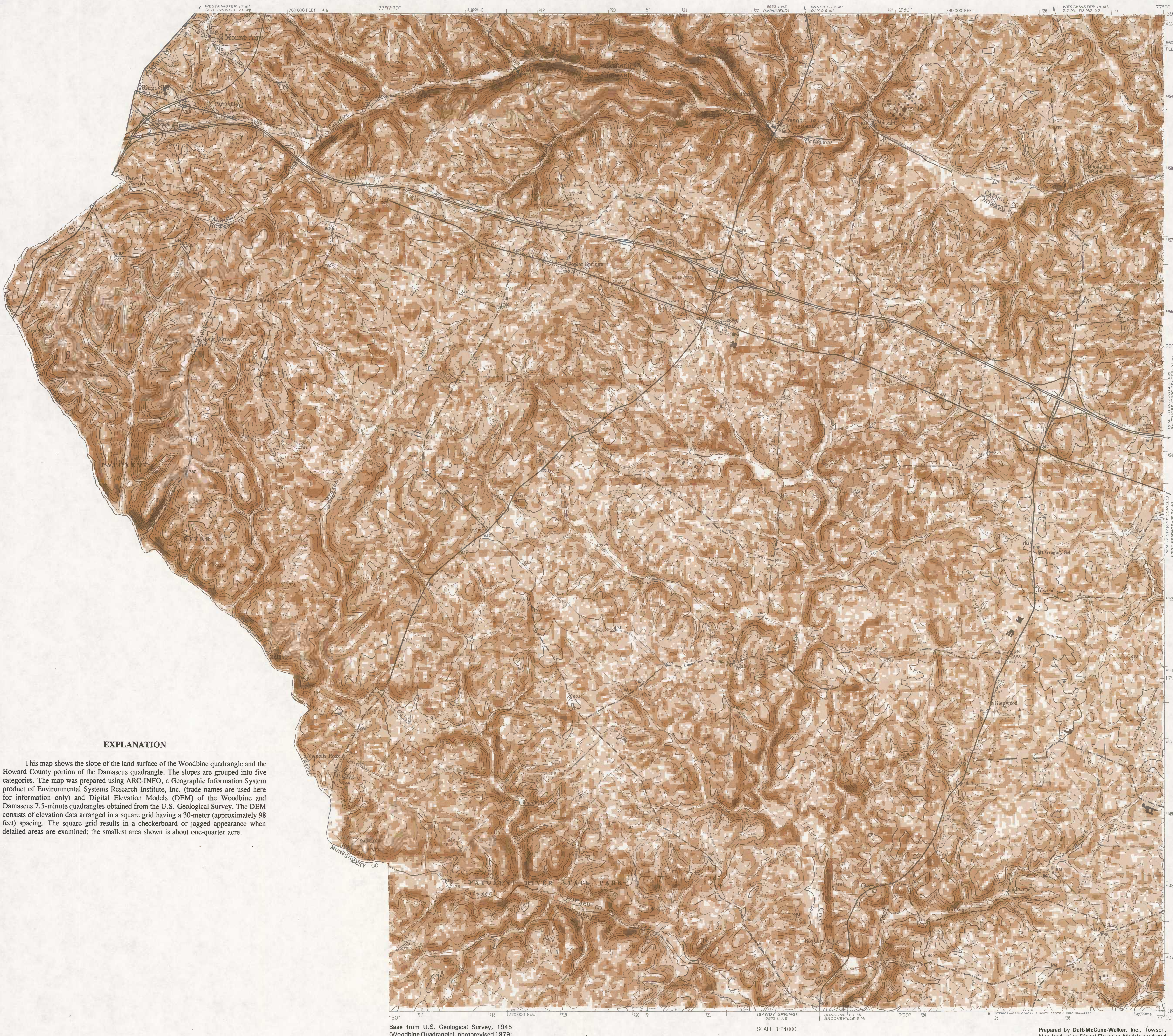
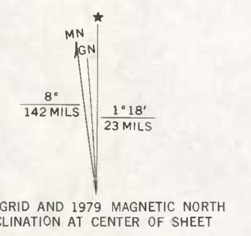
MAP 1. SLOPE OF THE LAND SURFACE



EXPLANATION

This map shows the slope of the land surface of the Woodbine quadrangle and the Howard County portion of the Damascus 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 Woodbine and Damascus 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, 1945 (Woodbine Quadrangle), photorevised 1979; and 1944 (Damascus Quadrangle), photorevised 1979; scale 1:24,000.



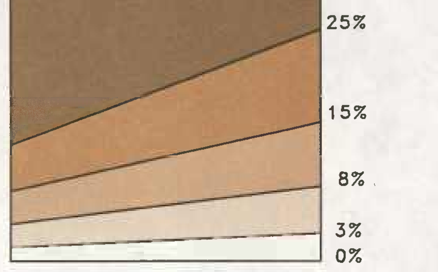
UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

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



1993

Prepared in cooperation with the
Howard County Department of Public Works

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). Additional wells in the vicinity of Carrs Mill were inventoried and data describing them are tabulated herein. Locations of wells and springs in the northern part of the quadrangle, in Carroll County (Hilleary and Weigle, 1981), were verified and the inventory supplemented; information for these wells was added to the data base and is also presented. 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 metal tags stamped with the permit numbers attached to the casing, 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 the 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 Bc 38 is the 38th site inventoried in the second tier from the north, third column from the west, in Howard County.

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.

Hilleary, J.T., and Weigle, J.M., 1981, Carroll County ground-water information: Well records, spring records, and chemical-quality data: Maryland Geological Survey, Basic Data Report No. 12, 251 p.

EXPLANATION

○188 Water well and number

○111 Spring and number

SUPPLEMENTAL RECORDS OF WELLS IN THE WOODBINE-DAMASCUS QUADRANGLES

Well number	Well permit number	Owner	Driller	Date of construction	Altitude of land surface (ft)	Topographic setting	Depth drilled (ft)	Use of water	Geologic unit	Casing: Depth (ft)	Casing: Diameter (in)	Finish	Water level (ft)	Date measured	Pumping test: Yield (gpm)	Pumping test: Drawdown (ft)	Pumping test: Specific capacity (gpm/ft)	Pumping test: Hours pumped	Pumping test: Date	Other data available	Well number
CL Ec 2	CL-00-7298	Lettiari, John	L F Easterday	01-30-1951	790	S	68	H	300GLLS	--	--	-	32	01-30-1951	2	--	--	--	01-30-1951	-	CL Ec 2
CL Ec 3	CL-00-7814	Reaver, Harry E	Dewey Brown	05-28-1951	740	S	55	H	300GLLS	10	--	X	35	05-28-1951	3	--	--	0.5	05-28-1951	-	CL Ec 3
CL Ec 4	CL-00-8312	Logue, E T	L F Easterday	07-25-1951	760	S	93	U	300GLLS	--	--	X	25	07-25-1951	2	68	0.03	--	07-25-1951	-	CL Ec 4
CL Ec 5	CL-00-9823	Jones, Charles	Edward Brown	04-21-1952	815	H	95	U	300GLLS	24	6	X	55	04-21-1952	5	35	.14	1	04-21-1952	-	CL Ec 5
CL Ec 6	--	Krantz, Henry C	--	--	650	S	59	H	300GLLS	--	6	-	35.09H	08-24-1956	--	--	--	--	--	-	CL Ec 6
CL Ec 7	CL-02-0589	Krantz, Henry C	Frownfelter	08-30-1955	650	S	70	S	300GLLS	31	6	X	39	08-30-1955	22	11	2.00	3	08-30-1955	-	CL Ec 7
CL Ec 8	CL-02-1256	Davis, Gordon H	L F Easterday	10-21-1955	565	S	129	H	300GLLS	10	6	X	48	10-21-1955	5	81	.06	--	10-21-1955	-	CL Ec 8
CL Ec 9	--	Watersville M E Church	Edward Brown	03 -- 1955	580	V	41	H	300GLLS	30	6	X	--	--	3.3	--	--	--	03 -- 1955	-	CL Ec 9
CL Ec 13	--	Mt. Airy, Town of	Edward Brown	08 -- 1967	780	S	253	U	300GLLS	23	6	X	34	08 -- 1967	20	--	--	--	08 -- 1967	L	CL Ec 13
CL Ec 14	--	Mt. Airy, Town of	Edward Brown	08 -- 1967	760	S	100	U	300GLLS	--	6	X	34	08 -- 1967	6	--	--	--	08 -- 1967	L	CL Ec 14
CL Ec 16	CL-68-0340	Mt. Airy, Town of	L F Easterday	02-27-1968	745	S	430	U	300GLLS	40	6	X	20	02-27-1968	38	410	.09	.5	02-27-1968	-	CL Ec 16
CL Ec 18	--	Mt. Airy, Town of	L F Easterday	01 -- 1972	640	S	400	U	300GLLS	--	--	X	--	--	1	--	--	--	01 -- 1972	-	CL Ec 18
CL Ec 19	--	Mt. Airy, Town of	L F Easterday	01 -- 1972	640	S	300	U	300GLLS	--	--	X	--	--	1	--	--	--	01 -- 1972	-	CL Ec 19
CL Ec 20	CL-72-0333	Mt. Airy, Town of	L F Easterday	08-11-1972	735	S	300	U	300GLLS	20	6	X	50	08-11-1972	7	250	.03	1	08-11-1972	-	CL Ec 20
CL Ec 47	CL-69-0286	Dorsey, Welton	Dewey Brown	01-30-1969	760	S	125	H	300GLLS	22	6	X	75	01-30-1969	4	35	.11	1	01-30-1969	-	CL Ec 47
CL Ec 48	CL-68-0027	Gillis, Herman	L F Easterday	08-26-1967	770	S	220	H	300GLLS	20	6	X	50	08-26-1967	5	170	.03	.5	08-26-1967	-	CL Ec 48
CL Ec 52	CL-68-0308	Poole, Alva R	Joseph Mayne	04-22-1968	680	H	133	H	300GLLS	26	6	X	60	04-22-1968	6	73	.08	2	04-22-1968	-	CL Ec 52
CL Ec 54	CL-69-0138	Prizzle, Robert	A C Reider	10-10-1968	620	S	93	H	300GLLS	69.5	6	X	40	10-10-1968	10	48	.21	--	10-10-1968	-	CL Ec 54
CL Ec 62	CL-72-0430	Mt. Airy Baptist Ch.	Keyser-Garver	02-08-1972	845	H	350	U	300GLLS	42	6	X	40	02-08-1972	1	--	--	1	02-08-1972	-	CL Ec 62
CL Ec 66	CL-71-0387	Baker, James	A C Reider	08-13-1971	785	S	145	H	300GLLS	30	6	X	10	08-13-1971	1	120	.01	.5	08-13-1971	-	CL Ec 66
CL Ec 67	CL-71-0306	Cross, Michael A	Robert Cline	04-23-1971	790	S	320	H	300GLLS	40	6	X	80	04-23-1971	1	240	.00	1	04-23-1971	-	CL Ec 67
CL Ec 68	CL-72-0356	Padgett, Bertie	L F Easterday	12-16-1971	700	S	160	H	300GLLS	18	6	X	30	12-16-1971	4	130	.03	1	12-16-1971	-	CL Ec 68
CL Ec 70	CL-71-0200	Gue, Irene	Joseph Mayne	01-15-1971	670	S	89	H	300GLLS	42	6	X	30	01-15-1971	7	20	.35	1.5	01-15-1971	-	CL Ec 70
CL Ec 88	CL-68-0027	Gillis, Herman	L F Easterday	08-21-1967	770	S	140	U	300GLLS	--	--	X	--	08-21-1967	0	--	--	--	08-21-1967	-	CL Ec 88
CL Ec 89	CL-68-0027	Gillis, Herman	L F Easterday	08-21-1967	770	S	180	U	300GLLS	--	--	X	Dry	08-21-1967	0	--	--	--	08-21-1967	-	CL Ec 89
CL Ec 90	CL-68-0027	Gillis, Herman	L F Easterday	08-23-1967	770	S	100	U	300GLLS	--	--	X	Dry	08-23-1967	0	--	--	--	08-23-1967	-	CL Ec 90
CL Ec 91	CL-68-0279	Gillis, Herman	L F Easterday	01-16-1968	770	S	120	U	300GLLS	--	--	X	Dry	01-16-1968	0	--	--	--	01-16-1968	-	CL Ec 91
CL Ec 92	CL-81-1764	144 Business Center	Keyser-Garver	02-19-1985	780	U	205	C	300GLLS	39	6	X	20	02-19-1985	6	30	.20	3	02-19-1985	-	CL Ec 92
CL Ec 93	CL-73-9335	Pheasant Ridge Estates	W B Quynn	02-19-1981	700	V	400	P	300GLLS	20	6	X	62	02-19-1981	5	338	.01	.4	02-19-1981	-	CL Ec 93
CL Ec 94	CL-73-9335	Pheasant Ridge Estates	W B Quynn	02 -- 1981	700	V	70	U	300GLLS	--	--	X	--	--	--	--	--	--	--	-	CL Ec 94
CL Ec 95	CL-73-2535	Pheasant Ridge Estates	C A Cromwell	08-01-1974	700	V	150	P	300GLLS	21	6	X	12	08-01-1974	50	63	.79	2	08-01-1974	-	CL Ec 95
CL Ec 96	CL-04-0987	Pheasant Ridge Estates	C A Cromwell	11-18-1960	715	V	78	U	300GLLS	22	6	X	5	11-18-1960	10	20	.50	2	11-18-1960	-	CL Ec 96
CL Ec 97	CL-05-0505	Pheasant Ridge Estates	Robert Cline	11 -- 1962	715	V	295	U	300GLLS	20.5	6	X	40	11 -- 1962	5	--	--	2	11 -- 1962	-	CL Ec 97
CL Ec 98	CL-04-7799	Pheasant Ridge Estates	C A Cromwell	07-09-1962	715	V	96	U	300GLLS	21	6	X	14	07-09-1962	8	--	--	24	07-09-1962	-	CL Ec 98
CL Ec 99	CL-04-7800	Pheasant Ridge Estates	C A Cromwell	07-27-1962	715	V	125	U	300GLLS	21	6	X	50	07-27-1962	7	75	.09	1	07-27-1962	-	CL Ec 99
CL Ec 100	CL-04-7378	Pheasant Ridge Estates	C A Cromwell	07-29-1962	715	V	140	U	300GLLS	12	6	X	--	--	1.9	--	--	--	07-29-1962	-	CL Ec 100
CL Ec 101	CL-05-0506	Pheasant Ridge Estates	A R Keyser	11 -- 1962	715	V	200	U	300GLLS	--	--	X	Dry	11 -- 1962	0	--	--	--	11 -- 1962	-	CL Ec 101
CL Ec 102	CL-73-9874	Pleasant View Nurs Hm.	Ralph Mayne	11-24-1981	705	S	325	T	300GLLS	56	6	X	30	11-24-1981	5	295	.02	5	11-24-1981	-	CL Ec 102
CL Ec 103	CL-73-6740	Pleasant View Nurs Hm.	Ralph Mayne	01-19-1981	740	H	300	T	300GLLS	21	6	X	50	01-19-1981	5	135	.04	8	07-14-1977	-	CL Ec 103
	CL-73-9460														8	250	.03	4	01-19-1981		
CL Ec 104	CL-73-6740	Pleasant View Nurs Hm.	Ralph Mayne	07 -- 1977	740	H	245	U	300GLLS	--	--	X	Dry	07 -- 1977	0	--	--	--	07 -- 1977	-	CL Ec 104
CL Ec 105	--	Pleasant View Nurs Hm.	--	--	740	H	--	T	300GLLS	--	--	-	--	--	--	--	--	--	--	-	CL Ec 105
CL Ed 1	--	--	--	--	460	S	100	U	300MRGR	20	6	X	--	--	25	--	--	4	1949	-	CL Ed 1
CL Ed 2	--	--	--	--	440	S	100	U	300MRGR	30	6	X	--	--	20	--	--	--	1949	-	CL Ed 2
CL Ed 3	--	--	--	1922	439	S	75	U	300MRGR	--	6	-	--	--	--	--	--	--	--	-	CL Ed 3
CL Ed 4	CL-00-4289	--	Maryland Drl	07 -- 1949	435	S	176	U	300MRGR	8	6	X	8	07 -- 1949	5.25	77	.07	10	07 -- 1949	-	CL Ed 4
CL Ed 10	CL-02-3059	Kessler, Herbert F	All Maryland	05-05-1956	515	S	64	H	300PRTB	11.5	6	X	30	05-05-1956	25	--	--	2	05-05-1956	-	CL Ed 10
CL Ed 26	CL-71-0469	Beebe, Clarence	Dewey Brown	06-30-1971	625	H	64	H	300PLGV	18	6	X	40	06-30-1971	8	10	.80	1	06-30-1971	-	CL Ed 26
CL Ed 39	CL-72-0113	Gravel, Robert	Dewey Brown	09-21-1971	570	M	56	H	300PLGV	30	6	X	40	09-21-1971	10	--	--	1	09-21-1971	-	CL Ed 39
CL Ed 83	CL-71-0276	Mize, Robert H	L F Easterday	06-15-1971	580	H	100	H	300PLGV	65	6	X	30	06-15-1971	15	70	.21	1	06-15-1971	-	CL Ed 83
CL Ed 84	CL-70-0430	Grimm, Carl W	C Driver	06-15-1970	625	S	70	H	300PRTB	39	5	X	40	06-15-1970	15	10	1.50	.5	06-15-1970	-	CL Ed 84
CL Ed 89	CL-73-0635	Dailey, Donald	L F Easterday	10-10-1973	520	S	140	H	300PRTB	28	6	X	40	10-10-1973	30	100	.30	1	10-10-1973	-	CL Ed 89
CL Ed 95	CL-73-1365	VanAller, William H	A C Reider	08-27-1973	545	S	110	H	300PLGV	93	6	X	35	08-27-1973	10	65	.15	1	08-27-1973	-	CL Ed 95
CL Ed 96	CL-72-0170	Burdette, Windsor	L F Easterday	09-24-1971	560	H	140	H	300PLGV	88	6	X	30	09-24-1971	10	110	.09	1	09-24-1971	-	CL Ed 96
CL Ed 97	CL-68-0047	Dubbert, William F Jr.	Dewey Brown	09-20-1967	700	H	88	H	300PRTB	30	--	X	55	09-20-1967	5	10	.50	1	09-20-1967	-	CL Ed 97
CL Ed 105	CL-72-0111	Shamer, Kenneth H	Westminster	08-24-1971	560	H	203	H	300MRGR	30	6	X	45	08-24-1971	4	153	.03	11	08-24-1971	-	CL Ed 105
CL Ed 112	CL-71-0388	Combs, Page D	C Driver	05-15-1971	640	S	100	H	300PRTB	50	5	X	55	05-15-1971	8	--	--	.5	05-15-1971	-	CL Ed 112
CL Ed 113	CL-72-0392	Calvano, Nicholas J	L F Easterday	01-26-1972	575	H	120	H	300PLGV	20	6	X	50	01-26-1972	8	70	.11	1	01-26-1972	-	CL Ed 113
CL Ed 120	CL-73-7789	Walter, Walter P	Joseph Mayne	10-27-1978	625	H	120	M	300PRTB	26	6	X	40	10-27-1978	5	75	.07	4	10-27-1978	-	CL Ed 120
CL Ed 121	CL-81-1831	Wright, Hazel B	S Bollinger	03-29-1985	650	S	350	H	300PRTB	20	6	X	60	03-29-1985	2	270	.01	6	03-29-1985	-	CL Ed 121
CL Ed 122	CL-73-6790	Sraver, Frank W	Joseph Mayne	01-13-1978	620	S	305	H	300PRTB	28	6	X	48	01-13-1978	2	42	.05	6	01-13-1978	-	CL Ed 122
CL Ed 123	CL-73-0759	McCauley, Robert L	Keyser-Gerver	04-19-1973	570	S	400	H	300PRTB	47	6	X	120	04-19-1973	15	--	--	1	04-19-1973	-	CL Ed 123
CL Ed 124	CL-81-2447	Woodbine Shopping Ctr.	Joseph Mayne	09-26-1985	625	H	125	C	300PRTB	61	6	X	50	09-26-1985	10	8	1.25	3	09-26-1985	-	CL Ed 124
CL Ed 125	CL-81-1340	Squire	S Bollinger	07-30-1984	570	H	145	H	300PRTB	61	6	X	34	07-30-1984	12	96	.13	3	07-30-1984	-	CL Ed 125
CL Ed 126	CL-81-5802	Mauner, Lawrence	L F Easterday	08-09-1988	570	U	260	H	300PLGV	57	6	X	28	08-09-1988	6	138	.04	3	08-09-1988	-	CL Ed 126
CL Ed 127	CL-73-2239	Brady Fabrications	A P Edmondson	06-14-1974	540	S	60	C	300MRGR	23	6	X	20	06-14-1974	20	--	--	2	06-14-1974	-	CL Ed 127
CL Ed 128	CL-73-7299	Parrott Materials Inc.	L F Easterday	06-05-1978	555	S	120	H	300MRGR	40	6	X	45	06-05-1978	15	75	.20	2	06-05-1978	-	CL Ed 128
CL Ed 129	CL-88-0938	Tye, William Jr.	S Bollinger	03-22-1990	565	H	165	H	300MRGR	39	6	X	35	03-22-1990	10	45	.22	3	03-22-1990	-	CL Ed 129
CL Ed 130	CL-88-0564	Hardy, Tim	Ralph Mayne	10-25-1989	440	V	145	H	300MRGR	23	6	X	7	10-25-1989	10	5	2.00	3	10-25-1989	-	CL Ed 130
CL Ed 131	CL-88-1195	Line, Willard	Wayne Harley	07-17-1990	550	S	150	H	300PLGV	40	6	X	45	07-17-1990	12	5	2.40	3	07-17-1990	-	CL Ed 131
CL Ed 132	CL-73-7789	Walter, Walter P	Joseph Mayne	10 -- 1978	625	H	160	U	300PRTB	--	--	X	Dry	10 -- 1978	0	--	--	--	10 -- 1978	-	CL Ed 132
CL Ed 133	CL-73-1804	Ramblin Pines Campgrnd	H Dillon	01-05-1974	610	H	150	P	300PLGV	40	6	X	30	01-05-1974	3	120	.02	6	01-05-1974	-	CL Ed 133
CL Ed 134	CL-73-2984	Ramblin Pines Campgrnd	H Dillon	08-20-1975	610	H	115	P	300PLGV	65	6	X	--	--	7	--	--	6	08-20-1975	-	CL Ed 134
CL Ed 135	CL-73-9722	Ramblin Pines Campgrnd	H Dillon	08-12-1981	585	S	165	P	300PLGV	51	6	X	51	08-12-1981	10	24	.42	4	08-12-1981	-	CL Ed 135
CL Ed 136	CL-05-7723	Colonial Pipeline Co.	Edward Brown	06-01-1964	485	S	200	H	300PLGV	61	6	X	30	06-01-1964	18	--	--	6	06-01-1964	-	CL Ed 136
CL Ed 137	CL-05-7416	Colonial Pipeline Co.	Edward Brown	05-13-1964	510	S	300	U	300PLGV	56	6	X	38	05-13-1964	1.5	37	.04	--	05-13-1964	-	CL Ed 137
CL Ed 138	CL-05-7621	Colonial Pipeline Co.	Edward Brown	05-22-1964	510	S	215	U	300PLGV	32	6	X	44	05-22-1964	2	--	--	1	05-22-1964	-	CL Ed 138
CL Ed 139	CL-74-0385	Colonial Pipeline Co.	S Bollinger	10-27-1982	580	H	165	H	300PLGV	21	6	X	46	10-27-1982	10	42	.24	3	10-27-1982	-	CL Ed 139
CL Ed 140	CL-81-0384	The Woodbine Church	Ralph Mayne	09-20-1983	540	S	185	M	300PRTB	38	6	X	50	09-20-1983	10	135	.07	3	09-20-1983	-	CL Ed 140
CL Ed 141	CL-73-5213	Woodbine Shopping Ctr.	Joseph Mayne	11-11-1976	625	H	165	C	300PRTB	68	6	X	45	11-11-1976	6	115	.05	2	11-11-1976	-	CL Ed 141
CL Ed 142	CL-73-3973	Woodbine Shopping Ctr.	Joseph Mayne	03-22-1976	625	H	165	C	300PRTB	58	6	X	55	03-22-1976	5	110	.05	2	03-22-1976	-	CL Ed 142
HO Bc 305	MO-88-0477	The Bryant Group	Joseph Mayne	08-23-1989	530	S	145	H	300MRGR	77	6	X	35	08-23-1989	12	--	--	3	08-23-1989	-	HO Bc 305
HO Bc 306	HO-88-0473	The Bryant Group	Joseph Mayne	08-23-1989	570	H	75	H	300MRGR	60	6	X	40	08-23-1989	12	7	1.7	3	08-23-1989	-	HO Bc 306
HO Bc 307	HO-88-0755	The Bryant Group	Joseph Mayne	08-23-1989	560	S	165	M	300MRGR	22	6	X	49	08-23-1989	12	10	1.2	3	08-23-1989	-	HO Bc 307
HO Bc 308	HO-88-0424	Brush	Joseph Mayne	03-02-1989	570	S	145	H	300MRGR	60	6	X	49	03-02-1989	15	--	--	3	03-02-1989	-	HO Bc 308
HO Bc 309	HO-88-0756	The Bryant Group	Joseph Mayne	08-28-1989	545	S	185	H	300MRGR	78	6	X	47	08-28-1989	15	3	5.0	3	08-28-1989	-	HO Bc 309
HO Bc 310	HO-88-0757	The Bryant Group	Joseph Mayne	08-28-1989	550	S	83	H	300MRGR	74	6	X	35	08-28-1989	12	6	2.0	3	08-28-1989	-	HO Bc 310
HO Bc 311	HO-88-0425	The Bryant Group	Joseph Mayne	03-02-1989	585	H	125	U	300MRGR	51	6	X	50	03-02-1989	15	--	--	3	03-02-1989	-	HO Bc 311
HO Bc 312	HO-88-0758	The Bryant Group	Joseph Mayne	07-20-1989	570	W	225	H	300MRGR	52	6	X	28	07-20-1989	12	36	.33	3	07-20-1989	-	HO Bc 312
HO Bc 313	HO-88-0426	The Bryant Group	Joseph Mayne	03-09-1989	590	H	225	H	300MRGR	100	6	X	55	03-09-1989	8.5	20	.43	3	03-09-1989	-	HO Bc 313
HO Bc 314	MO-88-0415	The Bryant Group	Joseph Mayne	06-28-1989	575	S	285	H	300MRGR	22	6	X	45	06-28-1989	3	175	.02	6	06-28-1989	-	HO Bc 314
HO Bc 315	HO-88-0413	The Bryant Group	Joseph Mayne	03-20-1989	600	M	145	M	300MRGR	40	6	X	68	03-20-1989	15	1	15	3	03-20-1989	-	HO Bc 315
HO Bc 316	HO-88-0427	The Bryant Group	Joseph Mayne	03-10-1989	605	H	380	H	300MRGR	67	6	X	58	03-10-1989	1.75	210	.008	6	03-10-1989	-	HO Bc 316
HO Bc 317	HO-88-0411	The Bryant Group	Joseph Mayne	03-20-1989	600	H	365	H	300MRGR	84	6	X	57	03-20-1989	2.4	196	.01	6	03-20-1989	-	HO Bc 317
HO Bc 318	HO-88-0478	The Bryant Group	Joseph Mayne	05-16-1989	605	M	165	U	300MRGR	82	6	X	60	05-16-1989	15	2	7.5	3	05-16-1989	-	HO Bc 318
HO Bc 319	HO-88-0479	The Bryant Group	Joseph Mayne	07-01-1989	580	S	205	H	300MRGR	62	6	X	40	07-01-1989	15	4	3.8	3	07-01-1989	-	HO Bc 319
HO Bc 320	HO-88-0480	The Bryant Group	Joseph Mayne	07-01-1989	560	S	225	H	300MRGR	140	6	X	25	07-01-1989	6.5	147	.04	3	07-01-1989	-	HO Bc 320
HO Bc 321	HO-88-0481	The Bryant Group	Joseph Mayne	07-03-1989	545	S	205	H	300MRGR	80	6	X	33	07-03-1989	8.5	49	.17	3	07-03-1989	-	HO Bc 321

SUPPLEMENTAL RECORDS OF SPRINGS IN THE WOODBINE-DAMASCUS QUADRANGLES

Spring number	Owner	Altitude of land surface (ft)	Topographic setting	Use of water	Geologic unit	Discharge (gal/min)	Date discharge measured	Other data available
CL Eb 1	Cuthbertson, M B	810	W	-	300GLLS	--	--	Q
CL Ec 10	Hartman, E F	575	V	H	300GLLS	3	04-05-1955	-

EXPLANATION OF CODES

Topographic setting
- H Hilltop
- S Hillside
- U Undulating
- V Valley
- W Draw

Use of water
- C Commercial
- H Domestic
- N Industrial
- P Public supply
- S Stock
- T Institution
- U Unused

Finish
- X Open hole

Water level
- M Measured

Geologic unit
- 300GLLS Gillis Formation
- 300MRGR Morgan Run Formation
- 300PLGV Pleasant Grove Schist
- 300PRTB Prettyboy Schist

Other data available
- L Geophysical logs
- Q Water-quality data

Maryland Geological Survey

MAP 2. LOCATIONS OF WELLS AND SPRINGS

Quadrangle Atlas No. 25

Base from U.S. Geological Survey, 1945 (Woodbine Quadrangle), photorevised 1979; and 1944 (Damascus 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

QUADRANGLE LOCATION

1993

Prepared in cooperation with the Howard County Department of Public Works

MAP 3. DEPTH TO THE WATER TABLE

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; Matthews, 1969), 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). Statistical analysis of water-level data from long-term observation wells in Howard County indicate that extreme water levels occurred most commonly during January (highest levels) and May—June (lowest levels); consequently, water levels measured during these months were excluded from the set used to construct this map.

Static water levels (not affected by pumping) reported by drillers for 791 wells in the area shown on this map range from at land surface to 187 ft below (fig. 1), and average about 40 ft. The reported levels in figure 1 are from one-time measurements, but ground-water levels fluctuate seasonally and, to a lesser magnitude, over longer periods (fig. 2) in response to climatic variations. Precipitation information at Damascus provided in figure 2 was obtained from the U.S. Weather Bureau (subsequently an agency within the Environmental Science Services Administration, or ESSA, and the National Oceanic and Atmospheric Administration, or NOAA). The water level in well HO Bb 26 fluctuated between approximately 19 and 42 ft below land surface during the period October 23, 1978, to June 18, 1981, based on 1,174 daily mean water levels; half of the time the water was at a depth of approximately 34 ft (fig. 3).

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.

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 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., 1969, Soil survey of Carroll County, Maryland: U.S. Department of Agriculture, Soil Conservation Service, 92 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 Bc 38 ○ Observation well and number

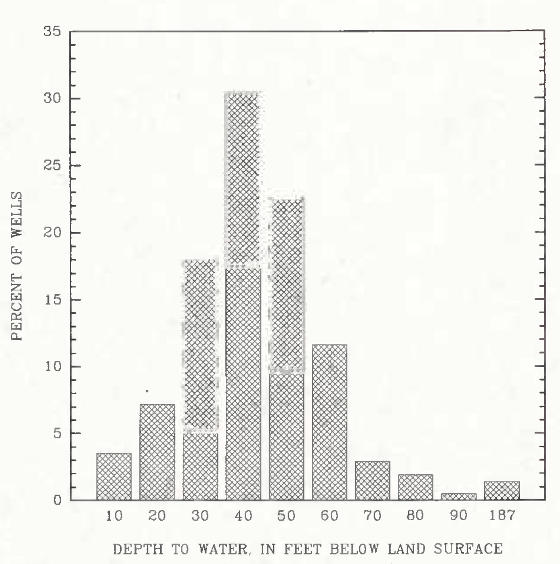


Figure 1.—Distribution of reported water levels in 791 wells in the Woodbine and Damascus quadrangles.

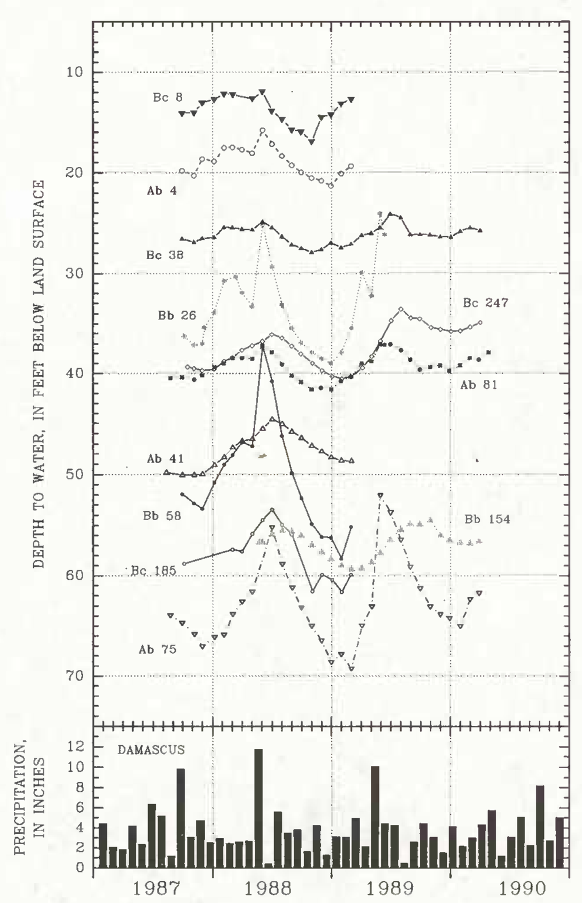


Figure 2.—Water-level fluctuations during the period 1987-1990 measured in eleven observation wells. Locations of the wells (first two letters of identifier, "HO", omitted here for clarity) are shown on the map. Precipitation measured at Damascus (NOAA).

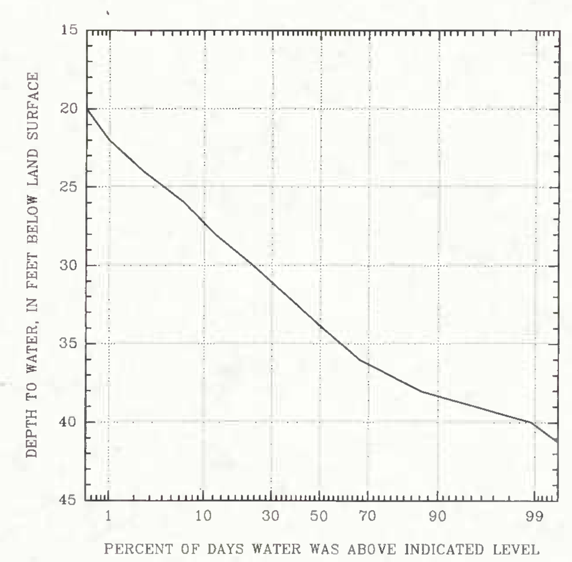


Figure 3.—Water-level duration curve for observation well HO Bb 26, based on the 1,174 daily means obtained during the period 1978-89.

Base from U.S. Geological Survey, 1945 (Woodbine Quadrangle), photorevised 1979; and 1944 (Damascus Quadrangle), photorevised 1979; scale 1:24,000.

1994

Prepared in cooperation with the Howard County Department of Public Works

MAP 4. AVAILABILITY OF GROUND WATER

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.

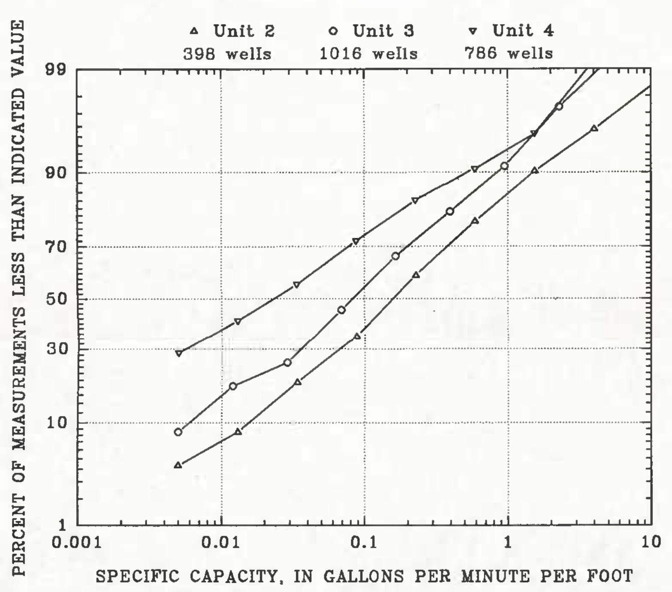


Figure 1.—Cumulative-frequency distributions of specific capacities of wells in the three geohydrologic units.

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 Woodbine and Damascus quadrangles, 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 Pleasant Grove Formation, a fine-grained schist and phyllite. Reported yields of 199 wells in the Woodbine and the Howard County portion of the Damascus quadrangles range from 0 ("dry hole") to 60 gallons per minute, with a median yield of 10 gallons per minute. Mean yield is 10.7 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 168 wells range from 0.000 to 17 gallons per minute per foot of drawdown, with a median of 0.145 (gal/min)/ft. Mean specific capacity is 0.779 (gal/min)/ft. Well depths range from 24.7 to 500 feet for 208 wells, with a median of 145 ft and a mean of 159.3 ft. Water levels measured in 221 wells range from 2.25 to 187 ft below land surface, with a median of 33 ft and a mean of 36.5 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.

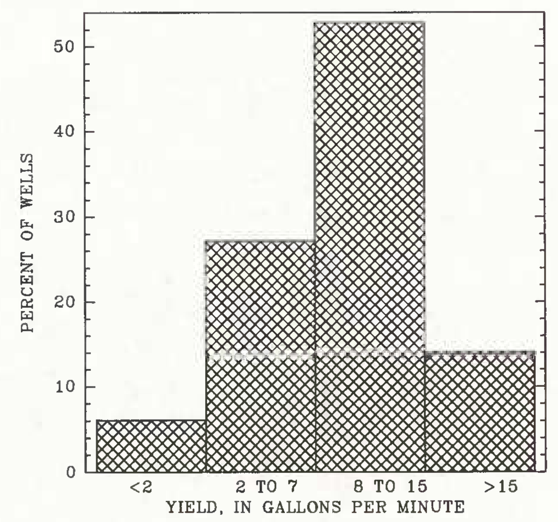


Figure 2.—Distribution of well yields, Geohydrologic Unit 2 (199 wells).

GEOHYDROLOGIC UNIT 3: In the Woodbine and Damascus quadrangles this unit includes areas underlain by the Prettyboy Schist, a fine-grained schist, and the Morgan Run Formation, a fine- to medium-grained schist bearing separately-mapped lenses and layers of mafic and ultramafic rocks. Reported yields of 359 wells in the mapped area range from 0 to 60 gal/min; the median is 7 gal/min and the mean is 9.5 gal/min. Specific capacities of 334 wells range from 0.000 to 8 (gal/min)/ft, with a median of 0.08 (gal/min)/ft and a mean of 0.253 (gal/min)/ft. Depths of 368 wells range from 33.2 to 500 ft. Median well depth is 160 ft and mean depth is 180.0 ft. Water levels measured in 393 wells range from 0.55 to 126 ft below land surface, with a median of 40 ft and a mean of 41.5 ft.

About 4 percent of the wells in Geohydrologic Unit 3 were dry holes, and about 8 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.

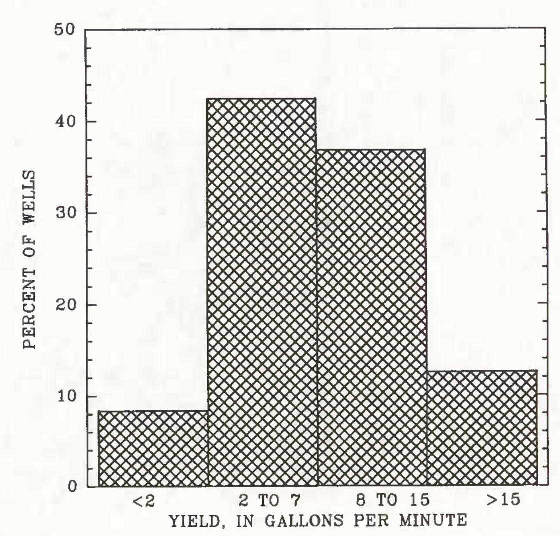
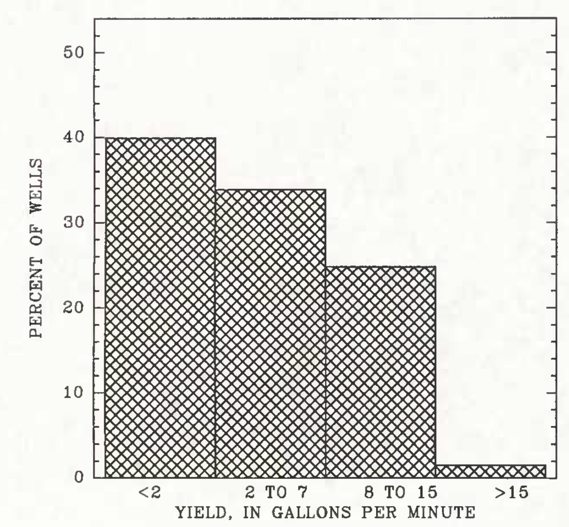


Figure 3.—Distribution of well yields, Geohydrologic Unit 3 (359 wells).

GEOHYDROLOGIC UNIT 4: Geohydrologic Unit 4 is underlain by the Gillis Group, consisting of phyllite in the Woodbine and Howard County portion of the Damascus quadrangles. Reported yields of 133 wells range from 0 to 30 gal/min. Median yield is 3 gal/min and mean yield is 4.6 gal/min. Specific capacities of 120 wells range from 0.000 to 10 (gal/min)/ft, with a median of 0.02 (gal/min)/ft and a mean of 0.266 (gal/min)/ft. Depths of 128 wells range from 41 to 610 ft, with a median of 195 ft and a mean of 221.2 ft. Water levels measured in 102 wells range from 8 to 175 ft below land surface. Median water level is 45 ft and mean water level is 44.1 ft below land surface.

Obtaining an adequate well yield in this unit can be a serious problem (fig. 4). Almost 20 percent of the wells were dry holes, and about 40 percent yield less than 2 gal/min. The chances of obtaining a yield sufficient for municipal or certain industrial or commercial uses are quite low, as only 1.5 percent of inventoried wells were reported to yield more than 15 gal/min.



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SUMMARY

Reported yields of 693 wells in the Woodbine and the Howard County portion of the Damascus quadrangles range from 0 to 60 gal/min, with a median of 7 gal/min. Mean yield is 8.9 gal/min. Nearly 7 percent of the wells inventoried in the map area were dry holes, and about 14 percent yield less than 2 gal/min. Approximately 11 percent of the wells yield more than 15 gal/min. Specific capacities of 623 wells range from 0.000 to 17 (gal/min)/ft, have a median of 0.08 (gal/min)/ft and a mean of 0.397 (gal/min)/ft. Depths of 706 wells range from 24.7 to 610 ft, with a median of 160 ft and a mean of 181.8 ft. Water levels measured in 718 wells range from 0.55 to 187 ft below land surface, with a median of 40 ft and a mean of 40.3 ft.

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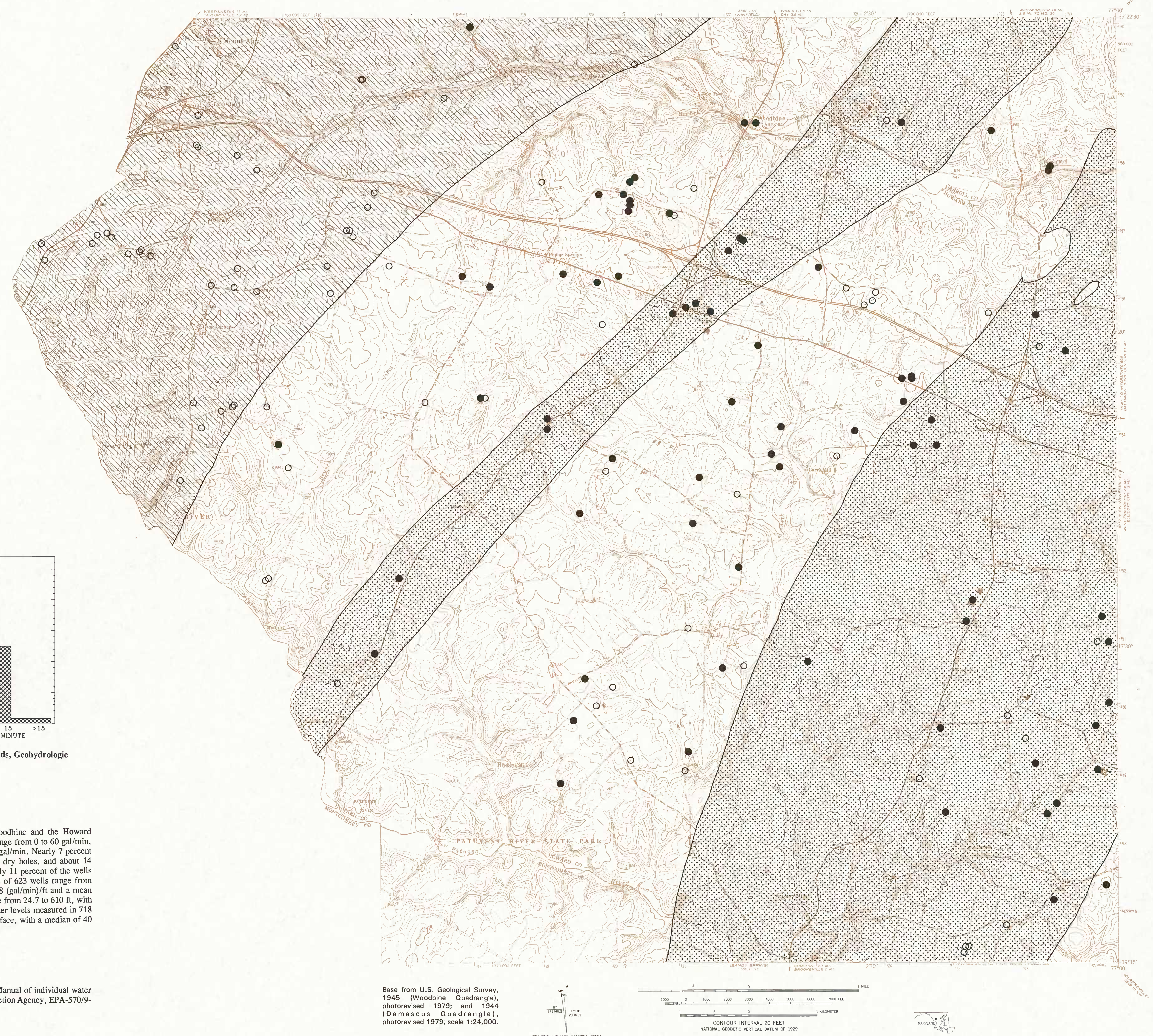

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Prepared in cooperation with the Howard County Department of Public Works

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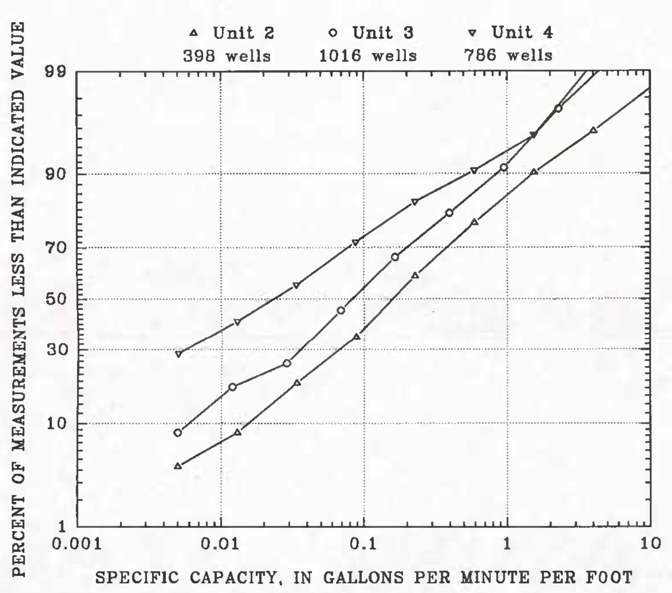

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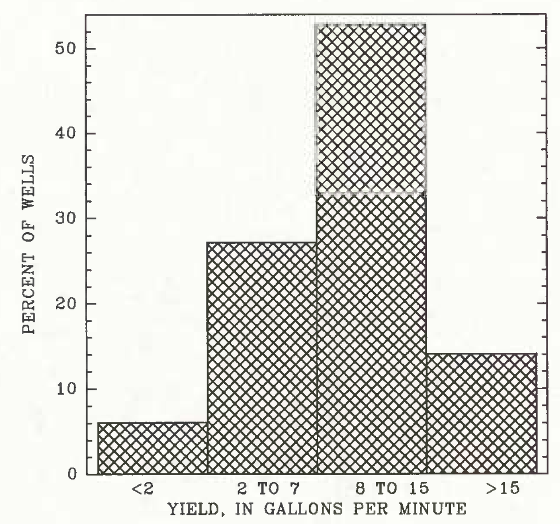

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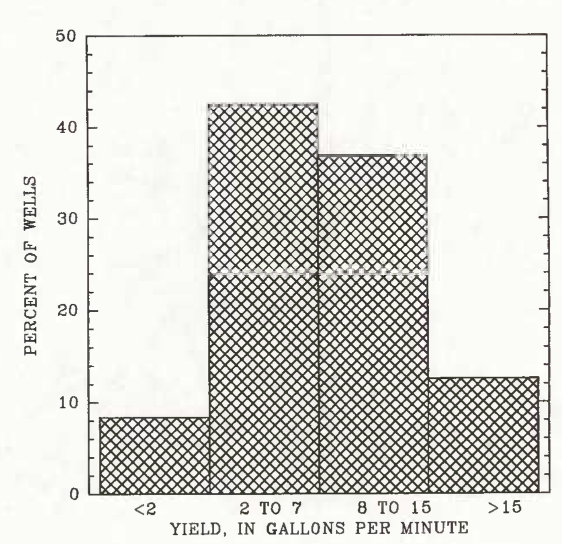

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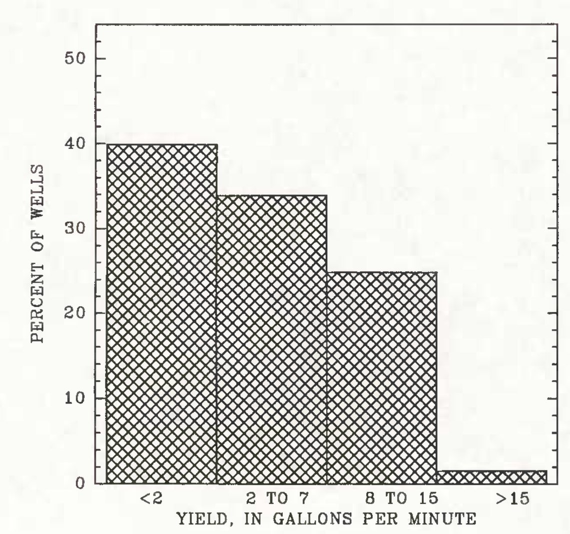

Figure 4.—Distribution of well yields, Geohydrologic Unit 4 (133 wells).

SUMMARY

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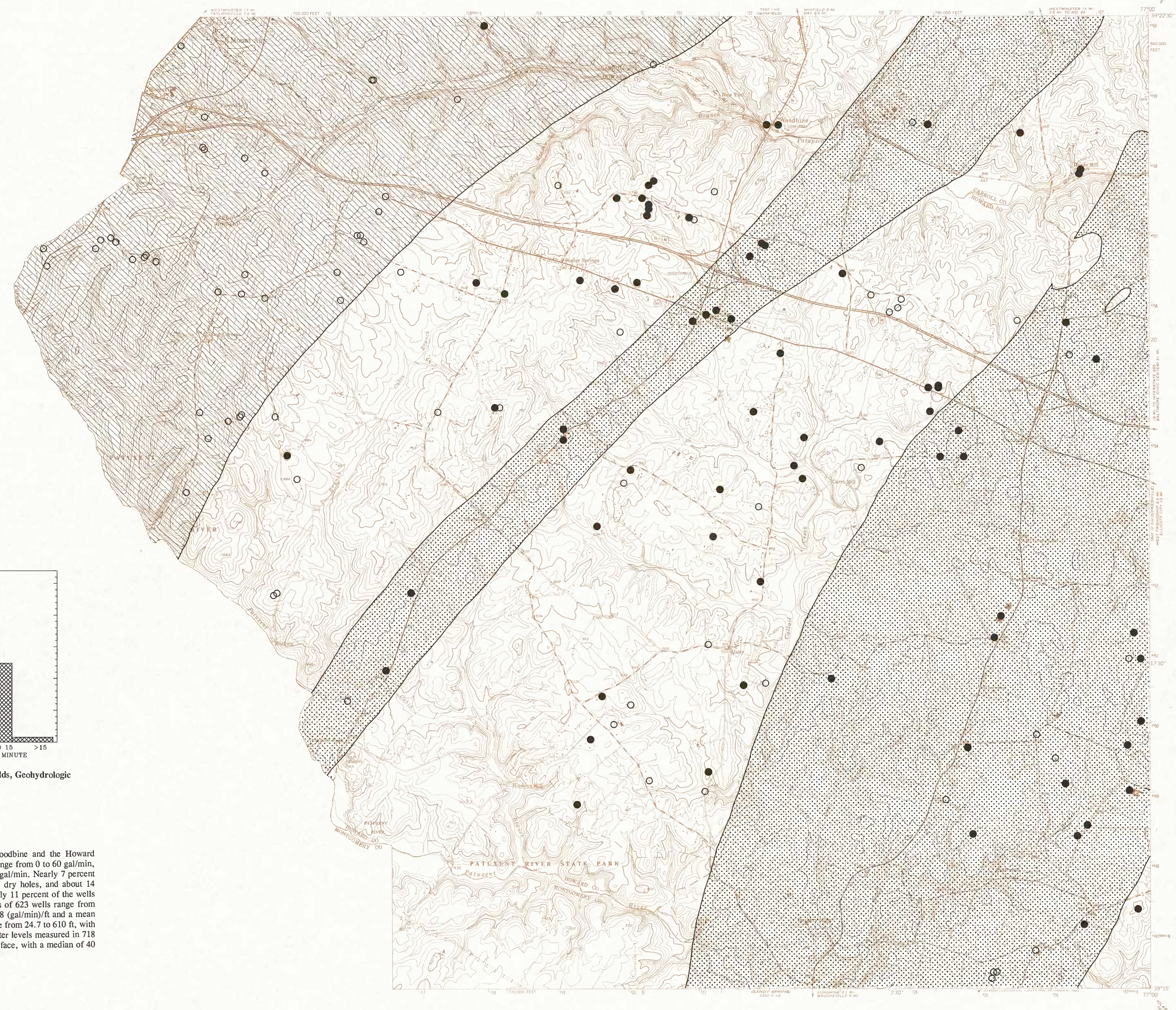
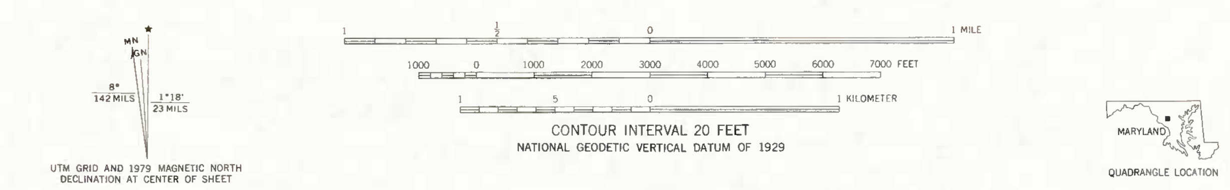


Base from U.S. Geological Survey, 1945 (Woodbine Quadrangle), photorevised 1979; and 1944 (Damascus Quadrangle), photorevised 1979; scale 1:24,000.



1994

Prepared in cooperation with the
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). 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 included for six 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. Similar shapes are not characteristic of geologic units; 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—chloride-sulfate-bicarbonate or as calcium-sodium—bicarbonate-chloride-sulfate water types (fig. 1). Some trace metals were detected at all sites (table 2); beryllium, chromium, cobalt, molybdenum, nickel, and vanadium were undetected at all sites. Radon concentrations in ground water in the mapped area range from 1,400 to 7,300 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 15 of those 22 sites exceeded 3,000 pCi/L. No carbamate-group pesticides were detected; of the triazine group of pesticides, atrazine, metolachlor, simazine, and prometone were detected (table 3).

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

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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.

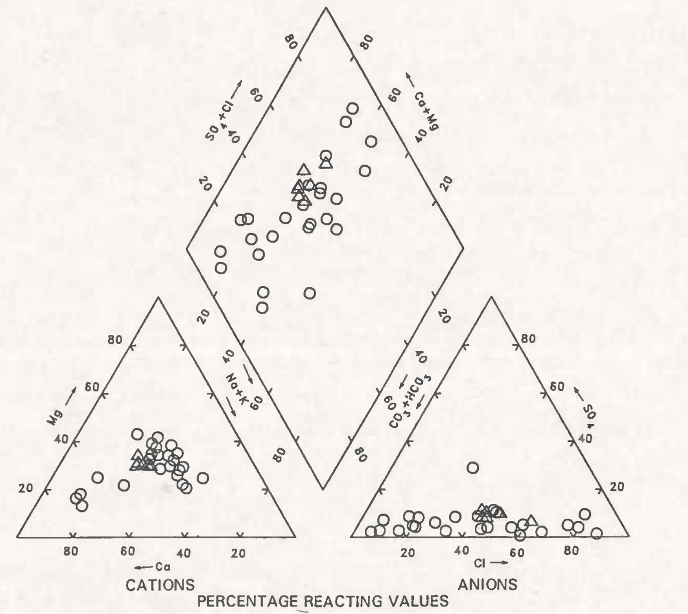

Figure 1.—Major-ion percentages in water sampled from the Woodbine and the Howard County portion of the Damascus quadrangles (32 sites). Ground-water samples are shown by circles; the triangles are base-flow samples. Percentages are computed from concentrations expressed in milliequivalents per liter. 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
01590800	B	—	—	12-20-88	126	7.1	40	9.2	4.2	6.7	1.6	21	5.0	14	0.1	2.8	3.4	70	01590800
				04-26-89	156	6.5	35	7.4	4.0	5.7	1.3	15	4.5	12	.1	2.6	3.5	72	
				10-06-89	101	6.6	42	9.8	4.2	6.1	2.5	31	4.0	14	.1	2.2	5.3	70	
01590900	B	—	—	12-20-88	95	6.6	28	6.4	3.0	5.4	1.5	13	3.3	10	<.1	3.0	7.6	62	01590900
				04-26-89	133	6.4	30	6.7	3.3	5.8	1.6	15	2.5	11	.1	2.9	5.8	66	
				10-13-89	101	8.5	30	6.9	3.2	5.8	1.7	24	2.0	10	<.1	3.3	8.9	56	
01591200	B	—	—	12-20-88	152	6.5	48	10	5.5	6.3	2.0	15	4.1	14	<.1	7.2	9.0	94	01591200
				04-26-89	163	7.0	52	11	6.0	7.1	2.6	24	4.3	17	.1	6.3	6.8	112	
				10-13-89	161	6.8	51	11	5.7	6.7	3.1	18	3.0	15	<.1	7.5	9.4	104	
01591350	B	—	—	12-20-88	196	6.6	55	12	6.0	10	1.5	13	4.3	29	<.1	5.8	8.4	114	01591350
				04-26-89	197	7.0	59	13	6.4	12	1.6	22	4.5	30	.1	5.1	7.0	134	
				10-16-89	202	6.9	58	13	6.3	12	3.7	23	4.0	32	.1	5.4	9.4	110	
01591375	B	—	—	12-20-88	95	6.4	28	6.5	2.9	4.6	1.2	15	3.4	10	<.1	2.9	7.1	50	01591375
				04-26-89	93	6.9	30	6.8	3.2	5.0	1.3	16	2.7	10	.1	2.8	7.7	60	
				10-13-89	97	6.9	30	7.0	3.1	5.1	1.6	17	2.0	9.9	<.1	2.8	8.3	57	
01591400	B	—	—	12-21-88	124	7.5	40	9.0	4.3	7.9	1.6	15	4.8	16	<.1	3.7	7.9	87	01591400
				04-26-89	132	7.3	41	9.3	4.4	7.8	1.3	21	4.8	17	.1	3.4	6.1	95	
				10-13-89	143	7.0	42	9.4	4.5	7.8	1.7	21	4.0	17	<.1	4.0	10	73	
01591475	B	—	—	12-20-88	141	6.5	41	9.6	4.2	6.2	1.5	20	4.8	13	<.1	4.6	11	84	01591475
				04-26-89	130	7.2	42	9.9	4.2	6.7	1.7	23	6.3	13	.1	3.8	7.8	79	
				10-13-89	140	7.0	44	10	4.5	6.4	2.0	21	4.0	14	<.1	4.7	12	86	
HO Aa 8	W	GLLS	37-200	04-10-89	114	5.9	43	12	3.1	3.3	0.8	29	3.2	5.8	.1	3.6	7.8	67	HO Aa 8
HO Ab 2	W	GLLS	?-85	05-15-82	47	5.5	11	1.9	1.6	2.9	.9	6.0	1.0	3.5	.1	—	6.9	39	HO Ab 2
HO Ab 78	W	GLLS	54-300	04-18-89	78	5.3	19	3.8	2.3	6.2	1.0	7.0	<1.0	8.3	.1	3.6	8.9	60	HO Ab 78
HO Ab 103	W	PRTB	42-160	04-18-89	109	5.1	32	6.7	3.7	6.0	1.0	4.0	<1.0	14	.1	4.7	7.6	84	HO Ab 103
HO Ac 25	W	MRGR	50-120	05-22-89	100	6.4	42	14	1.6	3.3	.8	39	<1.0	1.8	<.1	2.5	10	71	HO Ac 25
HO Ac 82	W	PRTB	30-140	05-09-89	64	5.7	21	5.8	1.5	3.2	.6	16	<1.0	3.0	.1	2.3	11	41	HO Ac 82
HO Ac 92	W	MRGR	19-200	05-15-90	132	6.4	53	9.8	6.8	5.9	.4	39	7.8	5.9	<.1	4.6	20	87	HO Ac 92
				05-15-90	132	6.4	50	8.7	6.8	6.3	.6	39	<1.0	6.4	.2	4.8	19	85	
HO Bb 59	W	GLLS	49-300	05-01-89	30	5.3	9	1.5	1.3	1.8	.50	9	<1.0	2.9	.1	1.3	5.9	20	HO Bb 59
				11-01-89	22	5.4	10	1.6	1.4	1.6	.40	5	<1.0	2.8	<.1	1.5	5.9	—	
HO Bb 66	W	GLLS	19-105	04-11-90	103	5.1	21	4.9	2.2	8.7	.6	4.0	<1.0	11	.1	6.6	9.3	82	HO Bb 66
HO Bb 73	W	GLLS	19-300	04-26-90	70	5.1	21	3.5	3.0	3.3	.8		<1.0	5.3	<.1	4.9	7.3	49	HO Bb 73
HO Bb 88	W	MRGR	48-240	05-01-90	155	6.7	63	20	3.2	4.4	.3	55	3.2	11	<.1	1.2	12	96	HO Bb 88
HO Bb 138	W	MRGR	21-100	05-01-89	89	5.5	26	5.0	3.2	5.0	1.4	12	<1.0	8.2	.1	4.9	10	65	HO Bb 138
HO Bb 155	W	MRGR	112-203	05-08-90	89	6.0	28	5.2	3.7	7.3	.5	29	<1.0	4.0	.1	2.6	27	66	HO Bb 155
HO Bb 156	W	MRGR	18-100	04-10-89	26	5.4	5.0	.85	.61	2.15	.6	5.0	<.20	1.8	.1	1.5	6.1	20	HO Bb 156
HO Bb 160	W	PLGV	20-64	04-11-90	103	5.8	31	6.5	3.5	5.8	.8	10	2.3	7.8	.2	6.1	14	87	HO Bb 160
HO Bc 8	W	SKVLG	?-78	12-17-52	101	6.1	23	5.4	2.3	9.6	1.8	18	12	9.0	.05	—	29	77	HO Bc 8
HO Bc 25	W	MRGR	38-200	05-31-90	240	5.0	60	12	7.3	11	1.9	8	<1.0	45	<.1	8	11	186	HO Bc 25
HO Bc 63	W	SKVLG	37-75	06-14-89	96	5.5	19	3.6	2.5	5.2	1.1	15	<1.0	9.3	<.1	3.9	9.6	61	HO Bc 63
HO Bc 157	W	MRGR	40-100	11-08-89	60	5.6	19	3.4	2.5	3.1	.6	11	<1.0	3.2	<.1	3.9	9.2	30	HO Bc 157
HO Bc 172	W	MRGR	61-225	11-29-89	28	6.1	8.0	1.7	1.0	2.3	.4	12	<1.0	.8	<.1	<.1	13	31	HO Bc 172
HO Bc 176	S	SKVLG	—	04-17-90	187	6.7	86	28	3.9	5.2	1.1	80	2.5	5.7	<.1	2.2	16	109	HO Bc 176
HO Bc 187	W	SKVLG	62-145	12-09-88	75	5.5	24	5.2	2.6	5.45	1.5	10	1.0	9.8	<.1	3.8	13	64	HO Bc 187
HO Bc 203	W	SKVLG	42-300	04-26-90	103	5.8	39	9.3	3.9	3.9	1.5	—	7.6	4.4	<.1	2.0	16	64	HO Bc 203
				04-26-90	103	5.8	39	9.3	3.9	3.9	1.5	—	7.6	4.5	<.1	2.0	16	63	
HO Bc 246	W	SKVLG	45-105	03-20-89	122	5.6	33	5.3	4.8	7.4	1.8	10	<.2	11	.1	5.8	11	81	HO Bc 246
HO Bc 264	S	SKVLG	—	05-08-89	205	5.3	52	11	5.8	16	2.0	11	13	35	.1	.01	13	149	HO Bc 264
				10-25-89	334	5.4	75	16	8.5	28	1.6	11	5.0	76	<.1	.02	17	197	
HO Bc 294	W	SKVLG	28-140	05-03-90	33	4.9	9.0	1.6	1.1	2.8	.6	4.0	<.01	3.0	<.1	1.6	10	27	HO Bc 294
HO Bc 304	W	SKVLG	31-103	01-09-90	153	5.8	44	8.1	5.8	8.0	1.8	14	<1.0	22	<.1	6.9	15	120	HO Bc 304

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 Aa 8	04-10-89	<10	<2	<0.5	<1	<5	<3	10	31	<10	<4	12	<10	<10	<1.0	52	<6	4	7,300	HO Aa 8
HO Ab 78	04-18-89	<10	20	<.5	<1	<5	<3	<10	18	<10	<4	19	<10	<10	<1.0	32	<6	7	3,100	HO Ab 78
HO Ab 103	04-18-89	<10	16	<.5	<1	<5	<3	80	25	<10	<4	1	<10	<10	<1.0	34	<6	11	3,400	HO Ab 103
HO Ac 25	05-22-89	<10	12	<.5	<1	<5	<3	70	5	<10	<4	12	<10	<10	<1.0	38	<6	310	3,500	HO Ac 25
HO Ac 82	05-09-89	<10	4	<.5	2	<5	<3	30	4	<10	<4	8	<10	<10	2.0	41	<6	<3	4,100	HO Ac 82
HO Ac 92	05-15-90	20	5	<.5	<1	<5	<3	30	<3	<10	<4	<1	<10	<10	<1.0	48	<6	<3	3,200	HO Ac 92
	05-15-90	<10	4	<.5	<1	<5	<3	30	5	<10	<4	<1	<10	<10	<1.0	48	<6	<3	—	
HO Bb 59	05-01-89	<10	14	<.5	<1	<5	<3	40	5	<10	<4	9	<10	<10	<1.0	7	<6	9	2,800	HO Bb 59
	11-01-89	10	11	<.5	<1	<5	<3	40	8	<10	<4	8	<10	<10	1.0	8	<6	11	2,400	
HO Bb 66	04-11-90	20	29	<.5	<1	<5	<3	170	9	<10	<4	19	<10	<10	<1.0	33	<6	18	2,500	HO Bb 66
HO Bb 73	04-26-90	40	30	<.5	3	<5	<3	40	6	10	<4	41	<10	<10	1.0	15	<6	12	3,300	HO Bb 73
HO Bb 88	05-01-90	<10	<2	<.5	<1	<5	<3	<10	8	<10	5	13	<10	<10	<1.0	150	<6	<3	1,700	HO Bb 88
HO Bb 138	05-01-89	<10	35	<.5	<1	<5	<3	30	6	<10	<4	23	<10	<10	<1.0	51	<6	19	3,700	HO Bb 138
HO Bb 155	05-08-90	<10	<2	<.5	<1	<5	<3	<10	6	<10	7	5	<10	<10	<1.0	66	<6	<3	6,900	HO Bb 155
HO Bb 156	04-10-89	10	9	<.5	2	<5	<3	50	6	<10	<4	15	<10	<10	<1.0	4	<6	14	3,600	HO Bb 156
HO Bb 160	04-11-90	<10	13	<.5	<1	<5	<3	50	10	<10	<4	1	<10	<10	<1.0	55	<6	7	1,800	HO Bb 160
HO Bc 25	05-31-90	<10	47	<.5	<1	<5	<3	80	10	20	10	11	<10	<10	<1.0	190	<6	28	3,800	HO Bc 25
HO Bc 63	06-14-89	20	25	<.5	<1	<5	<3	120	3	<10	<4	32	<10	<10	<1.0	51	<6	25	3,400	HO Bc 63
HO Bc 157	11-08-89	<10	11	<.5	<1	<5	<3	50	12	<10	<4	1	<10	<10	<1.0	36	<6	18	2,700	HO Bc 157
HO Bc 172	11-29-89	<10	<2	<.5	<1	<5	<3	20	<3	<10	<4	1	<10	<10	<1.0	22	<6	<3	—	HO Bc 172
HO Bc 176	04-17-90	<10	19	<.5	2	<5	<3	<10	6	<10	<4	4	<10	<10	<1.0	55	<6	<3	—	HO Bc 176
HO Bc 187	12-09-88	<10	19	<.5	4	<5	<3	30	110	<10	<4	46	<10	<10	<1.0	47	<6	17	3,400	HO Bc 187
HO Bc 203	04-26-90	<10	10	<.5	<1	<5	<3	30	29	10	<4	4	<10	<10	<1.0	58	<6	4	1,500	HO Bc 203
	04-26-90	<10	10	<.5	<1	<5	<3	30	30	10	<4	4	<10	<10	<1.0	58	<6	5	1,400	
HO Bc 246	03-20-89	40	50	<.5	2	<5	<3	20	11	10	<4	31	<10	<10	<1.0	67	<6	15	2,600	HO Bc 246
HO Bc 264	05-08-89	10	48	<.5	2	<5	<3	<10	25	<10	<4	9	<10	<10	<1.0	110	<6	6	—	HO Bc 264
	10-25-89	20	94	<.5	<1	<5	<3	10	8	<10	<4	9	<10	<10	<1.0	160	<6	10	—	
HO Bc 294	05-03-90	<10	7	<.5	2	<5	<3	<10	6	<10	<4	3	<10	<10	<1.0	17	<6	4	3,700	HO Bc 294
HO Bc 304	01-09-90	10	43	<.5	<1	<5	<3	20	3	<10	<4	8	<10	<10	<1.0	100	<6	12	3,200	HO Bc 304

TABLE 3. PESTICIDES

[Concentrations in micrograms per liter; ND, not detected; —, not sampled]

Site	Date sampled	Triazine group	Carbamate group
HO Ab 78	04-18-89	ND	ND
HO Ab 103	04-18-89	ND	ND
HO Ac 25	05-22-89	ND	—
HO Ac 82	05-09-89	ND	ND
HO Ac 92	05-15-90	ND	ND
HO Bb 59	05-01-89	—	ND
	11-01-89	ND	ND
HO Bb 66	04-11-90	Atrazine 0.20	ND
HO Bb 73	04-26-90	ND	ND
HO Bb 88	05-01-90	Atrazine 0.10 Metolachlor 1.8	ND
HO Bb 138	05-01-89	ND	ND
HO Bb 155	05-08-90	ND	ND
HO Bb 156	04-10-89	ND	—
HO Bb 160	04-11-90	ND	ND
HO Bc 157	11-08-89	—	ND
HO Bc 172	11-29-89	—	ND
HO Bc 176	04-17-90	ND	ND
HO Bc 187	12-09-88	ND	—
HO Bc 203	04-26-90	Atrazine 0.20	ND
	04-26-90	Atrazine 0.20	ND
HO Bc 246	03-20-89	ND	—
HO Bc 264	05-08-89	Atrazine 0.30 Simazine 0.10	ND
	10-25-89	Atrazine 0.20 Metolachlor 0.2 Prometone 0.1	ND
HO Bc 294	05-03-90	ND	ND
HO Bc 304	01-09-90	ND	ND

Triazine group	*Carbamate group*
Alachlor	Aldicarb
Ametryne	Aldicarb sulfone
Atrazine	Aldicarb sulfoxide
Cyanazine	Carbofuran
Metolachlor	3-Hydroxy carbofuran
Metribuzin	Methomyl
Prometone	1-Naphthol
Prometryne	Oxamyl
Propazine	Propham
Simazine	Sevin
Simetryne	
Trifluralin	

Geologic unit codes

GLLS	Gillis Group
MRGR	Morgan Run Formation
PLGV	Pleasant Grove Formation
PRTB	Prettyboy Schist
SKVLG	Sykesville Formation

Maryland Geological Survey

MAP 5. GROUND-WATER QUALITY

Quadrangle Atlas No. 25

EXPLANATION

- △ Stream base-flow sampling site
- ○ Well
- Spring

Base from U.S. Geological Survey, 1945 (Woodbine Quadrangle), photorevised 1979; and 1944 (Damascus 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

Maryland Geological Survey Quadrangle Atlas No. 25

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).

CONSTRAINT FACTORS

Certain geohydrologic conditions must be considered in order to determine the suitability of a site for installation of a septic system. The Code of Maryland Regulations (COMAR) specifies values for the following factors (as well as for some additional factors that cannot be shown at the scale of this map—see pamphlet for summary of regulations); however, peculiarities of individual sites may lead the approving authority to deny issuance of a permit, grant a variance, or increase required distances. 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, 1969; 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. 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 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 drawn automatically from digital hydrography.

6. ***Geologic unit***: Ground-water availability is a problem in some of the geologic units (see Map 4), 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-absorption 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 100-ft buffers along streams, and includes areas where bedrock is less than 3 ft from land surface, mostly in the western and northwestern part of the mapped area (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 rocks included in Geohydrologic Unit 4 (Map 4 of this atlas) where obtaining an adequate water supply could be problematic. 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.

REFERENCES

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MAP 6. GEOHYDROLOGIC CONSTRAINTS ON SEPTIC SYSTEMS

Base from U.S. Geological Survey, 1945 (Woodbine Quadrangle), photorevised 1979; and 1944 (Damascus 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

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. 25
WOODBINE QUADRANGLE AND PART OF DAMASCUS QUADRANGLE: HYDROGEOLOGY

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

INTRODUCTION

This atlas presents hydrogeologic information for the Woodbine 7½-minute quadrangle and the Howard County portion of the Damascus 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.

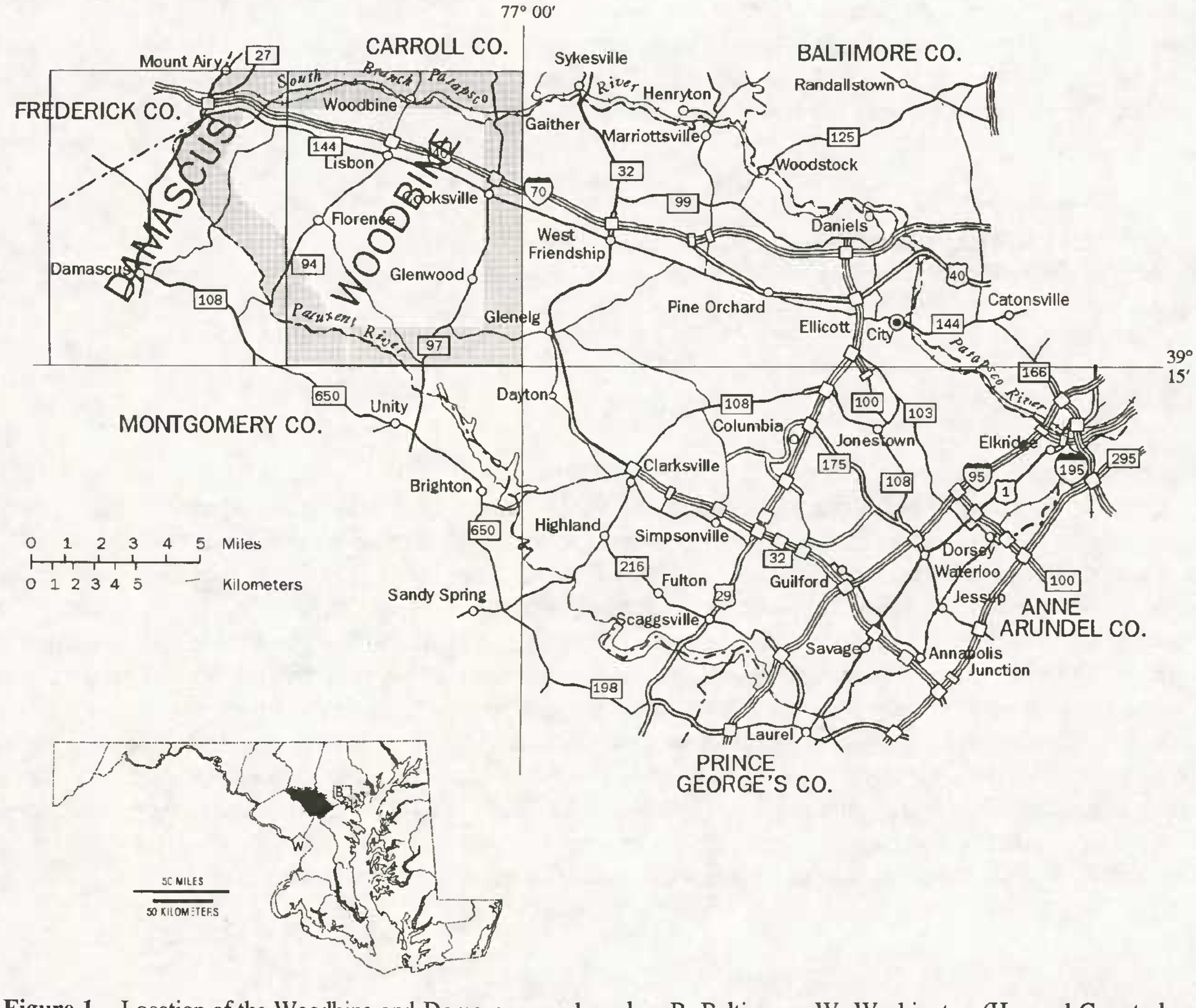

Figure 1. Location of the Woodbine and Damascus quadrangles. B, Baltimore; W, Washington (Howard County base map from Maryland State Highway Administration).

The Woodbine and Damascus quadrangles lie within the eastern division of the Piedmont physiographic province, about 25 miles west of Baltimore and about 25 miles north of Washington, D.C. The area is characterized by rolling hills, although the Patuxent River, the South Branch of the Patapsco River, and some of their major tributaries have cut steep valleys with well over 100 feet of local relief. Interstate 70 approximately follows a drainage divide which separates the Patapsco River watershed on the north and the Patuxent River watershed on the south.

The climate of this area is humid-temperate, with an annual precipitation of approximately 41 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 Interstate 70/US 40 (east-west) and Maryland Routes 94 and 97 (north-south). There are no incorporated towns in the map area, although there are numerous residential developments. Much of the land remains in agricultural use, and there are several small commercial areas. The Patuxent River State Park occupies much of the valley along the southern part of the map area.

Additional quadrangle atlases covering most of Howard County and the adjacent quadrangles in Carroll County have been published (Otton and Hilleary, 1980; Williams and others, 1981; 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 geologic units used in hydrogeologic analyses for this atlas are based on the geologic map compiled by Edwards (1993). The rocks underlying the Woodbine and Damascus quadrangles (fig. 2) have undergone a good deal of deformation, displacement, and metamorphism as a consequence of their location near a former orogenic continental margin. The Prettyboy Schist and the Gillis Group (phyllite) underlie the westernmost part of the map area, and are separated from the Liberty Complex by the Pleasant Grove Formation. This schist, quartzite, and metagraywacke unit shows evidence of intense shearing and coincides with an apparent major tectonic zone—a low-angle thrust fault along which the Liberty Complex was transported upon the Prettyboy Schist, and which has subsequently been folded and metamorphosed (but not strongly enough to obliterate evidence of high strain) (Muller and Edwards, 1985; Muller and others, 1989). The Liberty Complex, a polygenetic mélange that was thrust into its present location (Muller and others, 1989), comprises the Morgan Run Formation (mostly schist) and Sykesville Formation (mostly gneiss). Most of the deformation of the Liberty Complex and its emplacement from the east was completed during the Taconic Orogeny (Ordovician), although some additional deformation occurred near the end of the Paleozoic.

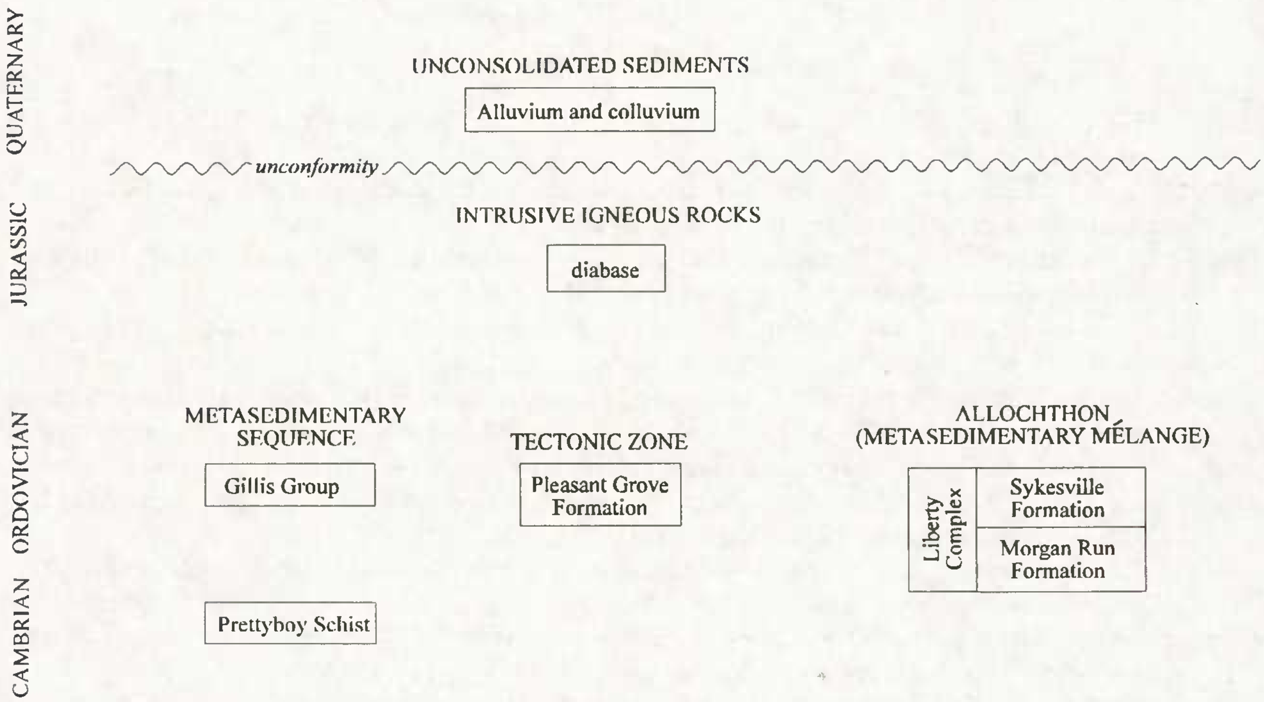

Figure 2. Generalized geologic column for the Woodbine quadrangle and the Howard County part of the Damascus quadrangle (based on Edwards, 1993).

A few narrow exposures of diabase intruding the Gillis Group in the westernmost part of the map area may represent a single, discontinuously-exposed dike that trends north-northeast–south-southwest. Such dikes, found in the Piedmont from Massachusetts to Virginia, are associated with Mesozoic rifting.

Unconsolidated alluvium underlies floodplains of some of the streams and may interfinger with colluvium at the bases of hillslopes. Thickness of this material is generally less than 15 ft.

Unweathered bedrock is exposed in limited areas. 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 20 to 50 ft thick in the map area; it is less than 20 ft thick along the higher-order streams and greater than 50 ft thick beneath some hilltops. 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 soil association in the interior and the Mt. Airy-Glenelg-Chester association in the west; westernmost Howard County is underlain by the Mt. Airy-Linganore-Glenelg association, and the Glenelg-Manor-Chester association underlies the northeast and southeast corners of the map area. 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 crystalline rocks that underlie the map area 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. It 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 Glenwood, the average hydrologic budget for the period 1979-90 is (Dine and others, 1995):

$$38 \text{ in.} = 10 \text{ in.} + 5 \text{ in.} + 23 \text{ in.} + 0 \text{ in.}$$

(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 Woodbine quadrangle and the Howard County portion of the Damascus quadrangle is generally good, notwithstanding the water is commonly somewhat acidic. 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). Concentrations in milligrams per liter are equivalent to concentrations in parts per million for values less than 7,000 mg/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. 25

WOODBINE AND DAMASCUS QUADRANGLES

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