DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1313–J (SHEET 2 OF 2)

DISCUSSION

Figure 1 is intended for use with table 1 as an approach to assessing the ground-water resources of the Culpeper basin; the figure shows geohydrologic subbasins that contain the historically more productive bedrock aquifers identified by letters keyed to the table. The subbasins indicated are generally enclosed by poor aquifers, consisting of either dense diabase surrounded by metamorphic rocks or crystalline basement rocks.

As an example of how the available data can be utilized at an early stage of comprehensive regional planning, let us consider subbasin B, Ashburn, in Loudoun County, Va. Based on table 1, it is deduced that about 2 million gallons per day of potable ground water can be produced on a sustained basis in the 15 mi² area defined. Assuming that the average person uses water at a rate of 100 gallons per day (gal/d), and an average household of four uses 400 gal/d, a regional planner could infer that the Ashburn subbasin would safely allow planning for indigenous water supplies to 5,000 homes on an interconnected system. At this stage a study to demonstrate the feasibility of developing ground-water supplies as sole source should be undertaken, far in advance of implementing a development plan. One possible approach to evaluate the subbasins is that of an exploratory drilling program of test holes 500 to 1,000 ft in depth located in the areas inferred to be favorable on the basis of interpreted fracture zones—faults, joints, or lineaments. Such a program might locate areas of fractured rock where potential wells could be spaced to minimize interference between pumping wells. Prince William, Fairfax, and Loudoun Counties have recently had good success in locating such potentially productive areas on the basis of limited exploratory programs (Laczniak and Zenone, 1985). Some deep wells from the same fractured S1 aquifer produce at much higher rates than estimated in table 1, thus well fields might be localized within the productive subbasin, with attendant savings on drilling, completion, and distribution costs.

Should yields in any subbasin be less than the amount required for the prospective use, conjunctive use of surface reservoir supplies to supplement ground water may be feasible. Alternatively, consideration might be given to importation of outside supplies, to limiting urban growth, or to decreasing the planned mix of urban and rural development.

OPPORTUNITIES

Areas that may provide potential opportunities for specific types of land use include:

MINERAL RESOURCE AREAS (Froelich and Leavy, 1981)—Areas considered for extraction of construction materials, such as potential sites for quarries for crushed stone (diabase and basalt) or sites for extraction of sand, gravel, or clay. The value of these commodities depends primarily on their proximity to a market, because the distance they can be transported at a competitive price is limited. Because of this high place value, such resources require prior assessment to plan for sequential long-range use and reclamation.

AREAS OVERLYING POTENTIAL GROUND-WATER SUPPLIES (Laczniak and Zenone, 1985)—Areas underlain by potential aquifers in limestone conglomerate, siltstone, and sandstone may be sources for supplemental municipal and industrial water supplies, or for high-yielding wells for local suburban developments. Lineaments may indicate the presence of fractured permeable rocks at depth (see sheet 1).

AREAS WITH POTENTIAL FOR LAND APPLICATION OF WASTE WATER, FOR LANDFILLS, OR FOR SLUDGE-DISPOSAL (Froelich, 1985)—Upland areas of thick, well-drained saprolite, residuum, or other non-consolidated materials potentially suitable for land application of treated waste water or for surface disposal of storm-water runoff. Landfill or sludge disposal requires similar sites, but also natural conditions that can minimize contamination to surface- and ground-water supplies. It also requires absence of major lineaments reflecting fractures, presence of clays with high cation-exchange capacity, detailed site-engineering studies, and consideration of many other factors prior to final selection.

POTENTIAL IMPOUNDMENT SITES (Froelich, 1985; Morsches and Zenone, 1981; Lynch and others, 1987)—Localities that have physical characteristics enabling the construction of 15–30 ft (5–10 m) or higher dams seated on firm bedrock. Such reservoirs could be used to store significant volumes of local runoff to be released during dry periods to augment low flow. Some could also be used to store water skimmed from high flows of the Potomac, Rapidan, Rappahannock, and Robinson Rivers, all through-going, east-flowing trunk streams that have headwaters in the Blue Ridge. All such potential sites would require detailed site investigations by geotechnical engineers to assess relevant physical properties that bear on water storage facilities.

REFERENCES CITED

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TABLE 1.—Summary of potential ground-water supplies by aquifer subbasins, Culpeper basin, Virginia and Maryland

SUBBASIN (see figure 1)		COUNTY (Va. unless noted)	AREA OF SEDIMENTARY BEDROCK IN SQ MI (SQ KM)	PREDOMINANT BEDROCK AQUIFER[1]	ESTIMATED MEDIAN YIELD[2]	ESTIMATED NUMBER OF WELLS[3]	ESTIMATED TOTAL PRODUCTION[4]	CURRENT UTILIZATION (1982)
A	Sterling	Fairfax, Loudoun	18(46)	S1 = S2	150	10	2	Shallow[5], domestic[6]
B	Ashburn	Loudoun	15(38)	S1	175	9	2 (3.5 if adj. area to west included)	Shallow, domestic
C	Dulles	Fairfax, Loudoun	33(84)	S1 = S2	150	25	5	Some deep[5], high-yield[6] wells
D	Flatlick	Fairfax	7(18)	S1 = S2	150	6	1	Few deep wells, mainly shallow domestic
E	Manassas-Cedar Run	Prince William, Fauquier	108(276)	S1 = S2	150	90	13.5	Deep, large[7] production near Manassas
F	Poolesville	Montgomery (Md.)	41(105)	S1 = S2	150	32	5	Moderate[7] production near Poolesville
G	Martinsburg	Montgomery (Md.)	20(51)	S1 = S2	150	15	2	Shallow, domestic
H	Lucketts	Loudoun	11(28)	S1>S2	175	7	1	Shallow, domestic
I	Leesburg	Loudoun	25(64)	S4>S1	175 +	20	3.5	Deep, large production near Leesburg
J	Goose Creek	Loudoun	12(31)	S3>S2	75	9	0.5	Shallow, domestic
K	Lenah	Loudoun	5(13)	S1 = S3	150	4	0.5	Shallow, domestic
L	Haymarket	Prince William	28(72)	S2>S1	100	20	2.0	Shallow, domestic
M	Thoroughfare	Prince William	52.5(134)	S2>B	50	38	2.0	Shallow, domestic
N	Opal	Fauquier	53(136)	S2>B	50	38	2.0	Shallow, domestic
O	Midland	Fauquier, Prince William	35(90)	S2>S1	100	27	2.7	Shallow, domestic
P	Brandy Station	Culpeper	8(20)	S2>S1	100	6	0.5	Shallow, domestic
Q	Culpeper	Culpeper	13.5(35)	S2>S1	100	12	1.2	Few deep, high-yield wells

[1] After units of Leavy and others, 1983: S1 -2 siltstone; S2 -sandstone; S1 = S2- siltstone and sandstone equal S1 > S2 - more siltstone than sandstone; S3 - quartz and schist pebble conglomerate (included in undivided unit Un on large map); S4 - limestone conglomerate; B - basalt.

[2] In gallons per minute (gal min); for liters per second multiply by 0.06309; based on tabular data of Laczniak and Zenone, 1984.

[3] Assumes average depth 500 ft (150 m), spacing 1 mi (1.6 km). Assumes detailed exploratory program to identity best location for each production well.

[4] Assumes sustained production in millions of gallons per day; for millions of liters per day, multiply by 3.785, estimates based on product of median yield times number of wells, and area; supported in part by unpublished model results simulating hypothetical stresses within subbasins of the study area (Laczniak and Zenone, 1984).

[5] "Shallow" wells produce from less than 200 ft (60 m) deep; "deep" wells produce from 500 to 1,000 ft (150–300 m) deep.

[6] "High" yield wells are greater than 200 gal min; "domestic" wells commonly yield 5–20 gal min

[7] "Large" production is greater than 1,000 gal min; "moderate" production is 200–500 gal min

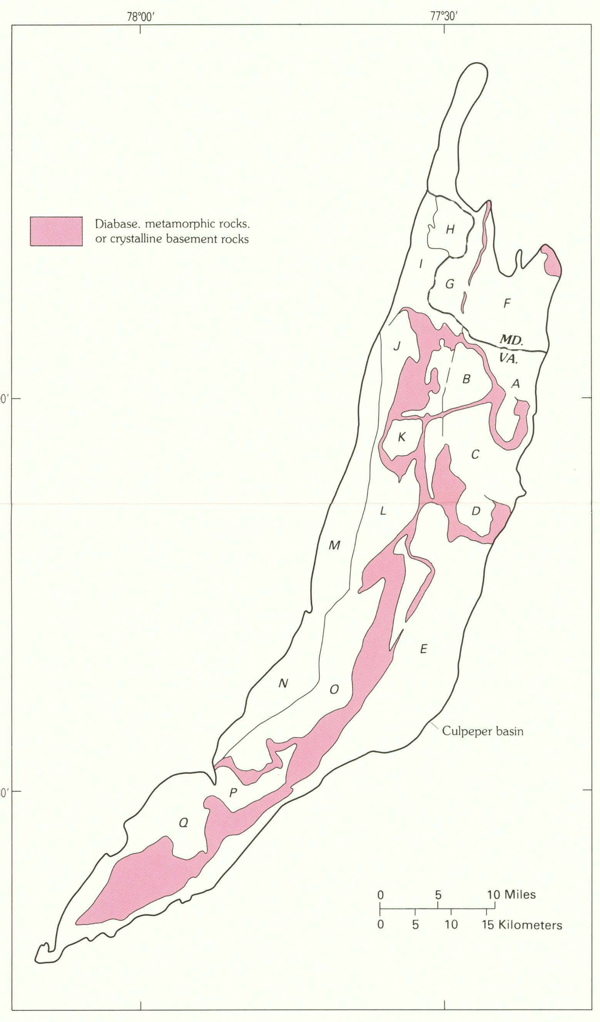

FIGURE 1.—Geohydrologic subbasins detailed in table 1.

EXPLANATION

[Note: see Leavy and others (1983) for description of rock types]

Potential mineral resource areas (Construction materials)

- D — Diabase
- B — Basalt
- Sand and gravel
- X — Clay

Aquifers

- S1 — Siltstone
- S2 — Sandstone
- S4 — Limestone conglomerate

Potential ground water supplies [Top of aquifer greater than 100 m (330 ft) deep]

- Siltstone
- Sandstone
- Limestone conglomerate

Potential land application areas, landfill, or sludge-disposal areas

Potential impoundment sites
Reservoirs for storage or peak-flow skimming

Thermally metamorphosed rocks, greenstone conglomerate, and quartz conglomerate, undivided

P — **Pre-Triassic rocks**

Outline of basin

Contact—Dashed where inferred

MAPS SHOWING GEOLOGIC AND HYDROLOGIC FACTORS AFFECTING LAND–USE PLANNING IN THE CULPEPER BASIN, VIRGINIA AND MARYLAND

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Base from U.S. Geological Survey 1:250,000
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