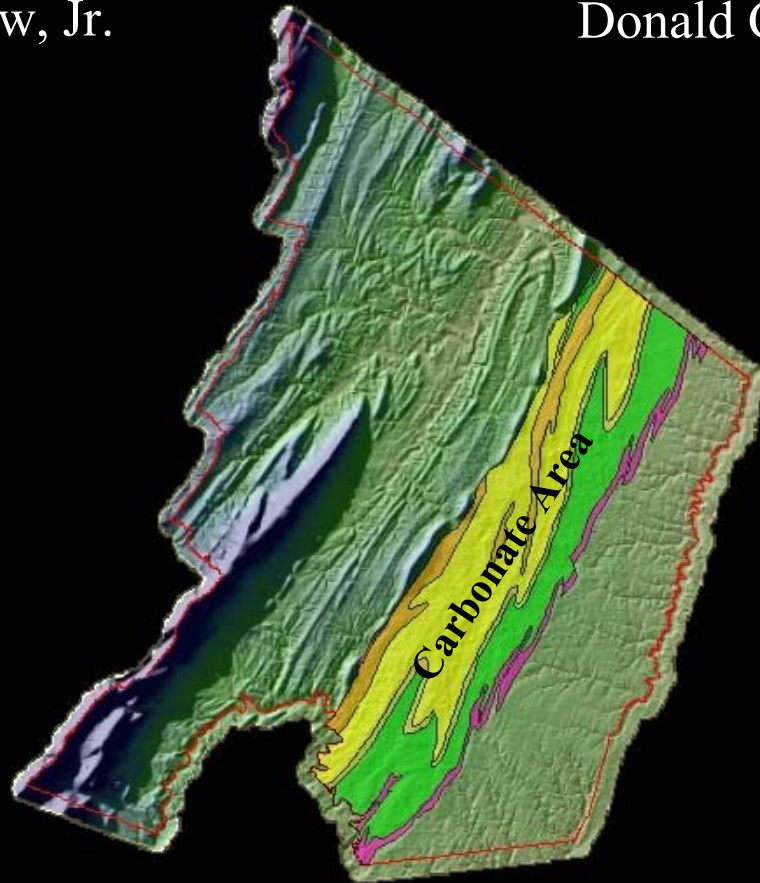# Frederick County Ground-Water

George E. Harlow, Jr.

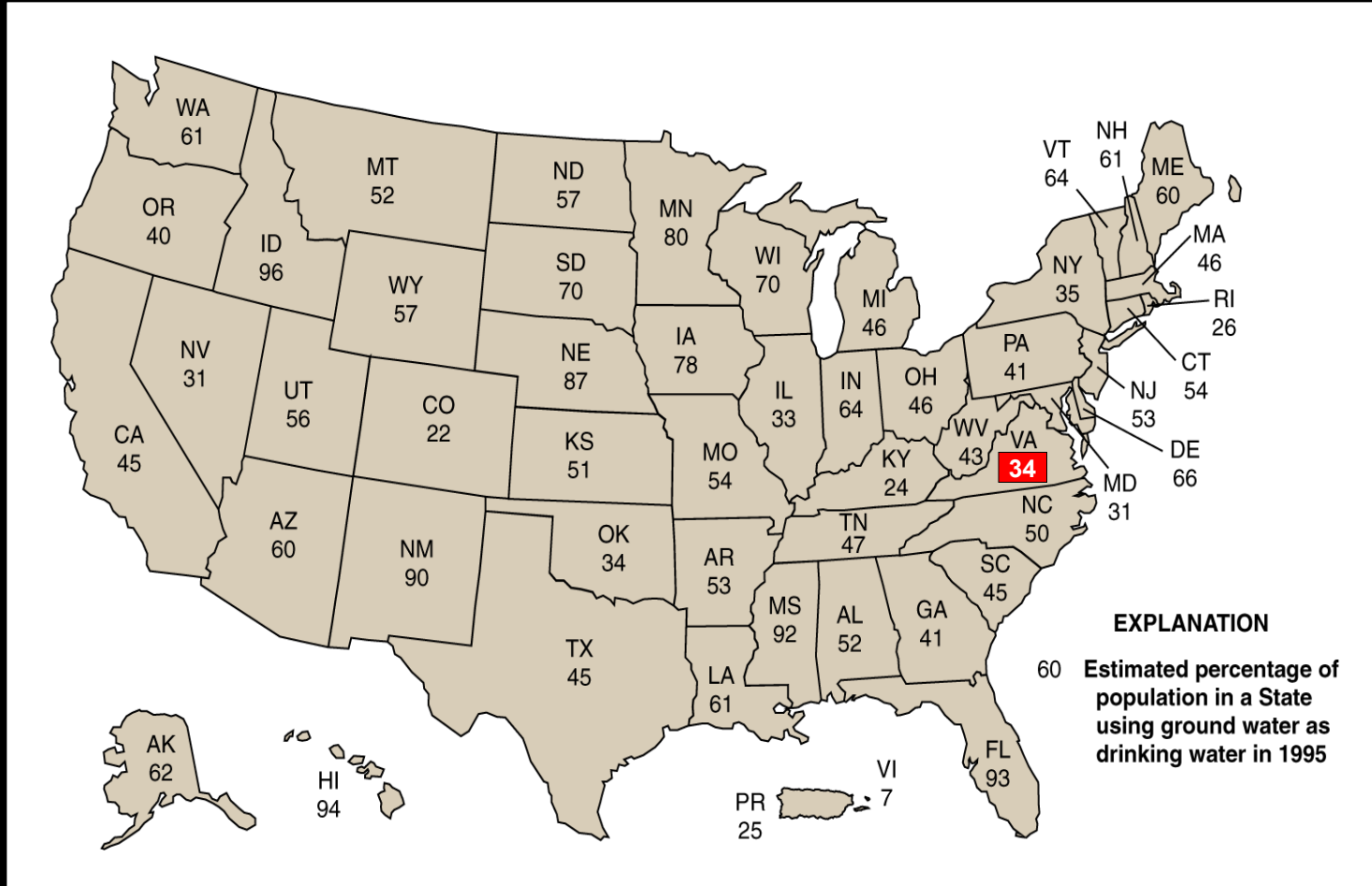Donald C. Hayes

Carbonate Area

Objective

- To better characterize the carbonate aquifer system in the Northern Shenandoah Valley

- Provide relevant hydrogeologic information that can be used to guide the development and management of this important water resource.
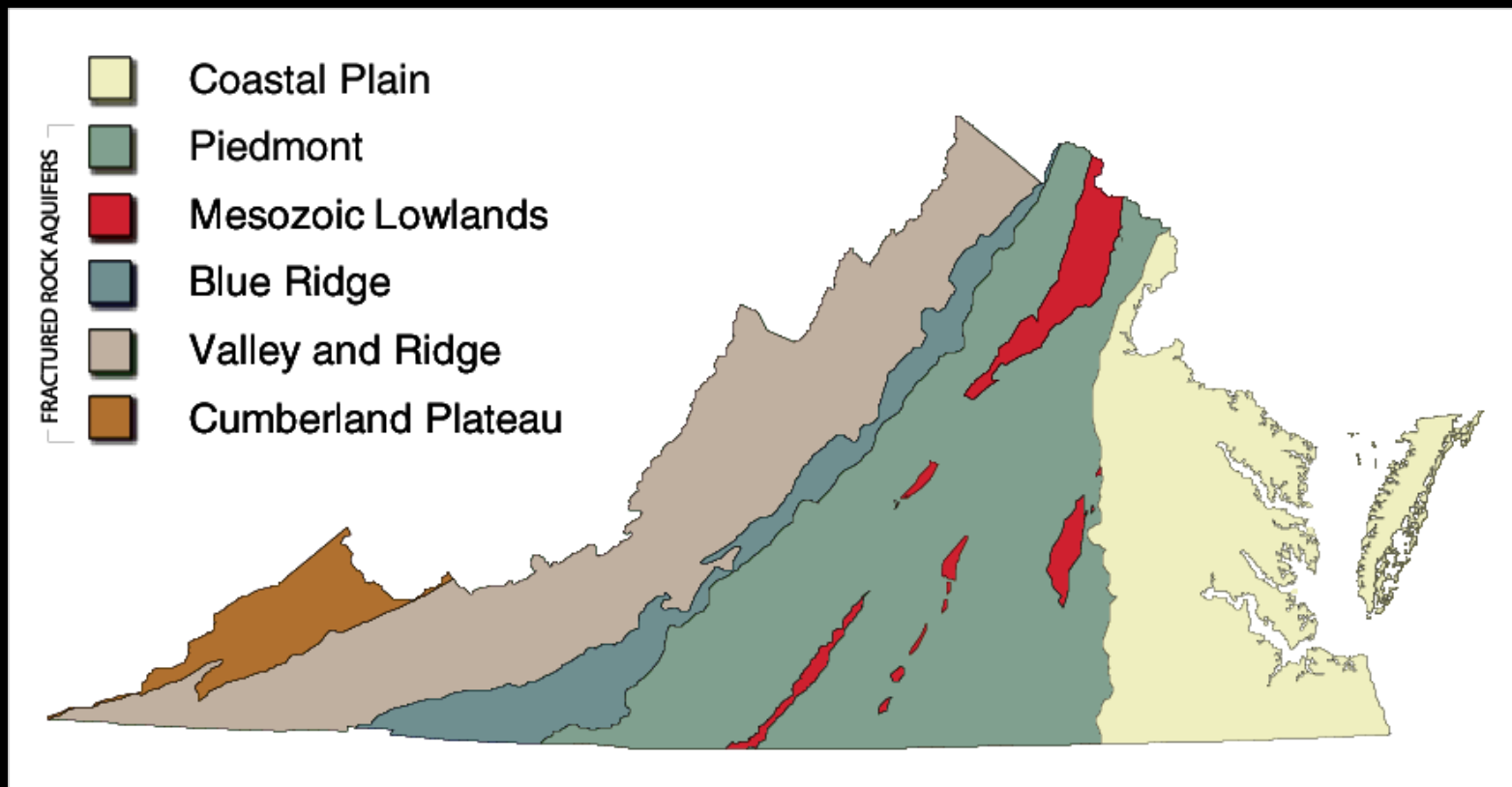
Previous USGS Ground-Water Studies

- Cady, R.C., 1938, Ground-water resources of northern Virginia: Virginia Geological Survey Bulletin 50, 200 p. (pp. 62–81)

- Cederstrom, D.J., 1972, Evaluation of yields of wells in Consolidated rocks, Virginia to Maine: Geological Survey Water-Supply Paper 2021, 38 p.

- Trainer, F.W. and Watkins, F.A., Jr., 1975, Geohydrologic Reconnaissance of the Upper Potomac River Basin: Geological Survey Water-Supply Paper 2035, 68 p.

Ground-Water Use in the United States (1995)

Map of the United States showing estimated percentage of population using ground water as drinking water in 1995:

- WA 61
- MT 52
- ND 57
- MN 80
- VT 64
- NH 61
- ME 60
- OR 40
- ID 96
- WY 57
- SD 70
- WI 70
- NY 35
- MA 46
- RI 26
- NV 31
- UT 56
- CO 22
- NE 87
- IA 78
- MI 46
- PA 41
- CT 54
- NJ 53
- CA 45
- KS 51
- MO 54
- IL 33
- IN 64
- OH 46
- WV 43
- VA 34
- DE 66
- MD 31
- AZ 60
- NM 90
- OK 34
- AR 53
- KY 24
- TN 47
- NC 50
- SC 45
- TX 45
- LA 61
- MS 92
- AL 52
- GA 41
- FL 93
- AK 62
- HI 94
- PR 25
- VI 7

EXPLANATION

60 **Estimated percentage of population in a State using ground water as drinking water in 1995**

USGS

Physiographic Provinces of Virginia

Ground-Water Misconception
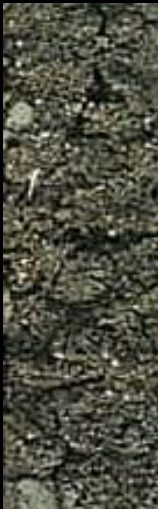
Aquifer Material

Sand

Crystalline rock

Carbonates

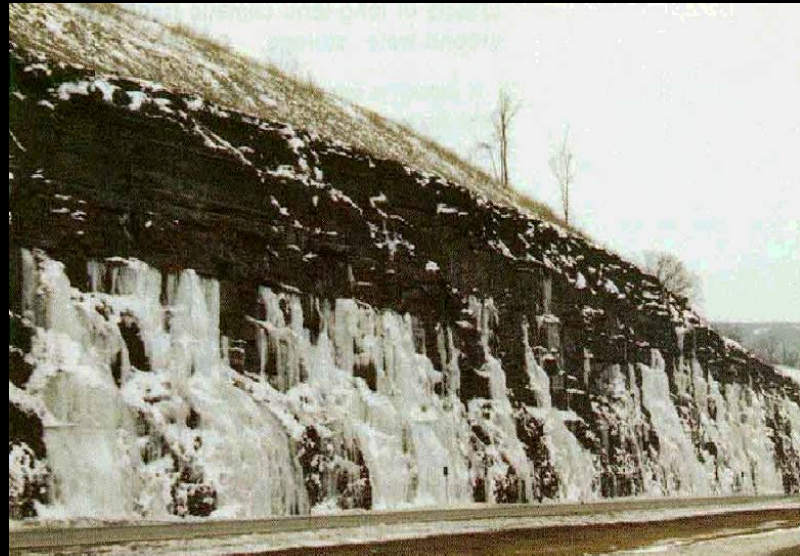Shell material

Sedimentary rock

Coal

Frederick County

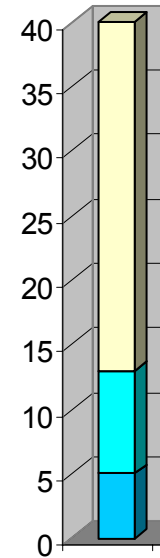# Fractured rock aquifers

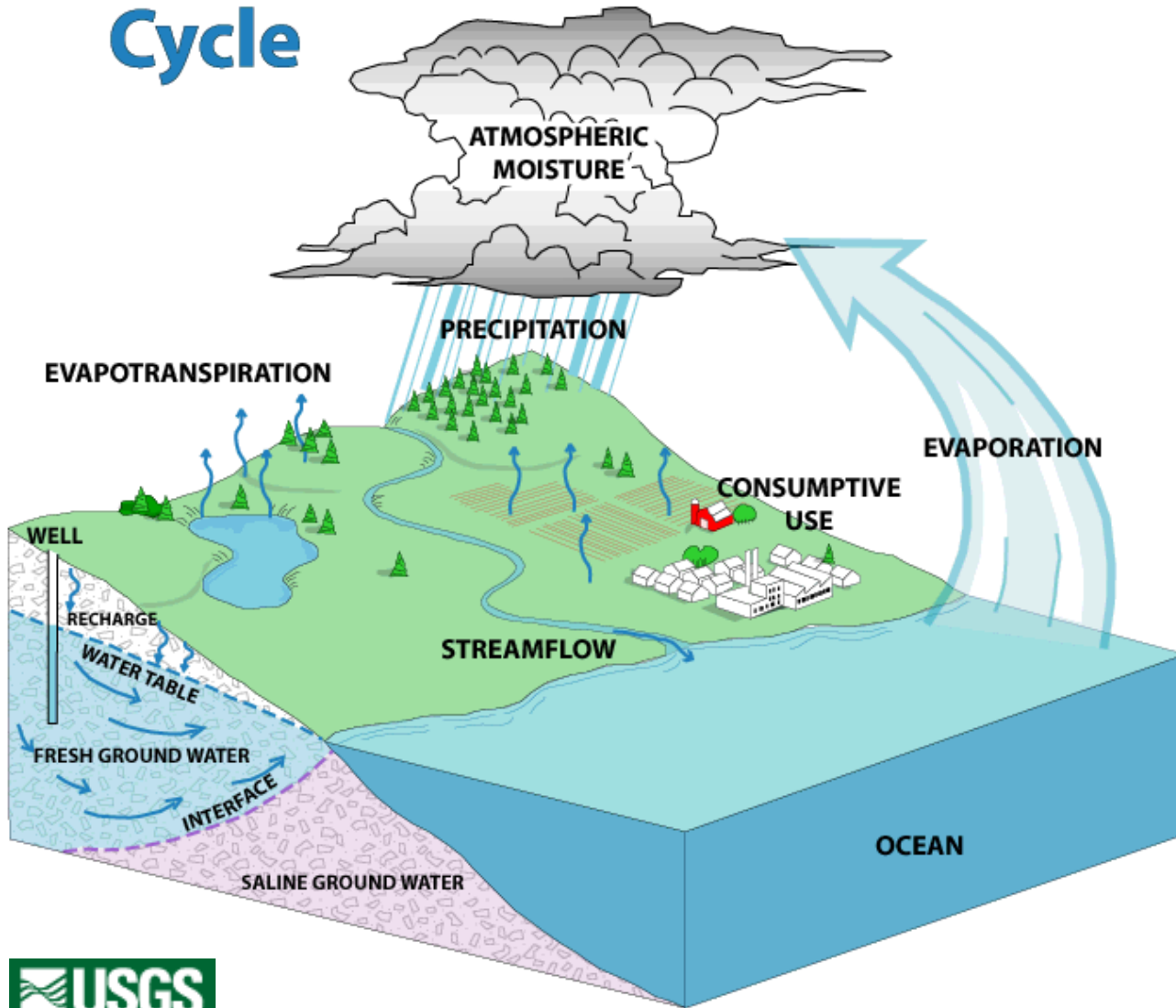Carbonate rock aquifers

Sedimentary rock aquifers
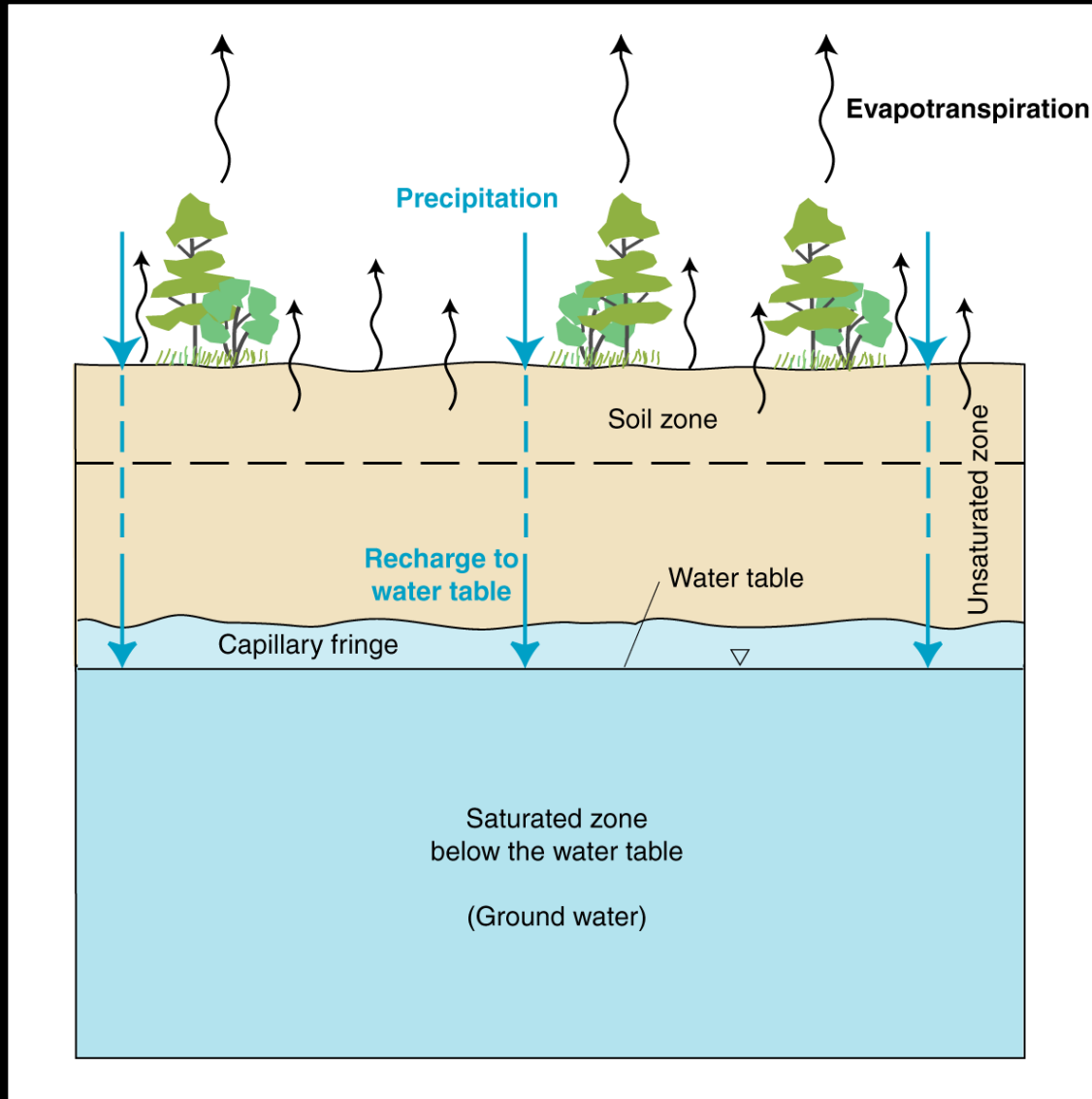
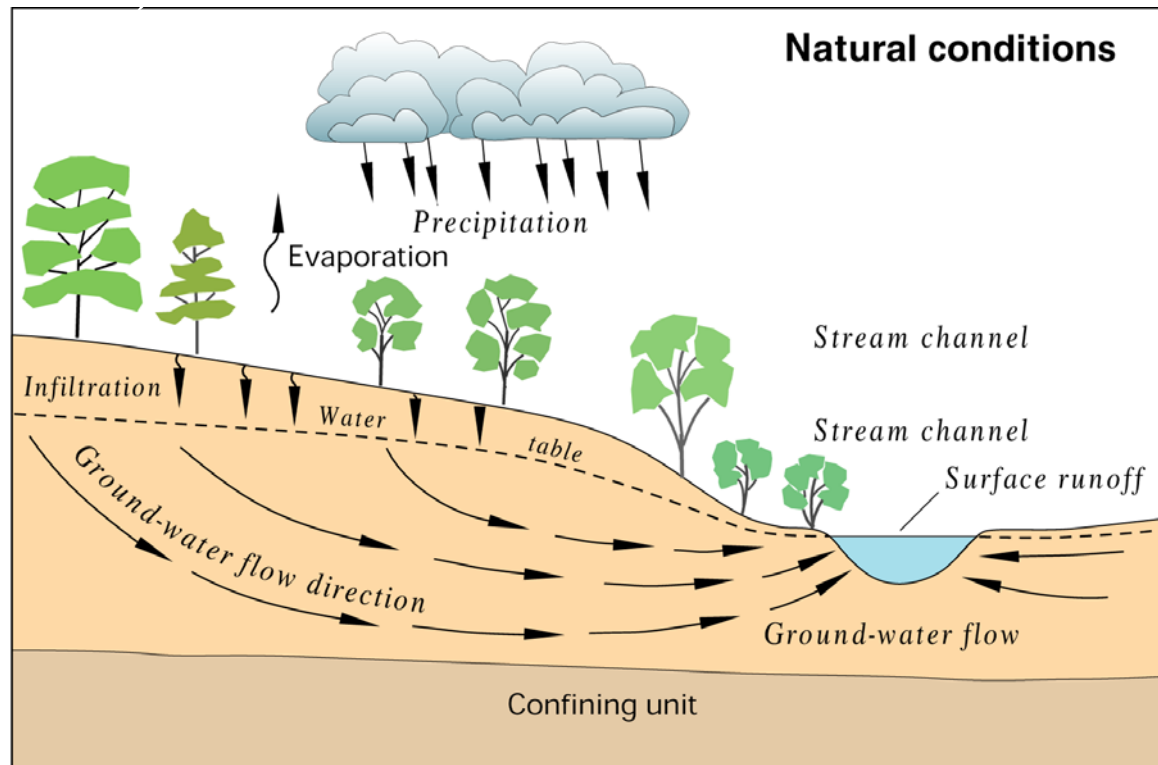

USGS

Karst Aquifers

From "*Living on Karst*"

USGS

Hydrologic Cycle

ATMOSPHERIC MOISTURE

PRECIPITATION

EVAPOTRANSPIRATION

EVAPORATION

CONSUMPTIVE USE

WELL

RECHARGE

WATER TABLE

FRESH GROUND WATER

STREAMFLOW

INTERFACE

SALINE GROUND WATER

OCEAN

USGS

40
35
30
25
20
15
10
5
0

Unsaturated zone, Capillary fringe, Water table, & Saturated zone

Ground-Water-Flow System (*Natural Conditions*)

Natural conditions

Precipitation

Evaporation

Infiltration

Water table

Ground-water flow direction

Stream channel

Stream channel
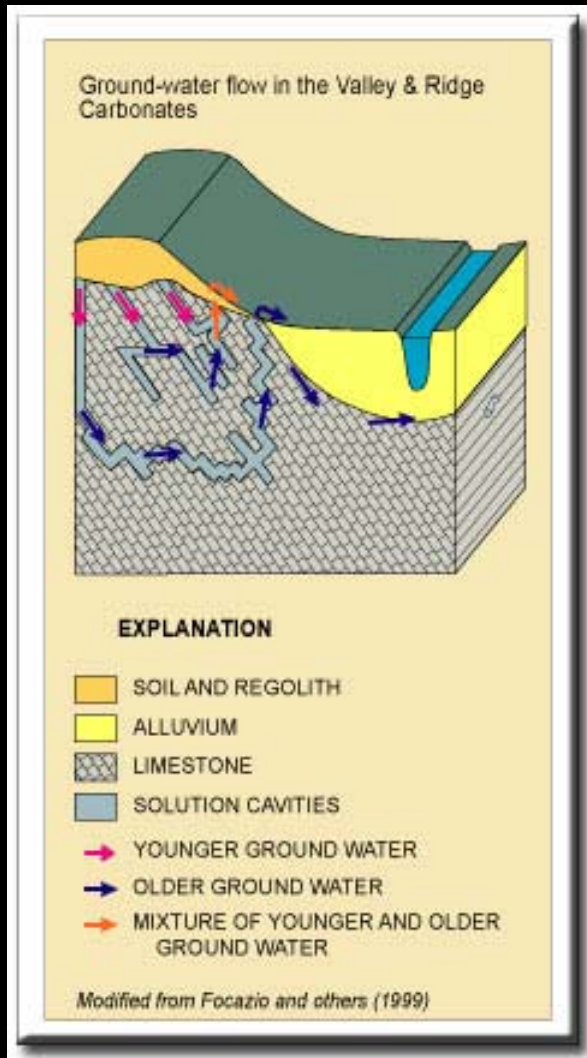
Surface runoff

Ground-water flow

Confining unit

Water is recharged to the ground-water system by percolation of water from precipitation and then flows to the stream through the ground-water system.

# Relation of ground-water pumpage and surface water
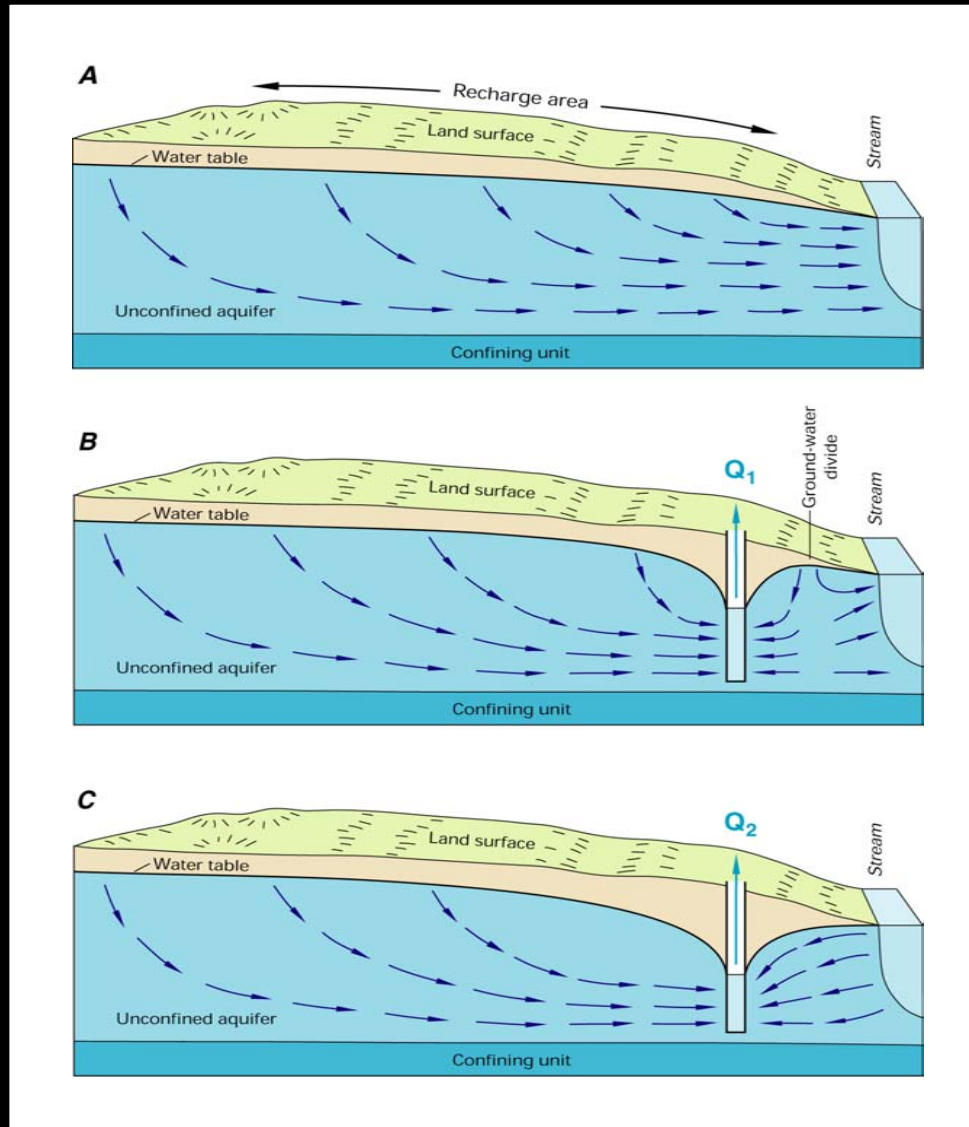
Ground-Water Flow in the Valley & Ridge

Ground-water flow in the Valley & Ridge Carbonates

EXPLANATION

- SOIL AND REGOLITH
- ALLUVIUM
- LIMESTONE
- SOLUTION CAVITIES
- → YOUNGER GROUND WATER
- → OLDER GROUND WATER
- → MIXTURE OF YOUNGER AND OLDER GROUND WATER

Modified from Focazio and others (1999)

Ground-Water Flow

Ground-water flow in the carbonate rocks of the Valley & Ridge occurs (1) in the regolith (alluvium, colluvium, and residuum), (2) along fractures, joints, and bedding plane partings in the bedrock, and (3) in solution channels and cavities (caves) formed by the dissolution of carbonate minerals. Ground-water storage in the carbonate rocks can be in the regolith and in the solution channels and cavities in the bedrock.

USGS

Ground-Water Flow in Carbonate Rocks
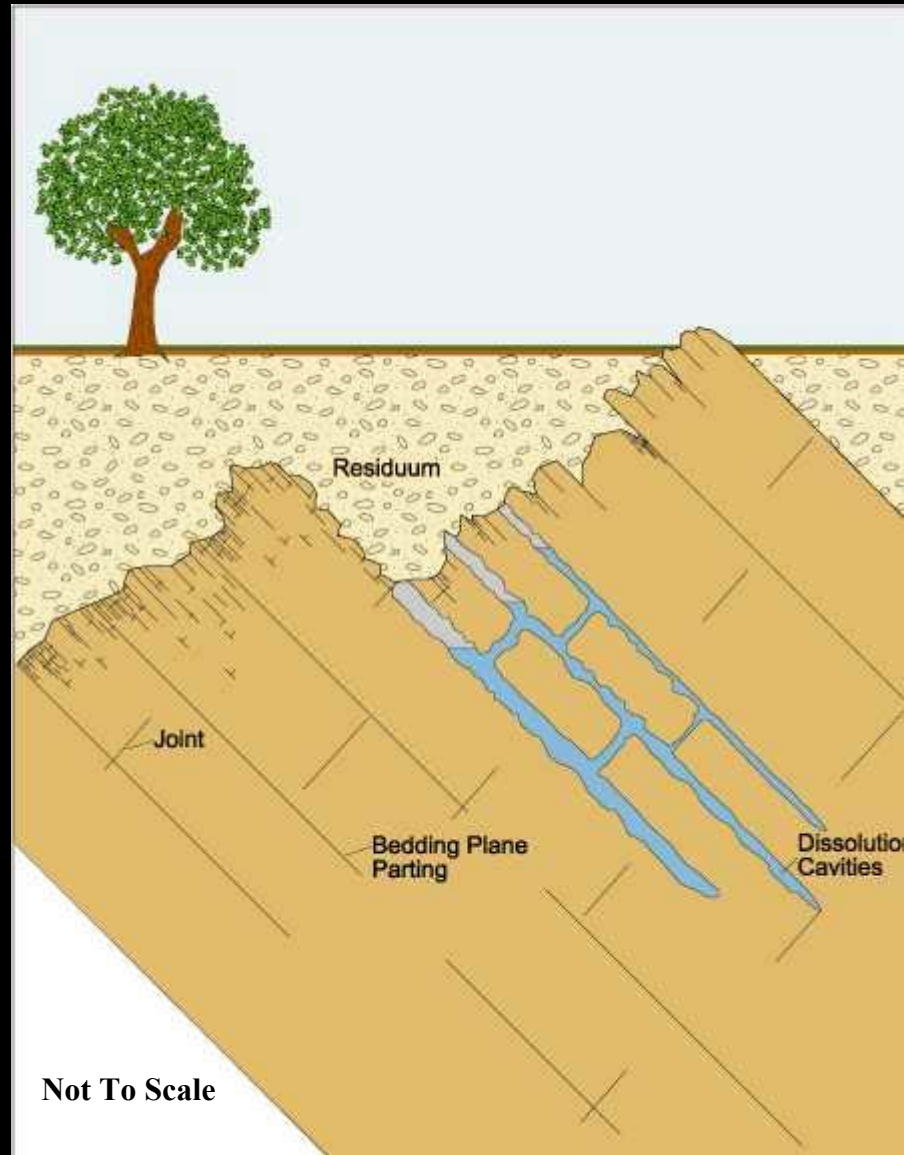
Ground-Water Flow from Karst Spring

Frederick County Carbonate Aquifer Web Link

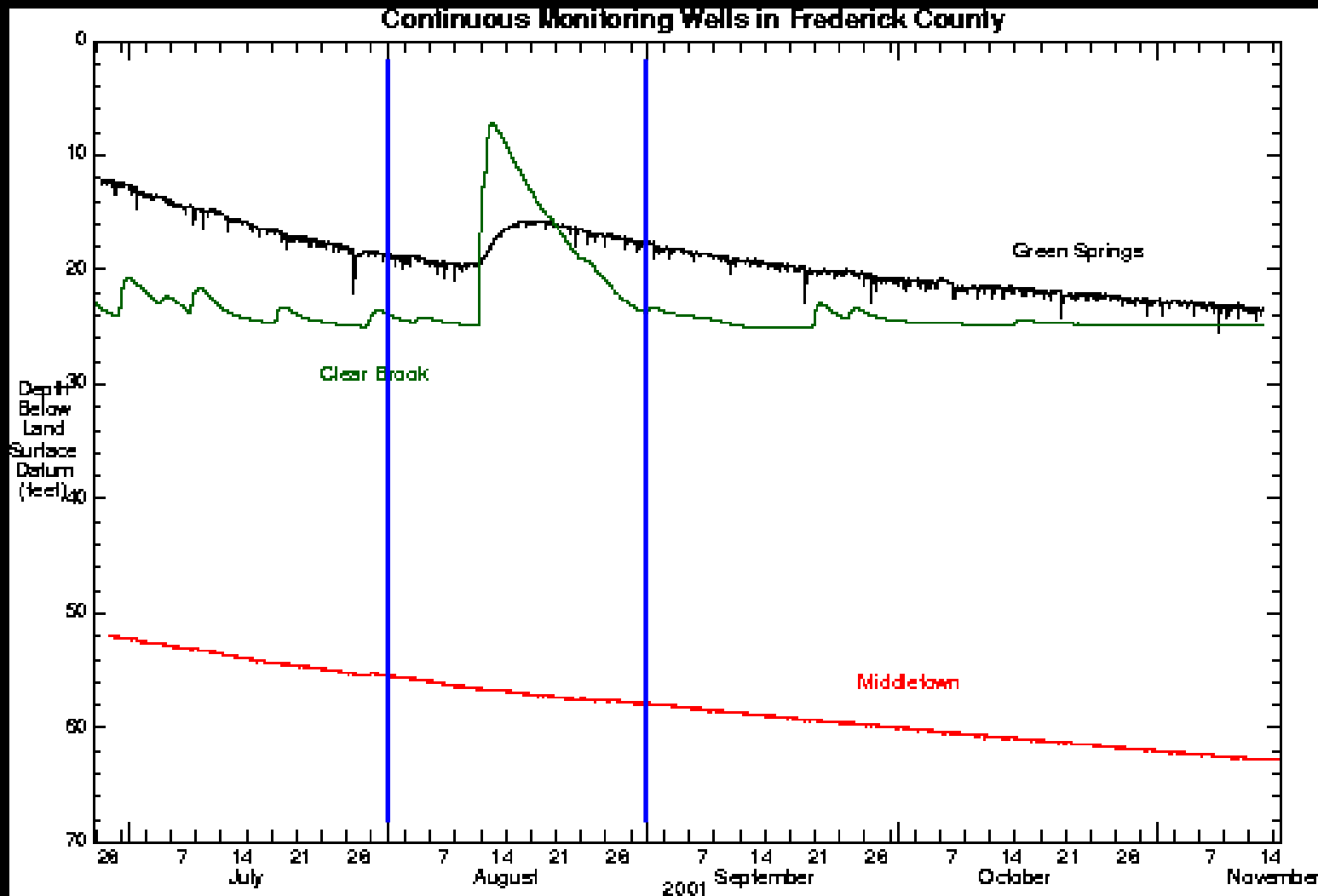- http://va.water.usgs.gov/va134/index.htm

Ground-Water Level Data

USGS

Ground-Water Level Data

Continuous Ground-Water Levels *(Hydrographs)*

Continuous Monitoring Wells in Frederick County

Green Springs

Clear Brook

Middletown

Depth Below Land Surface Datum (feet)

July   August   2001   September   October   November
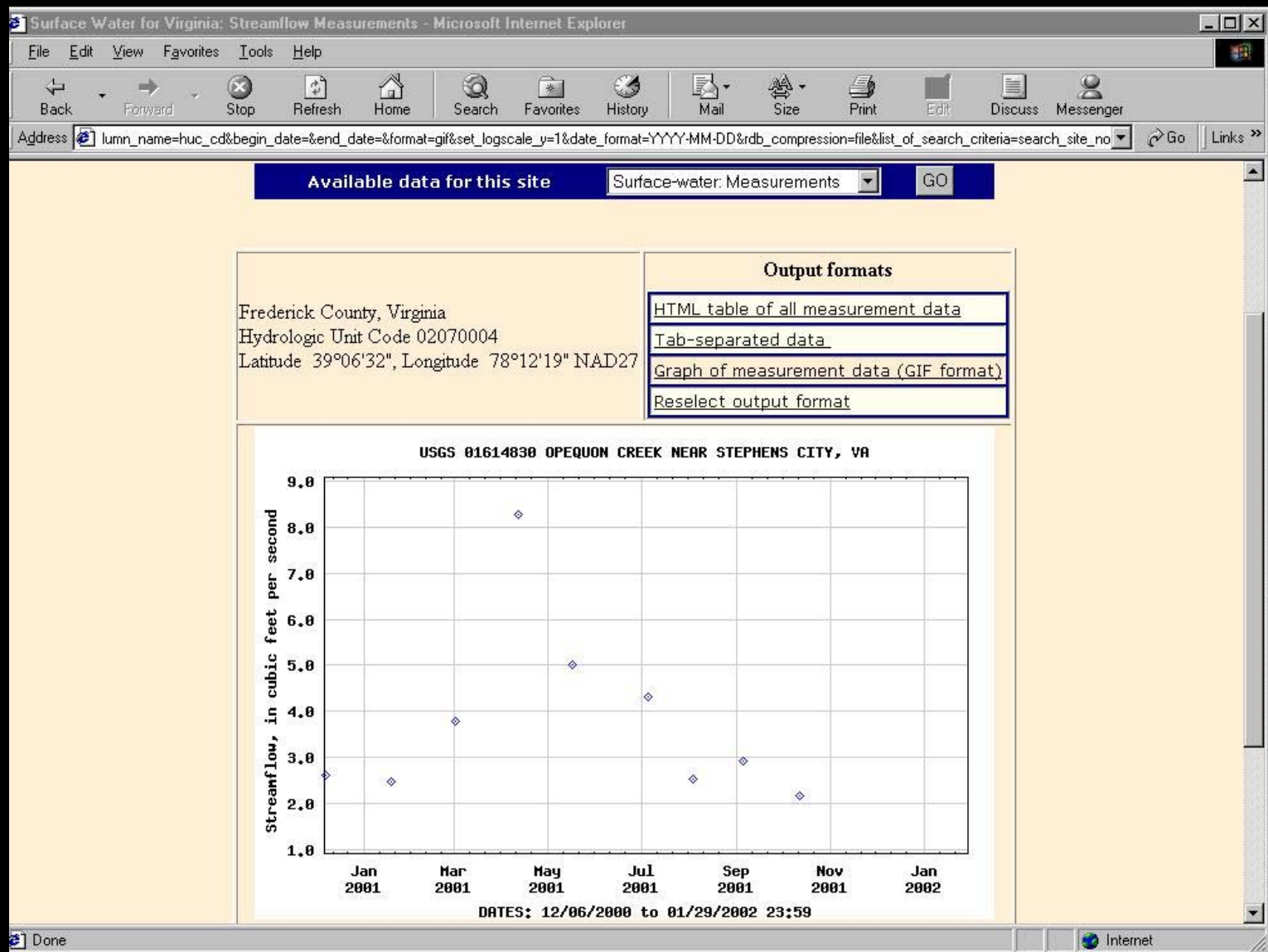
USGS

Instantaneous Ground-Water Levels
(Hydrographs)

Surface-Water Discharge Data

Surface-Water Discharge Data

Types of Drought

"*Meteorological drought** is defined as an interval of time, generally of the order of months or years, during which the actual moisture supply at a given place cumulatively falls short of climatically appropriate moisture supply.
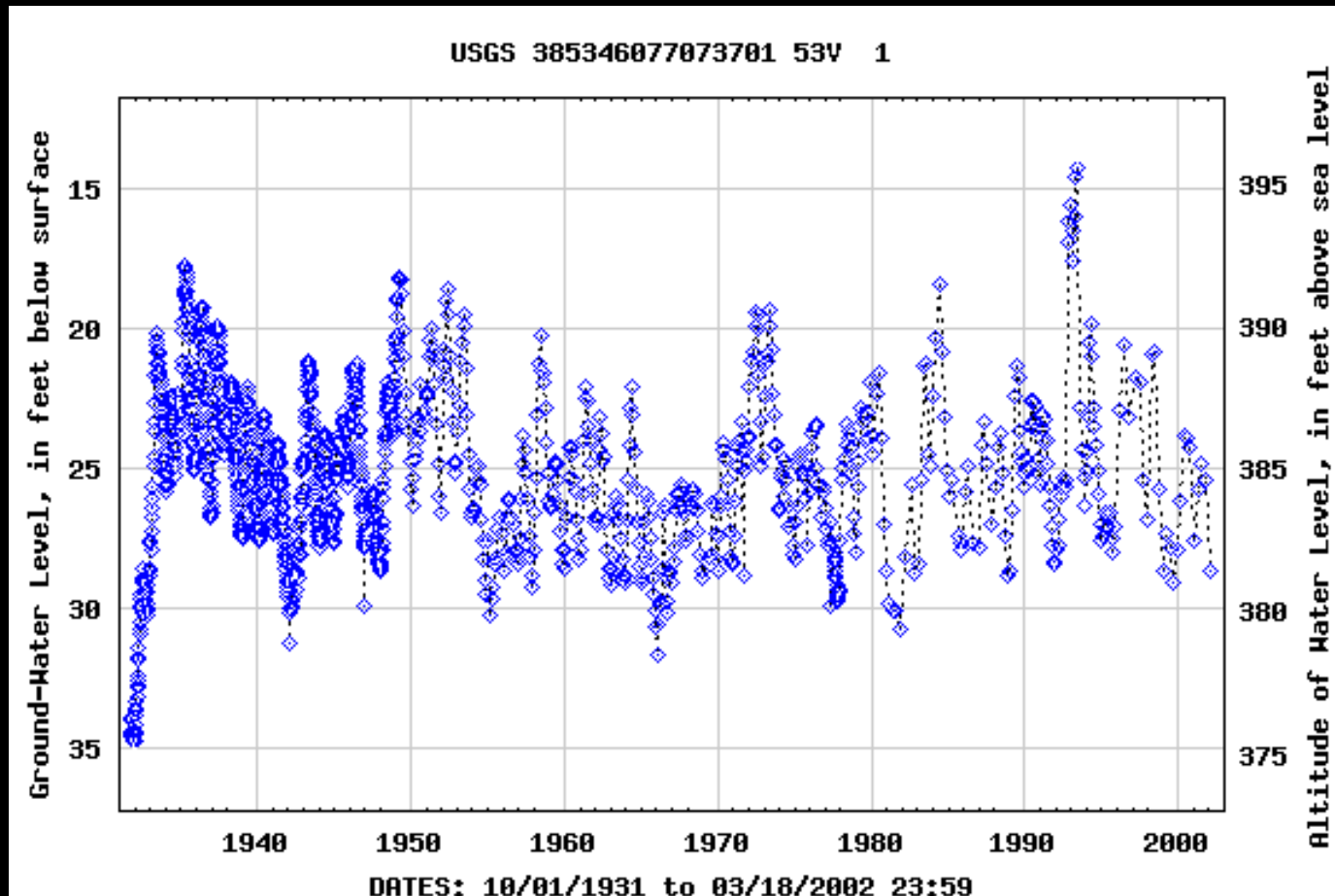
*Agricultural drought** is typically defined as a period when soil moisture is inadequate to meet evapotranspirative demands so as to initiate and sustain crop growth. Another facet of agricultural drought is a deficiency of water for livestock or other farming activities.

*Hydrologic drought** typically refers to periods of below-normal streamflow and/or depleted reservoir storage."
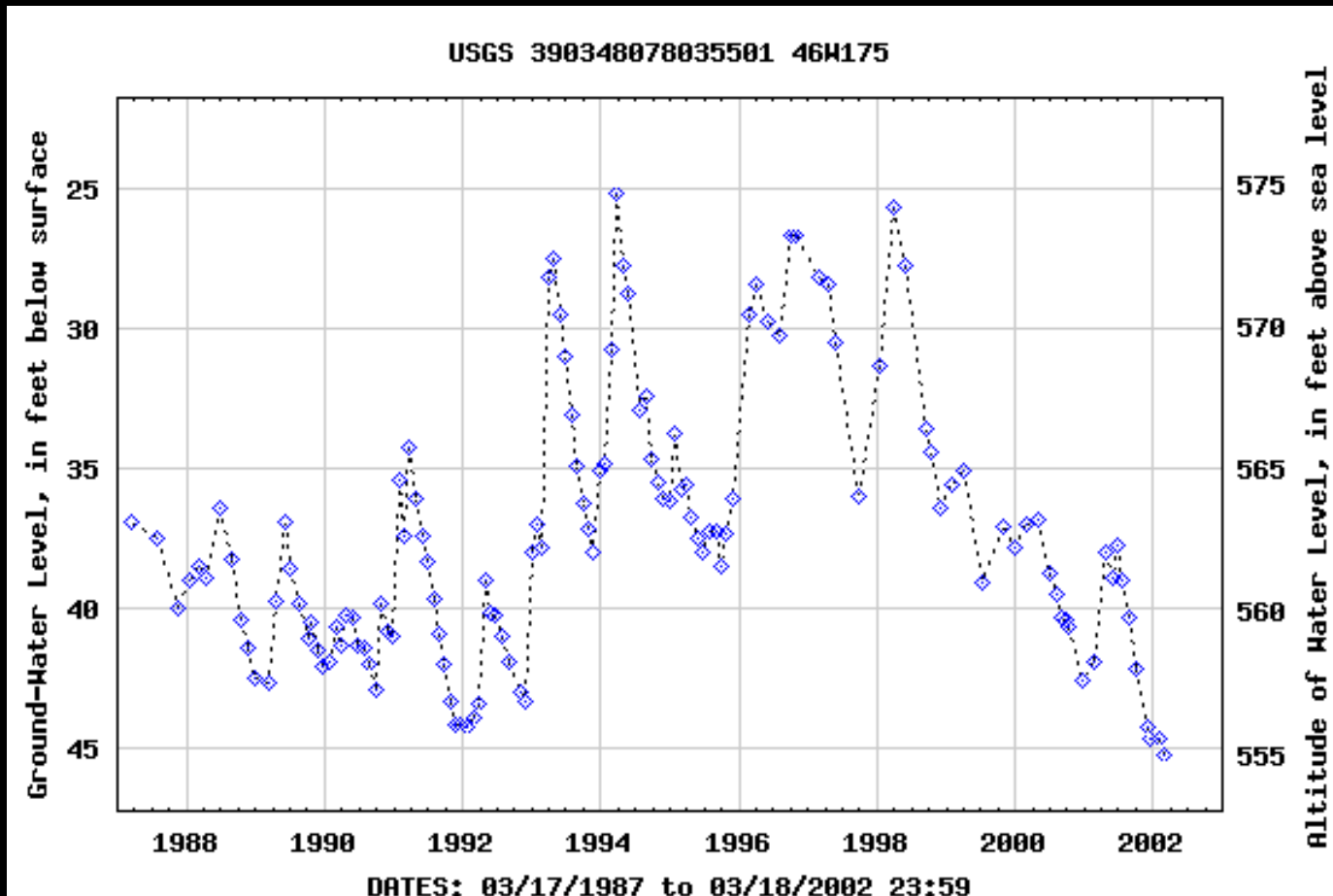
Water-supply drought typically refers to periods when water demand exceeds water availability.

*From pages 2.31 and 2.32 of Maidment David R., editor in chief *Handbook of hydrology*, New York, McGraw-Hill, Inc. 1992.
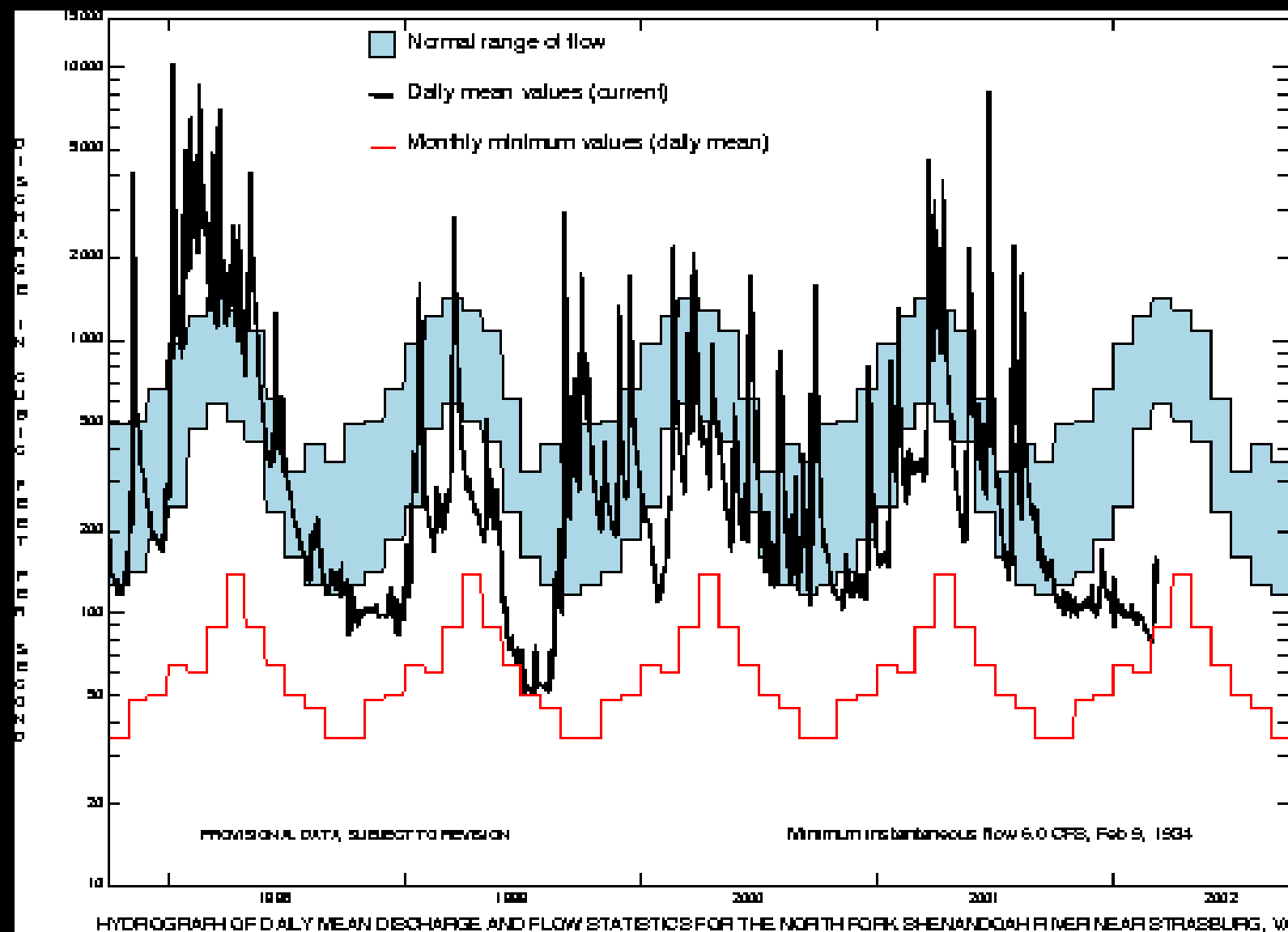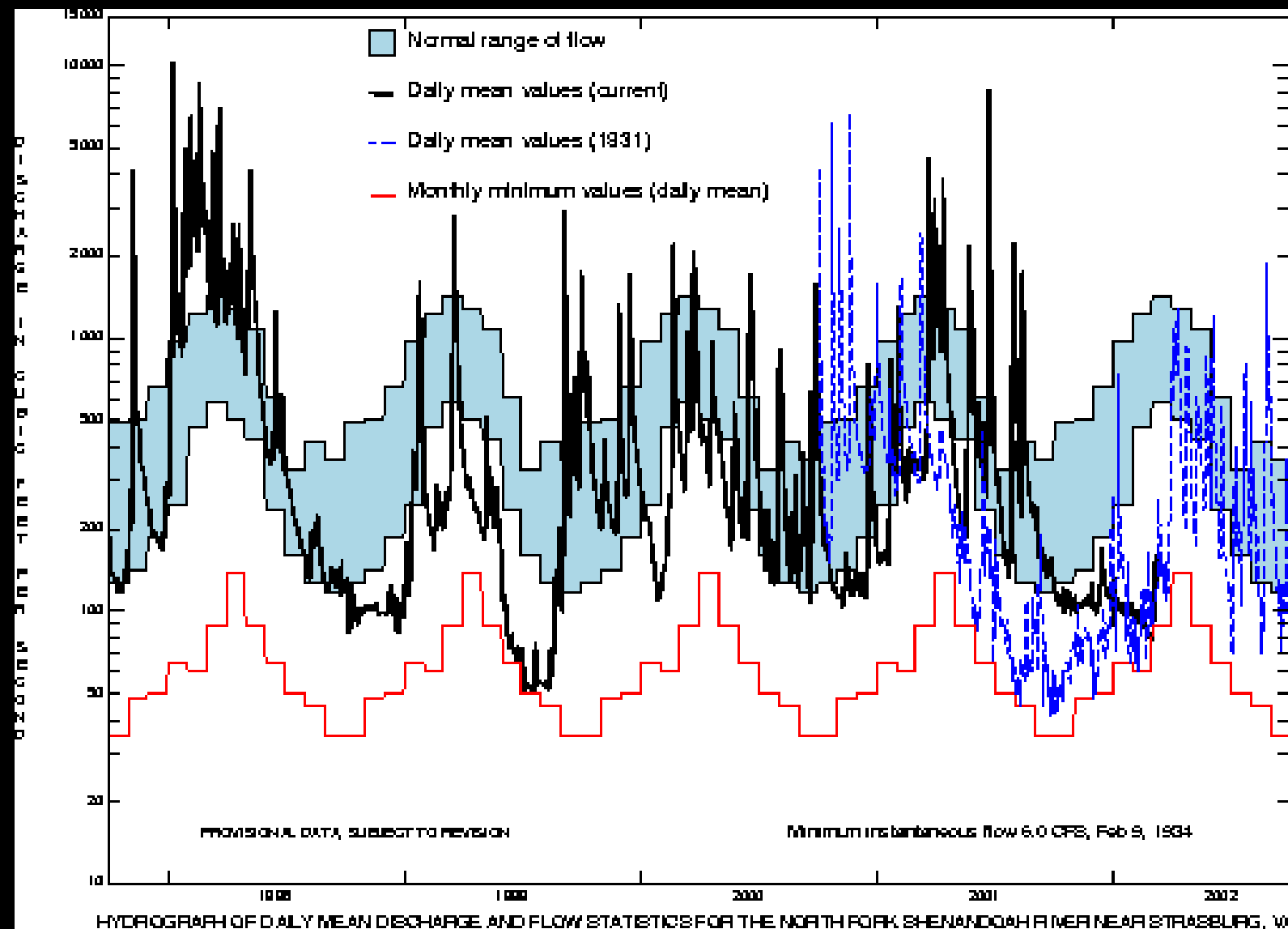
≋ USGS

Ground-Water Levels In Arlington County
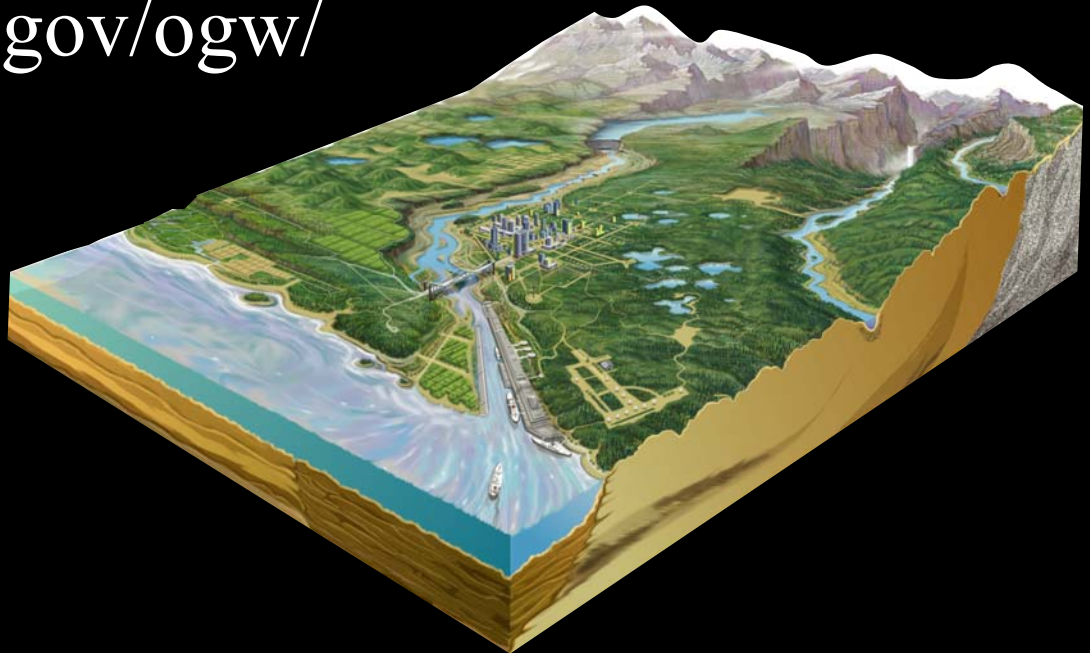
Ground-Water Levels In Clarke County

Streamflow Data

Streamflow Data Comparison with 1931

HYDROGRAPH OF DAILY MEAN DISCHARGE AND FLOW STATISTICS FOR THE NORTH FORK SHENANDOAH RIVER NEAR STRASBURG, VA.

Web Links

- USGS, WRD, Virginia District
http://va.water.usgs.gov/

- USGS, WRD, Office of Ground Water
http://water.usgs.gov/ogw/

Contact information

- George E. Harlow, Jr.

    Hydrologist
    U.S. Geological Survey
    1730 East Parham Road
    Richmond, VA 23228
    804-261-2631 804-261-2659 FAX
    geharlow@usgs.gov

- Donald C. Hayes

    Hydrologist/Surface-Water Specialist
    U.S. Geological Survey
    1730 East Parham Road
    Richmond, VA 23228
    804-261-2632 804-261-2659 FAX
    dchayes@usgs.gov