DELAWARE GEOLOGICAL SURVEY
UNIVERSITY OF DELAWARE, NEWARK
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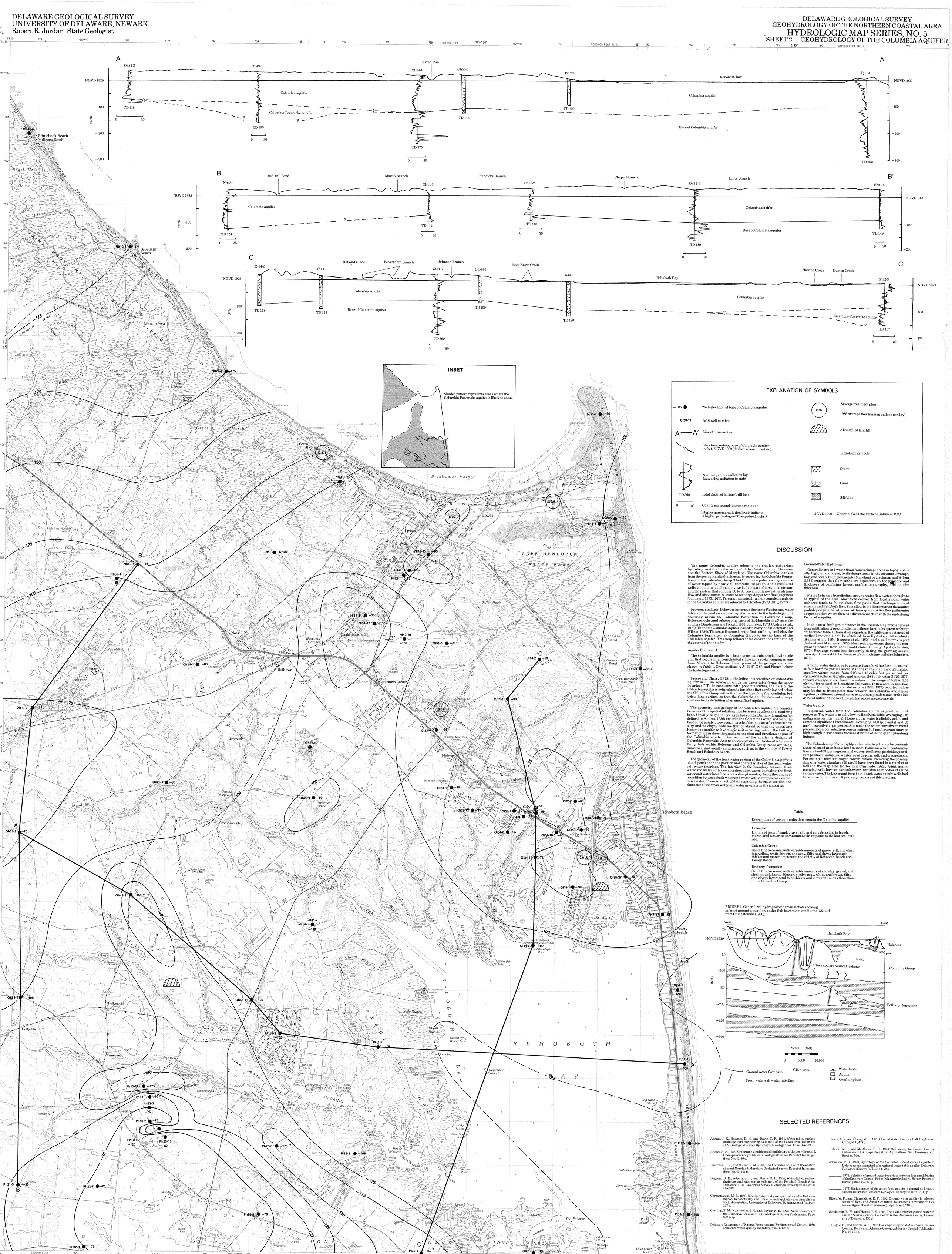
DELAWARE GEOLOGICAL SURVEY
GEOHYDROLOGY OF THE NORTHERN COASTAL AREA
HYDROLOGIC MAP SERIES, NO. 5
SHEET 2 — GEOHYDROLOGY OF THE COLUMBIA AQUIFER



EXPLANATION OF SYMBOLS

- —105 ● Well/elevation of base of Columbia aquifer
- Oi23-11 DGS well number
- A — A′ Line of cross-section
- —100 Structure contour, base of Columbia aquifer in feet, NGVD 1929 (dashed where uncertain)
- Natural gamma radiation log, Increasing radiation to right
- TD 360 Total depth of boring/drill hole
- 0 30 Counts per second/gamma radiation
- (Higher gamma radiation levels indicate a higher percentage of fine-grained rocks.)
- 0.75 Sewage treatment plant, 1986 average flow (million gallons per day)
- Abandoned landfill
- Lithologic symbols: Gravel; Sand; Silt/clay
- NGVD 1929 — National Geodetic Vertical Datum of 1929

DISCUSSION

The name Columbia aquifer refers to the shallow subsurface hydrologic unit that underlies most of the Coastal Plain in Delaware and the Eastern Shore of Maryland. The name Columbia is taken from the geologic units that it usually occurs in, the Columbia Formation and the Columbia Group. The Columbia aquifer is a major source of water tapped by nearly all domestic, irrigation, and agricultural wells, and many public supply wells. It is part of a regional stream-aquifer system that supplies 80 to 90 percent of fair-weather stream-flow and also transmits water to recharge deeper (confined) aquifers (Johnston, 1973, 1976). Persons interested in a more complete analysis of the Columbia aquifer are referred to Johnston (1973, 1976, 1977).

Previous studies in Delaware have used the terms Pleistocene, water-table aquifer, and unconfined aquifer to refer to the hydrologic unit occurring within the Columbia Formation or Columbia Group, Holocene rocks, and subcropping parts of the Manokin and Pocomoke aquifers (Sundstrom and Pickett, 1969; Johnston, 1973; Cushing et al., 1973). The name Columbia aquifer is used in Maryland (Bachman and Wilson, 1984). These studies consider the first confining bed below the Columbia Formation or Columbia Group to be the base of the Columbia aquifer. This map follows these conventions for defining the extent of the aquifer.

Aquifer Framework

The Columbia aquifer is a heterogeneous, anisotropic, hydrologic unit that occurs in unconsolidated siliciclastic rocks ranging in age from Miocene to Holocene. Descriptions of the geologic units are shown in Table 1. Cross-sections A-A′, B-B′, C-C′, and Figure 1 show the hydrologic units.

Freeze and Cherry (1978, p. 48) define an unconfined or water-table aquifer as "... an aquifer in which the water table forms the upper boundary." To be consistent with previous studies, the base of the Columbia aquifer is defined as the top of the first confining bed below the Columbia Group rather than as the top of the first confining bed below land surface, so that the Columbia aquifer does not always conform to the definition of an unconfined aquifer.

The geometry and geology of the Columbia aquifer are complex because of the spatial relationships between aquifers and confining beds. Usually, silty and/or clayey beds of the Bethany formation (as defined in Andres, 1986) underlie the Columbia Group and form the base of the aquifer. However, in much of the map area (see inset) these silty and/or clayey beds are thin or absent so that the underlying Pocomoke aquifer (a hydrologic unit occurring within the Bethany formation) is in direct hydraulic connection and functions as part of the Columbia aquifer. This section of the aquifer is designated Columbia-Pocomoke. Additional complexity is introduced where confining beds within Holocene and Columbia Group rocks are thick, numerous, and areally continuous, such as in the vicinity of Dewey Beach and Rehoboth Beach.

The geometry of the fresh-water portion of the Columbia aquifer is also dependent on the position and characteristics of the fresh water-salt water interface. The interface is the boundary between fresh water and water with a composition of seawater. In reality, the fresh water-salt water interface is not a sharp boundary but rather a zone of transition between fresh water and water with a composition similar to seawater. There is a lack of data regarding the exact position and character of the fresh water-salt water interface in the map area.

Ground-Water Hydrology

Generally, ground water flows from recharge areas in topographically high, inland areas, to discharge areas in the streams, swamps, bay, and ocean. Studies in nearby Maryland by Bachman and Wilson (1984) suggest that flow paths are dependent on the presence and thickness of confining layers, surface topography, and aquifer thickness.

Figure 1 shows a hypothetical ground-water flow system thought to be typical of the area. Most flow derived from local ground-water recharge tends to follow short flow paths that discharge to local streams and Rehoboth Bay. Some flow in the deeper part of the aquifer probably originated to the west of the map area. A few flow paths enter deeper aquifers where there is a direct connection with the underlying Pocomoke aquifer.

In this area, fresh ground water in the Columbia aquifer is derived from infiltration of precipitation into the soil and subsequent recharge of the water table. Information regarding the infiltration potential of surficial materials can be obtained from Hydrologic Atlas sheets (Adams et al., 1964; Boggess et al., 1964) and a soil survey report (Ireland and Matthews, 1974). Most recharge occurs during the non-growing season from about mid-October to early April (Johnston, 1973). Recharge occurs less frequently during the growing season from April to mid-October because of soil-moisture deficits (Johnston, 1973).

Ground-water discharge to streams (baseflow) has been measured at four low-flow partial record stations in the map area. Estimated baseflow values range from 0.03 to 1.45 cubic feet per second per square mile (cfs/mi²) (Talley and Andres, 1986). Johnston (1976, 1977) reports average winter baseflow values in the range of 0.88 to 1.03 cfs/mi² for central and southern Delaware. Differences in baseflow between the map area and Johnston's (1976, 1977) reported values may be due to interaquifer flow between the Columbia and deeper aquifers, a different ground-water evapotranspiration rate, or the less detailed nature of the low-flow partial record measurements.

Water Quality

In general, water from the Columbia aquifer is good for most purposes. The water is usually low in dissolved solids, averaging 118 milligrams per liter (mg/l). However, the water is slightly acidic and contains significant bicarbonate, averaging 6.08 (pH units) and 33 mg/l, respectively, properties that make the water corrosive to metal plumbing components. Iron concentrations (1.6 mg/l average) may be high enough in some areas to cause staining of laundry and plumbing fixtures.

The Columbia aquifer is highly vulnerable to pollution by contaminants released at or below land surface. Some sources of contamination are landfills, sewage, animal wastes, fertilizers, pesticides, petroleum products, industrial wastes, road de-icing salt, and dredge spoils. For example, nitrate-nitrogen concentrations exceeding the primary drinking water standard (10 mg/l) have been found in a number of wells in the map area (Ritter and Chirnside, 1982). Additionally, pumping wells have caused salt-water intrusion near bodies of saline surface water. The Lewes and Rehoboth Beach water supply wells had to be moved inland over 30 years ago because of this problem.

Table 1

Descriptions of geologic units that contain the Columbia aquifer

Holocene
Unnamed beds of sand, gravel, silt, and clay deposited in beach, marsh, and estuarine environments in response to the last sea level rise.

Columbia Group
Sand, fine to coarse, with variable amounts of gravel, silt, and clay; tan, yellow, white, brown, and gray. Silty and clayey layers are thicker and more numerous in the vicinity of Rehoboth Beach and Dewey Beach.

Bethany formation
Sand, fine to coarse, with variable amounts of silt, clay, gravel, and shell material; gray, blue-gray, olive-gray, white, and brown. Silty and clayey layers tend to be thicker and more continuous than those in the Columbia Group.

FIGURE 1. Generalized hydrogeologic cross-section showing inferred ground-water flow paths. Sub-baybottom conditions inferred from Chrzastowski (1986).

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Base map - USGS Topographic Division
Cape Henlopen, Lewes, Fairmount, and Rehoboth Beach quadrangles

UTM GRID AND 1984 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

GEOHYDROLOGY OF THE NORTHERN COASTAL AREA, DELAWARE

by

A. Scott Andres

1987

SCALE 1:24 000

1 0 1 2 KILOMETERS
1000 0 1000 2000 METERS
1 .5 0 1 MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10 000 FEET

CONTOUR INTERVAL 1.5 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
CONTROL ELEVATIONS SHOWN TO THE NEAREST 0.1 METER
OTHER ELEVATIONS SHOWN TO THE NEAREST 0.5 METER
DEPTH CURVES AND SOUNDINGS IN METERS—DATUM IS MEAN LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 1.3 METERS

Projection and 1000-meter grid, zone 18: Universal Transverse Mercator
10,000-foot grid ticks based on Delaware coordinate system
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 7 meters south and 32 meters west as shown by dashed corner ticks

MAP LOCATION