U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
and the GLOUCESTER COUNTY PLANNING BOARD

WATER-RESOURCES INVESTIGATIONS REPORT 92-4128
SHEET 1 OF 5

ABSTRACT

The Kirkwood-Cohansey aquifer system is the unconfined (water-table) aquifer in the 240-square mile upper Maurice River basin and adjacent areas in Gloucester County, New Jersey. This aquifer system is a major source of water in the basin, and withdrawals from it are expected to increase. A water-table map of the Kirkwood-Cohansey aquifer system was constructed from water levels measured in 91 wells and at 90 stream sites throughout the basin. Seasonal fluctuations of water levels in five observation wells typically range from 1 to 3 feet per year. The horizontal hydraulic conductivity of the water-table aquifer ranges from 90 to 250 feet per day, the transmissivity ranges from 4,300 to 20,000 feet squared per day, and the storage coefficient ranges from 0.0003 to 0.044. The vertical hydraulic conductivity of the underlying confining unit is approximately $5x10^{-5}$ feet per second.

A base-flow-separation technique was used to divide measurements of discharge in the Maurice River, Great Egg Harbor River, and Raccoon Creek into base-flow and direct-runoff components. Annual base flow for the Maurice River during 1933-86 ranged from 59.6 to 222 cubic feet per second, which is 74 to 92 percent of total flow. Mean discharge and base flow were determined and low-flow-correlation analyses were made for 12 low-flow partial-record sites. Mean annual precipitation in the study area was 44.5 inches during 1930-88, and mean annual discharge of the Maurice River at Norma was 20.01 inches during 1933-86, or 45 percent of precipitation. Annual potential evapotranspiration is estimated to be 24.8 inches.

Seventeen ground-water-sampling sites distributed throughout the basin were selected for water-quality analysis. No constituents determined exceeded U.S. Environmental Protection Agency primary drinking-water regulations. In several samples, the U.S. Environmental Protection Agency secondary maximum contaminant levels for iron, manganese, and pH were exceeded. The predominant cations in the ground water are sodium plus potassium; the major anion is chloride. The predominant cations in the surface water are sodium plus potassium and calcium; the major anions are chloride and sulfate. Samples from upstream sites show a higher ionic concentration of certain constituents than samples from the downstream sites. Land use was found to affect the quality of ground water and surface water in the basin.

Total consumptive water use in the upper Maurice River basin was equivalent to 0.91 inch of precipitation, or nearly 1,856 million gallons, in 1987. Of this amount, 766 million gallons was used for public water supply, 147 million gallons for private domestic water supply, 909 million gallons for irrigation, and 34 million gallons for industry. A water budget calculated for the upper Maurice River basin shows that ground-water recharge is about 18.57 inches per year.

INTRODUCTION

The unconfined Kirkwood-Cohansey aquifer system has been used for hundreds of years as a source of water for the people and industries of the Coastal Plain of New Jersey. It is, however, the most underutilized of the major aquifers in the Coastal Plain. The New Jersey Department of Environmental Protection (NJDEP) and Gloucester County Department of Environmental Affairs anticipate that the Kirkwood-Cohansey aquifer system will be a significant "new" source of ground water in the future and that the demand for water from this aquifer system will be great (William Whipple, Jr., New Jersey Department of Environmental Protection , oral commun., 1986; Richard Westergaard, Gloucester County Department of Environmental Affairs, oral commun., 1986). This report is a summary of information about the occurrence, availability, use, and ambient quality of ground and surface water in the Kirkwood-Cohansey aquifer system in the upper Maurice River basin, and adjacent areas in Gloucester County, New Jersey. The study was conducted by the U.S. Geological Survey (USGS) in cooperation with the New Jersey Department of Environmental Protection and the Gloucester County Department of Environmental Affairs.

Description of Study Area

The study area consists of approximately 240 mi^2 in Gloucester, Salem, Cumberland, and Atlantic Counties, New Jersey. In Gloucester County, the study area is that part of the county that is underlain by the Kirkwood Formation, the Cohansey Sand, Bridgeton Formation, and younger surficial deposits of Quaternary age. In Salem, Cumberland, and Atlantic Counties, the study area consists of that part of the Maurice River drainage basin north of the USGS gaging station at Norma (01411500) (fig. 1-1).

The study area is drained by the upper part of six streams: the Maurice River (drainage area, 112 mi^2), Great Egg Harbor River (drainage area, 60 mi^2), Mantua Creek (drainage area, 27 mi^2), Raccoon Creek (drainage area, 24 mi^2), Big Timber Creek (drainage area, 10 mi^2), and Oldmans Creek (drainage area, 7 mi^2). The topography varies from relatively flat in the Maurice and Great Egg Harbor River basins to gentle hills in the four remaining basins, which drain northward into the Delaware River. The altitude of the land surface ranges from 47 ft near Norma in Salem County to about 180 ft north of Cross Keys in Gloucester County. The southwestern and eastern parts of the study area are used primarily for agriculture or are forested (fig. 1-2), whereas the northern part of the study area is undergoing rapid development as a result of its proximity to the Philadelphia-Camden metropolitan area. Both residential and commercial development of the study area probably will continue during the next 25 years.

Geologic and Hydrogeologic Units

From oldest to youngest, the major geologic units found in the study area are the Kirkwood Formation, Cohansey Sand, and Bridgeton Formation (fig. 1-3). The lower part of the Kirkwood Formation is primarily micaceous silty clay and clayey silt that locally contains abundant diatoms. The upper part of the Kirkwood Formation is primarily fine- to medium-grained sand that is hydraulically connected to the fine- to coarse-grained sand of the overlying Cohansey Sand and younger deposits. The upper part of the Kirkwood Formation, the Cohansey Sand, and, where present, the Bridgeton Formation, form the Kirkwood-Cohansey aquifer system (table 1-1). Section A-A' (fig. 1-4) shows geophysical logs and the interpreted location of the contact between the underlying confining unit and the Kirkwood-Cohansey aquifer system. Lower parts of the aquifer system may be semiconfined as a result of the presence of clay lenses. Aquifer thickness ranges from a featheredge in the northwest to about 270 ft in the southeast, increasing at a rate of about 15 to 30 ft/mi toward the southeast. The altitude of the base and the thickness of the Kirkwood-Cohansey aquifer system are shown in figures 1-5 and 1-6, respectively.

Acknowledgments

The authors thank the land owners who allowed us access to their wells for water-level measurements and collection of water samples for water-quality analysis. Richard Westergaard and Robert Dixon of Gloucester County were helpful as sources of various geohydrologic and land-use information about Gloucester County.

Table 1-1.--Geologic and hydrologic units with lithologic and hydrologic characteristics of the surficial aquifer in the study area (Modified from Zapecza, 1989)

[ft^2/d, feet squared per day; ft/d, feet per day; ft/sec, feet per second]

System	Geologic unit	Lithologic Characteristic	Hydrogeologic Unit	Hydrologic Characteristics	Thickness (in feet)
Quaternary	Alluvial deposits	Sand, silt, and black mud.	Kirkwood-Cohansey aquifer system	Property / Range; Transmissivity 4300 - 20,000 ft^2/d; Hydraulic conductivity 90 - 250 ft/d; Storage Coefficient $3.0x10^{-4}$ - $4.4x10^{-2}$	0-4
Tertiary	Bridgeton Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly, glauconitic.			0-35
	Cohansey Sand	Sand, quartz, light-colored, coarse-grained, pebbly, local clay beds.			0-150
	Kirkwood Formation	Sand, quartz, grey to tan, very fine-to medium- grained.			0-100
		Clay, very fine-grained, micaceous, dark-colored, diatomaceous.	Confining unit	Vertical hydraulic conductivity approximately $5x10^{-5}$ ft /sec	0-100

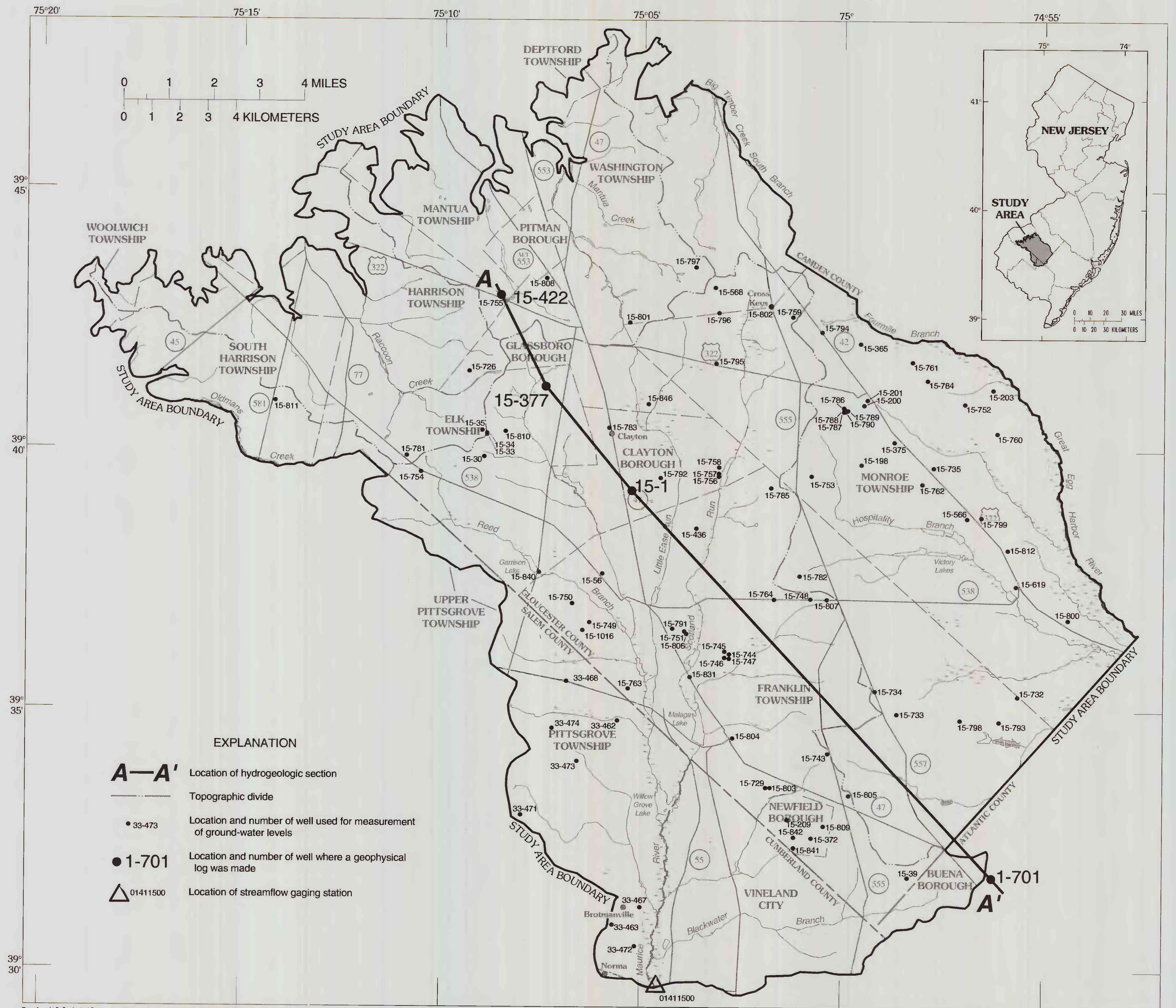

Figure 1-1. Topographic and cultural features, location of observation wells, and location of hydrogeologic section A-A'.

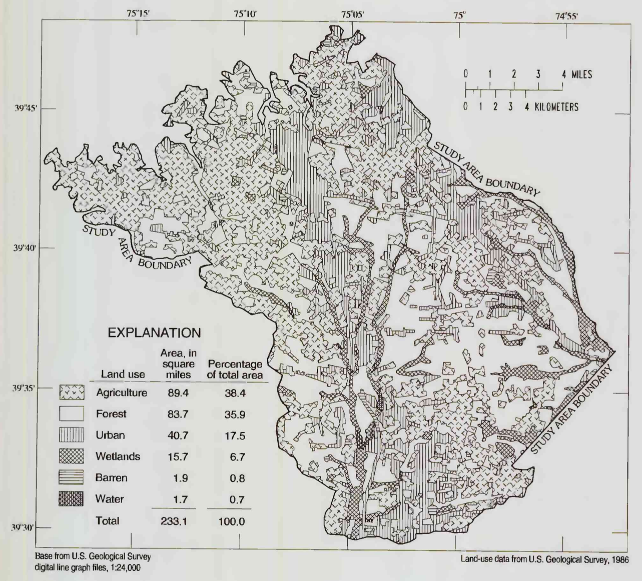

Figure 1-2. Land use in the study area.

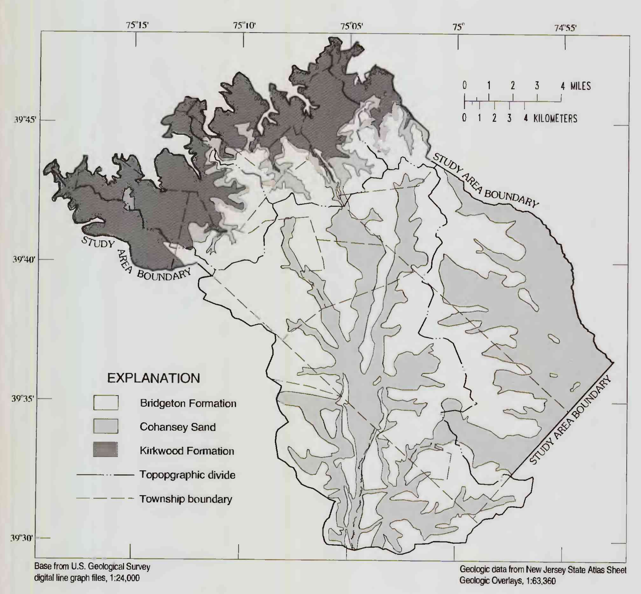

Figure 1-3. Geologic units in the study area.

Table 1-2.--Well identification table for figure 1-2

[* Depth of well in feet below land surface datum; MUA, Municipal Utility Authority; ED, Education; WD, Water Department; IRR, Irrigation; MW, Monitoring well; —, data missing]

Well number	Latitude	Longitude	Township	Local well identifier	Depth*
[illegible]					
15-729	393331	0750154	FRANKLIN	GREEN ACRES FLORIST 1	80
15-732	393517	0745539	FRANKLIN	BIAGI, JAMES 1	89
15-733	393457	0745839	FRANKLIN	WROBEL, ANTHONY 1	110
15-734	393523	0745912	FRANKLIN	DASE, DENNIS	110
15-743	393411	0750022	FRANKLIN	BOARD OF ED LAKE SCHOOL 1	98
15-744	393605	0750250	FRANKLIN	SANITARY LANDFILL EAST	35
15-745	393608	0750257	FRANKLIN	SANITARY LANDFILL NORTH	35
15-746	393601	0750257	FRANKLIN	SANITARY LANDFILL WEST	25
15-747	393600	0750250	FRANKLIN	SANITARY LANDFILL SOUTH	25
15-748	393708	0750049	FRANKLIN	JANVIER FIRE COMPANY 1	105
15-749	393641	0750619	FRANKLIN	DUFFIELD, CLAUDE 1	60
15-751	393631	0750357	FRANKLIN	DELSEA HIGH SCHOOL 2	110
15-763	393525	0750521	FRANKLIN	MOORE , EAYRE 2	60
15-764	393708	0750143	FRANKLIN	SCAFONIS , FELIX	49
15-782	393735	0750105	FRANKLIN	CASSADY, EDITH #1	42
15-785	393917	0750149	FRANKLIN	BEHL ROAD WELL D & M BUILDERS	56
15-791	393634	0750415	FRANKLIN	BOARD OF ED, REUTER SCHOOL	90
15-793	393448	0745606	FRANKLIN	FERRUCCI, MARY 10	50
15-798	393450	0745705	FRANKLIN	ADMIN BUILD GIRL SCOUTS	100
15-803	393331	0750148	FRANKLIN	GREEN ACRES FLORIST 2	95
15-804	393428	0750244	FRANKLIN	BOARD OF ED, MALICA SCHOOL	100
15-805	393322	0745950	FRANKLIN	BOARD OF ED, MAIN ROAD SCHOOL	100
15-806	393628	0750354	FRANKLIN	DELSEA REGIONAL SCHOOL IRR	120
15-807	393708	0750024	FRANKLIN	BASS, JOE 1	105
15-831	393539	0750348	FRANKLIN	FRANKLIN MUA	85
15-726	394130	0750921	GLASSBORO	AURA ORCHARDS SMITH, JOHN	62
15-750	393702	0750639	FRANKLIN	SCHOBER 2	33
15-755	394258	0750836	HARRISON	ZEE, DOUGLAS 1930	35
15-198	393944	0745934	MONROE	LESHAY 1965	141
15-200	394052	0745930	MONROE	MONROE MUA 4	106
15-201	394058	0745925	MONROE	MONROE MUA 5-1967	160
15-203	394110	0745618	MONROE	CARLSON,GUSTAY 2	65
15-365	394203	0745936	MONROE	MONROE MUA 6	44
15-375	394010	0745845	MONROE	MONROE MUA 7-1979	147
15-566	393842	0745655	MONROE	CECIL FIRE COMPANY 1 1	28
15-619	393724	0745542	MONROE	HOSPITALITY CREEK CAMPGROUND 1	98
15-735	393940	0745746	MONROE	DEMATTO , LOU 1	—
15-752	394054	0745700	MONROE	DECORA INCORPORATED 1	120
15-753	393931	0750039	MONROE	PATRICK, CURTIS 1	130
15-759	394232	0750126	MONROE	MESIANO , JIM 1	35
15-760	394020	0745611	MONROE	WILLIAMS , RONALD 1	30
15-761	394142	0745818	MONROE	LUCAS , HARRY IRRIGATION 1	38
15-762	393922	0745803	MONROE	AMERICAN TRAINING 1	32
15-784	394121	0745756	MONROE	PASCHT EDWARD 1	82
15-786	394049	0750000	MONROE	VIOLET PACKING MW 6	35
15-787	394045	0750000	MONROE	VIOLET PACKING MW 4	38
15-788	394046	0745959	MONROE	VIOLET PACKING MW 3	40
15-789	394046	0745954	MONROE	VIOLET PACKING MW 1	40
15-790	394045	0745958	MONROE	VIOLET PACKING MW 2	40
15-794	394216	0750034	MONROE	KNIGHTS OF COLUMBUS 1	85
15-795	394140	0750312	MONROE	SMITH, FRED 1965	100
15-796	394238	0750308	MONROE	SMITH, FRED 5	90
15-799	393843	0745634	MONROE	JESCO 1	130
15-800	393645	0745424	MONROE	BONOCINI NURSERY 1	90
15-801	394227	0750522	MONROE	CHILLARI , JOE 1	85
15-802	394246	0750151	MONROE	WAWA 1	50
15-812	393805	0745554	MONROE	CORONA PUMPS 1	110
15-209	393254	0750121	NEWFIELD	NEWFIELD WD 3	162
15-372	393246	0750127	NEWFIELD	NEWFIELD WD 2-A	154
15-809	393247	0750028	NEWFIELD	NEWFIELD WD 5	179
15-841	393222	0750112	NEWFIELD	SHIELDALLOY MONITORING WELL 7	63
15-842	393234	0750113	NEWFIELD	SHIELDALLOY MONITORING WELL 3	111
15-811	394055	0751412	SOUTH HARRISON	SHOEMAKER , G 1	32
15-568	394305	0750307	WASHINGTON	RALPH SMITH FARM 1	97
15-797	394331	0750343	WASHINGTON	SMITH, FRED HOUSE 1	90
33-462	393449	0750528	PITTSGROVE	WALKER BROTHERS FARM	70
33-463	393047	0750542	PITTSGROVE	RIENMAN, JOHN FOX 1	74
33-467	393113	0750500	PITTSGROVE	LEMORGAN #2	20
33-468	393533	0750653	PITTSGROVE	PIPER POOLS 2	70
33-471	393259	0750800	PITTSGROVE	CONCANNON, RON 1	70
33-472	393028	0750508	PITTSGROVE	LAVIN, HARRY	80
33-473	393401	0750637	PITTSGROVE	PRESS 1	88
33-474	393439	0750714	PITTSGROVE	HUNTER CONSTRUCTION	84
15-422	394259	0750853	HARRISON	ZEE, ORCHARDS 1980-1-	573
15-377	394113	0750727	ELK	IACONIANI, J 1	365
15-001	393913	0750517	CLAYTON	CLAYTON WD 3	800
01-701	393148	0745617	BUENA	BUENA MUA TW 1	460
15-1016	393633	0750630	FRANKLIN	DUFFIELD 2	60

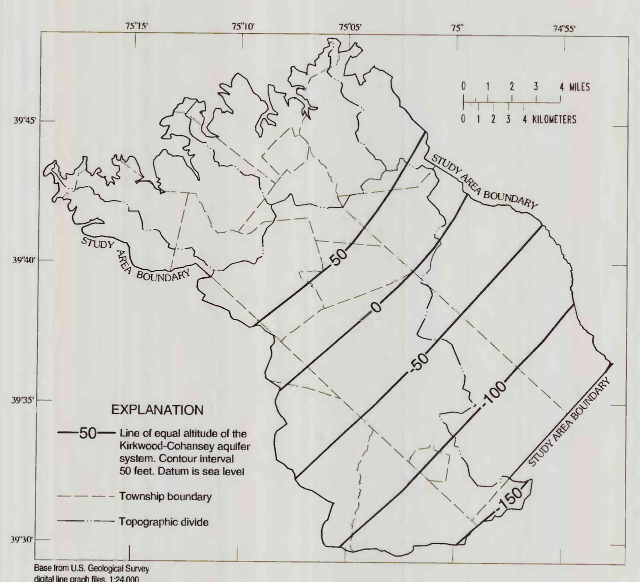

Figure 1-5. Altitude of the base of the Kirkwood-Cohansey aquifer system in the study area. (Hydrogeology from Zapecza, 1989, pl. 23.)

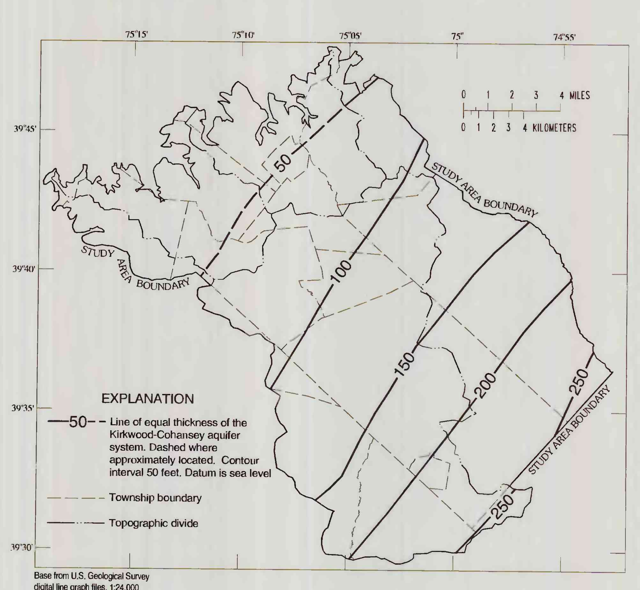

Figure 1-6. Thickness of the Kirkwood-Cohansey aquifer system in the study area. (Hydrogeology from Zapecza, 1989, pl. 24.)

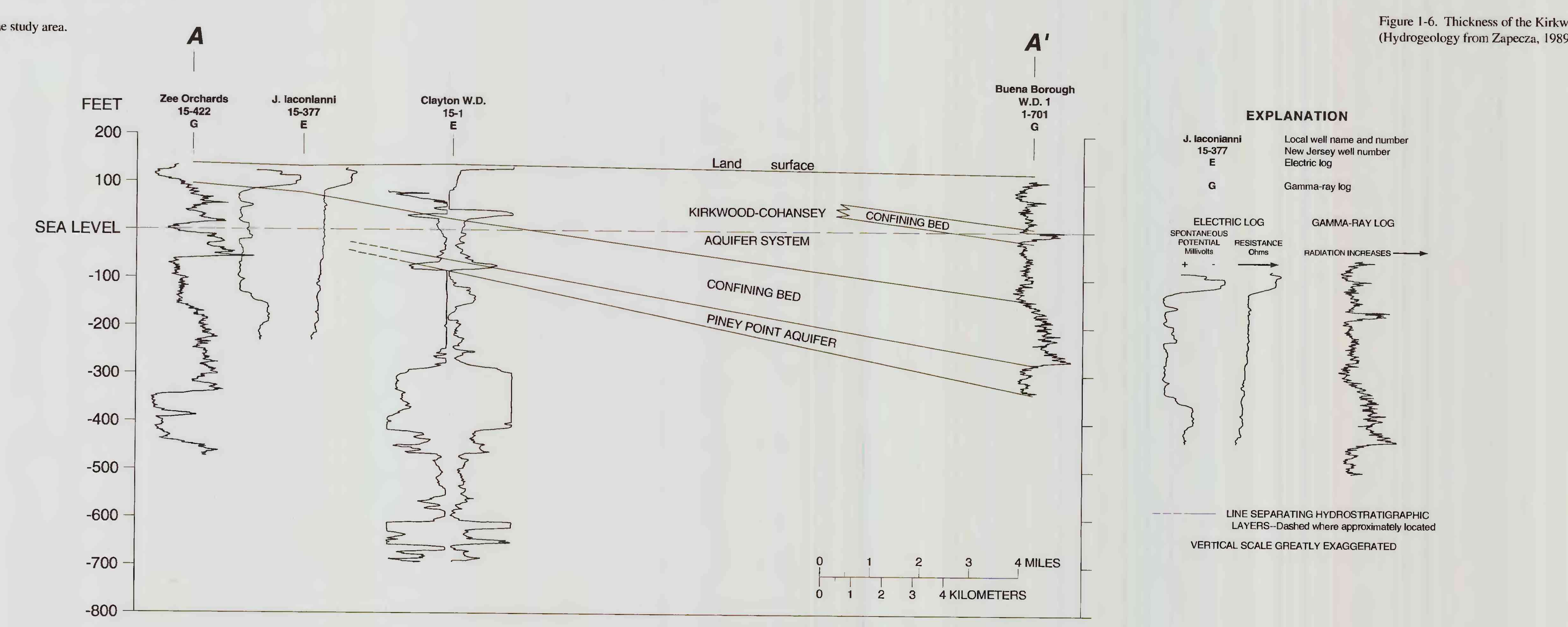

Figure 1-4. Hydrogeologic section A-A' through the study area. (Location is shown in fig. 1-2.)

HYDROLOGY OF THE UNCONFINED AQUIFER SYSTEM IN THE UPPER MAURICE RIVER BASIN AND ADJACENT AREAS IN GLOUCESTER COUNTY, NEW JERSEY, 1986-87

by
Pierre J. Lacombe and Robert Rosman

1995