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July 16, 1987

Maryland. Coastal Zone Management Program

GROUNDWATER PROTECTION REPORT

SOMERSET COUNTY, MARYLAND

Prepared for
DEPARTMENT OF TECHNICAL AND COMMUNITY SERVICES
Somerset County, Maryland

Prepared by
DUNN GEOSCIENCE CORPORATION
5000 Lenker Street, Mechanicsburg, PA 17055

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1. INTRODUCTION

1.1 Background and Purpose

Pursuant to COMAR 10.17.02 (November 18, 1985), new regulations governing the placement of sewage disposal systems in areas of high ground water conditions have been promulgated for Somerset and other counties for those areas which currently are not served by public water and sewer. The purpose of these new regulations is to establish guidelines for the protection of potable ground water supplies against contaminants emanating from on-site sewage disposal systems by requiring a minimum four (4) foot treatment zone for attenuation of seepages percolating from the bottom of the on-site sewage disposal system. Generally, in order to achieve the highest possible level of septic tank effluent waste treatment, a four (4) foot minimum of renovating soil is desirable. This zone of renovating soil must occur above the water table and have a permeability rate which allows the effluent to move sufficiently slow through the soil in order for the designed cleansing action to occur. For this to occur an evaluation of the suitability of the soil to perform the necessary attenuation should be determined following a logical sequence of investigations for soil type and classification, definition of limiting zones within or below the treatment zone, soil permeability, depth to water, and other criteria.

The use of a conventional in-ground gravity disposal system can be considered in those areas where suitable subsurface soil materials are present and high water table conditions, within less than five feet of the ground surface, do not exist. If, however, limiting zones or high water table conditions are prevalent, system failure or serious limitations on the adequate performance of conventional systems for disposal treatment may result. In these areas more sophisticated or complex disposal systems are required. Other than elevated sand mound systems these alternative, non-conventional systems generally rely on innovative or experimental design to allow for the disposal of the wastewater. Variations on the elevated sand mound systems which artificially create the necessary treatment zones are also sometimes implemented. These systems, if properly designed, constructed and maintained can provide the required renovation within areas where only limited treatment will occur with conventional systems. Unfortunately the alternative systems generally are more costly than conventional systems and may be prone to failure unless properly designed, constructed and maintained.

In Somerset County, as well as other coastal plain counties on the lower eastern shore of Maryland, high water table conditions commonly occur seasonally or even year round. Ground water penetration by seepage to the shallow aquifer has been permitted in those areas where less than a four (4) foot treatment zone exists. Ground water penetration involves the direct discharge of septic tank effluent into the shallow surficial aquifer provided the following criteria have been satisfied:

- Thick impermeable clays or an aquiclude exists between the receiving surficial material and the deeper potable water bearing aquifers;
- Water supply wells do not utilize the same surficial material;
- Water supply wells penetrating a deeper confined aquifer must be at least 150 feet from the sewage disposal facility;
- A maximum housing density of 160 residences per square mile must be satisfied;
- Alternative septic systems are constructed and sized which meet with County and State health official approval; and,
- Adequate protection of potable aquifers presently not in use is provided.

In general, the above criteria or guidelines have been useful in safeguarding the public health while at the same time avoiding widespread contamination of the primary ground water supplies for the area. However, considering possible increases in local population densities, housing and septic disposal/treatment requirements, more definitive mapping and characterization of the County's various shallow and deep ground water aquifers are necessary to satisfy the new regulations, and thereby preclude widespread degradation of the County's surficial aquifer. Thus, development of this "Ground Water Protection Report" for the purpose of identifying and characterizing aquifers and confining layers (aquicludes) occurring at depth or within the surficial soil zones is needed in order to establish a hierarchy for aquifer protection across the County. The document establishes "Management Areas" and management strategies including general density, design and construction requirements for the sewage disposal systems and minimum construction details for water supply wells tapping the County ground water aquifers.

2. DATA COMPILATION

2.1 Methodology

Data for this Ground Water Protection Report were collected from published reports, documents, and maps from the U.S. Geological Survey, the Maryland Geological Survey, the Soil Conservation Service, the Maryland and Somerset County Health Departments, and the Somerset County Department of Technical and Community Services. Valuable information also was obtained through technical discussions with knowledgeable personnel in these various agencies. In addition, numerous well records and chemical data which are currently on file with the County Health Department and the Maryland Department of Natural Resources, Water Supply Division were reviewed. This information was compiled and carefully analyzed for use in preparing this report. A detailed listing of references is provided at the end of this report.

As an initial step in the preparation of the report, available published and unpublished data sources were accumulated and reviewed for technical pertinence to the study. Specific information pertaining to current regulations, practices and conditions were reviewed to become familiar with present policies. Geologic mapping, hydrogeologic reports, and soil survey data were also reviewed and cross referenced with selected well records to verify the existing surface and subsurface materials and their characteristics. Data regarding specific wells, aquifer hydraulics and chemistry were verified primarily through the available published materials and technical discussions with State and County personnel.

However, due to the volume of well records and chemical analyses a complete and thorough review of archived documents was not possible in the given time frame. Hence, certain "gray areas" exist if not only for this reason but also for the lack of reported geologic, chemical and hydrologic information for some areas in Somerset County. For instance Smith Island is an area with a number of existing wells but sparse data are available. As a result gross generalizations were made regarding aquifer usage, water quality and hydrologic characteristics. Another area of concern is in the northeast designated as "Management Area A" in Figure 4-1. Although the Geologic Map of Somerset County shows (geologic) cross sections through this area, subsurface geology was not fully described in detail other than what is shown by section C-C' on the Generalized Cross Section map (see Exhibit II). Additional cross sections may be delineated as more well logs are recorded and reviewed. The County might consider implementing a controlled drilling and sampling program to establish an organized and complete listing of wells and test holes which would be used for future reference. Such information would be useful in attempting to eliminate any gray areas. Another alternative for data collection would require the landowner or developer to provide detailed information concerning well characteristics and water quality.

Subsequent to review of available reference materials general mapping of the County's principal aquifers was performed. Geologic cross sections delineating subsurface aquifers, aquicludes, and water levels were prepared based on available well data in conjunction with published geologic cross sections for this region. In addition, the compilation of principal soil types on a common map base for the entire County from available sources was also completed to aid in delineation of the "Management Area" designations. A map showing the approximate boundaries of the two principal Management Areas (A and B) as well as a technical discussion of the rationale used to designate these areas is contained in this report. Finally, technical criteria to be considered for the protection of the ground water resource in these management areas are also discussed.

3. GENERAL HYDROGEOLOGIC FRAMEWORK

Somerset County is located near the southern end of the Delmarva Peninsula on the Eastern Shore of Maryland. Lying within the Coastal Plain Physiographic Province, the County is characterized by relatively flat terrain, generally less than 20 feet in elevation. In the northeast portion of the County near the Worcester County line, elevations approach 50 feet above mean sea level. Somerset County is underlain by unconsolidated layers of sand, silt, clay and gravel deposits that thicken and dip gently to the southeast.

Most in-land soils of Somerset County are characterized as moderately to very poorly drained silt and clay loams. A loam is a soil composed of a mixture of clay, silt, sand and organic matter. These silty and clayey loams constitute more than half the soil types present throughout the County (see Figures 3-1, 3-2 and 3-3). All along the western boundary of the County (including Smith and South Marsh Island) and those surface areas bordering the County's estuaries, the predominant soil type is Tidal Marsh. This particular soil type accounts for nearly one-third of the soils in the County. Where soils are present throughout the County they may be as much as 20 feet thick. For ease of evaluation, the surficial soils are designated as overburden on geologic cross sections within this report due to the inconsistency of drill log notations and soil descriptions. Throughout the County the water table is usually encountered within 10 feet of ground surface. In areas of high-yield, long term well production, water levels may be depressed as much as 50 feet. This continued depression may cause saltwater intrusion or upwelling to the potable aquifers. Surface water drainage is generally directed south to the Pocomoke Sound and west to the Tangier Sound.

Four principal aquifers exist throughout Somerset County. In descending order from shallowest to deepest, these are the Columbia (Pleistocene - Pliocene), the Pocomoke, the Manokin, and the Cretaceous Series. Tables 3-1A and B show aquifer type specifications defined by COMAR 10.50.01 as well as reported specific aquifer transmissivities and concentrations of total dissolved solids. Based on reported chemical data and hydraulic parameters for silty sands, the four aquifers appear to meet the State's criteria for both Type I and II aquifers (Table 3-1). Ground water quality for these aquifers is generally good on a regional basis. Artesian conditions prevail for the Pocomoke, Manokin and Cretaceous aquifer where they are overlain by a confining clay layer. A general hierarchy of recommended aquifer usage follows.

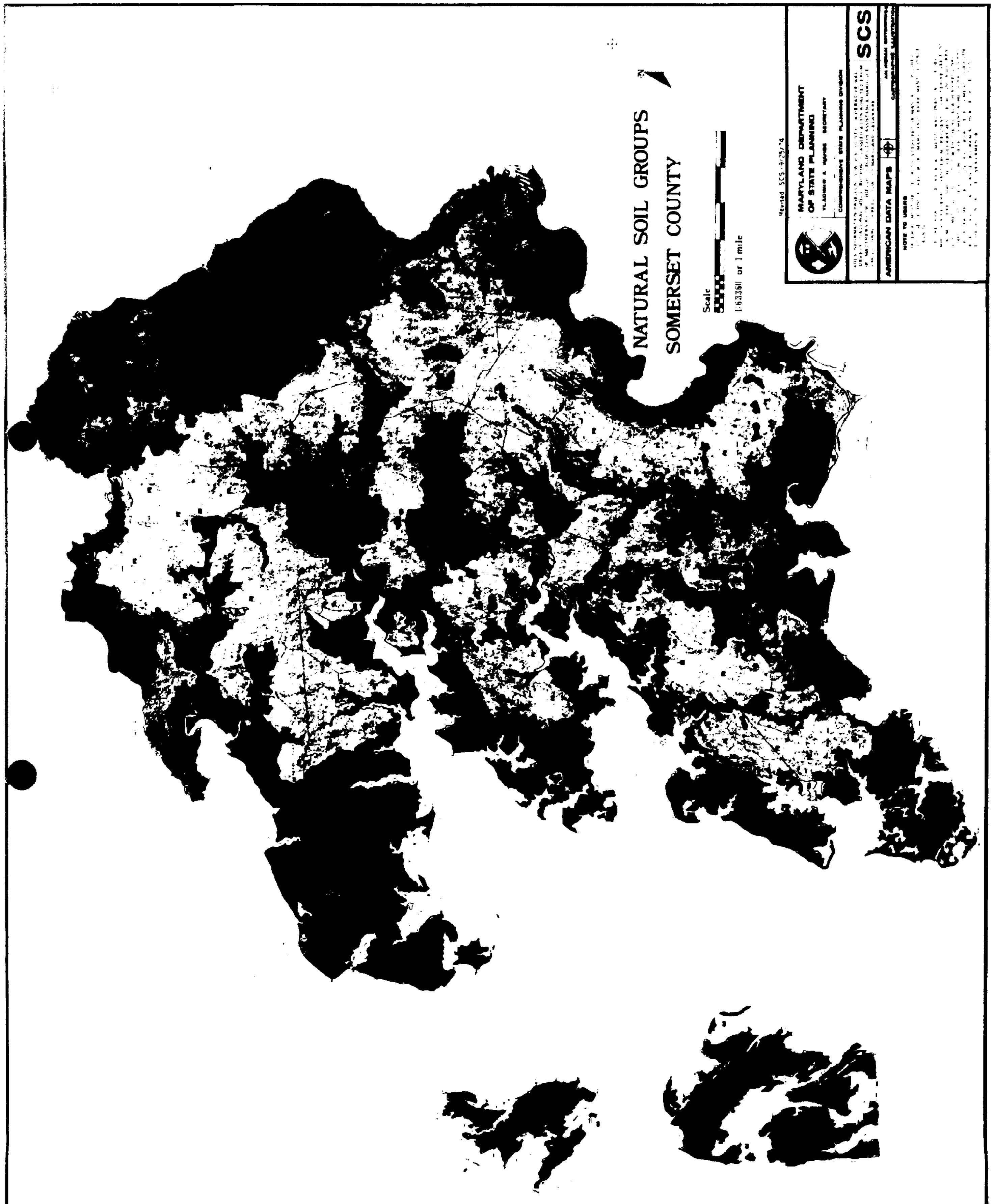
NATURAL SOIL GROUPS
SOMERSET COUNTY
Scale
1:63360 or 1 mile
MARYLAND DEPARTMENT OF STATE PLANNING
SCS
AMERICAN DATA MAPS

FIGURE 3—1

FIGURE 3-2

DESCRIPTIONS OF SOILS ON NATURAL SOIL GROUPS OF SOMERSET COUNTY MAP

A1	Deep, sandy, extremely well drained soils. Ground water contamination potential due to fast percolation rate.
A2	Unconsolidated sands constantly reworked by wind and waves. Ground water contamination probable.
B1	Deep well drained soils. Generally silty or loamy at the surface, and increasing clay in subsoil. Moderately fast percolation rates. Water table unlikely to be less than 5 ft. from surface.
E1	Sandy, well drained soil. Moderate-moderately fast percolation rates. Water table 1.5 ft. to 4 or 6 ft. below surface. Retains moisture well.
E2	Silty-loamy soils with clayey subsoils. Generally in perched water table. Moderate moisture retention. Shallow percolation tests fail.
E3	Deep, moderately well drained silty soils. Water table approximately 1.5-2.5 ft. from surface in wet seasons. Moderately slow permeability, high moisture retention.
F1	Poorly drained, wet sandy soils. Water table at or near surface. Septic tanks may "float". Severe ground water contamination potential.
F2	Poorly drained clay and silt. Moderate moisture retention and permeability. Water table fluctuates from surface to 4-6 ft. below surface. High water table poses severe contamination problem.
F3	Poorly drained silty and clayey soils. Low permeable subsoil. High water table.
G2	Deep, poorly drained silty and sandy soils. Flood potential water table at surface to approximately 3 ft. from surface.
G3	Tidal Marsh, Swamps
Ma	Made Land

Reference: Natural Soil Groups of Maryland, Maryland Department of State Planning, Technical Series Publication Number 199, Page 149, December, 1973.

FIGURE 3-3

SOIL TYPE - WATER TABLE RELATIONSHIPS
(Natural Soil Group in Parentheses)

Water Table	Soil Type(s)
Floods	Mixed Alluvial (G2)
Fluctuates with Tides	Tidal Marsh (G3), Coastal Beach (A2)
Ponded	Swamp (G3), Plummer (F1)
Permanently At or Above Surface	Muck and Peat (G2)
Seasonally At or Near Surface	Pocomoke (F2), Portsmouth (F3), St. Johns (F1)
Seasonally ≤ 1 Ft. From Surface	Fallsington (F1), Keyport (E2), Othello (F3)
Seasonally ≤ 1.5 Ft. From Surface	Leon (F1)
Seasonally ~ 2 Ft. From Surface	Klej (E1), Mattapex (E3), Woodstown (E1)
Seasonally in Substratum	Galestown (A1), Lakeland (A1)
Greater Than 4 Ft.	Downer (A1), Matapeake (B1), Sassafras (B1)

Reference: Soil Survey of Somerset County, Maryland, Matthews, E.D., and Hall, R.L., U.S. Department of Agriculture, Soil Conservation Service, 1966, page 90.

TABLE 3-1A

AQUIFER TYPE SPECIFICATIONS (FROM COMAR 10.50.01)

Type (gal/day/ft)	T (gal/day/ft)		K (gal/day/ft)	TDS (ppm)
I	> 1,000		> 100	< 500
II	> 10,000		> 100	500 - 6,000
		or		
	1,000 - 10,000		> 100	500 - 1,500
III	< 1,000 and/or		< 100 and/or	> 6,000

TABLE 3-1B

AQUIFER DESCRIPTIONS

Aquifer	T (gal/day/ft)	Type	TDS		
			Range (ppm)	Average (ppm)	Median (ppm)
Columbia	33,000 - 585,000	I or II	80 - 5,100	623	130
Pocomoke	8,000 - 40,000	I or II	110 - 990	375	300
Manokin	7,000 - 40,000	I or II	170 - 2,420	833	695
Cretaceous	-	I(?) or II	461 - 750	645	660

Note: T = Transmissivity (gal/day/ft); K = Hydraulic Conductivity (gal/day/ft^2); TDS = Total Dissolved Solids in parts per million (ppm)

The Manokin is probably the best aquifer as a drinking water supply due to its dependable water quality and yield. Water quality is reportedly good although chlorides may be a problem in the lower portion. Aquifer yield is more than adequate for domestic purposes. However, the southeastern portion of the County where the Manokin aquifer reaches depths of greater than 250 feet, the Pocomoke aquifer may be preferred due to costs associated with drilling a deeper well.

If moderate to high iron concentrations were not as prevalent as data indicates in the Pocomoke aquifer, the Pocomoke may be recommended over the Manokin as a primary water source. Several treatment systems can remove or decrease the amount of iron in the water. One particular method proven effective is ion exchange water softening. However, the well owner should investigate the costs associated with a treatment system versus drilling a well into the Manokin aquifer. While water quality is not a concern for some water supplies, such as for various industrial or commercial uses, the Pocomoke aquifer my be preferable as it would likely meet the quantitative needs for such water supplies.

The Cretaceous Series is an excellent source of water especially for high yielding public and industrial water supplies. Wells in this aquifer though are generally greater than 700 feet deep. The cost of such a deep well and the associated possibility of saltwater intrusion (depending on the pumping rate and influence) may be considerations addressed before using the Cretaceous aquifer as a water supply. Water quality is fairly good but water may be mineralized.

The Columbia (surficial) aquifer may be a viable source of ground water for commercial and industrial use if the existing water quality meets the needs of the facility. The Columbia Group is considered the surficial or water table aquifer, although in the northwestern area of the County, along the approximate limit of the Pocomoke aquifer, water table conditions exist for the Pocomoke aquifer (see Figure 3-4). The Columbia aquifer in the northeast sector of the County is susceptible to nitrate contamination emanating from on-lot disposal systems and manure applications to farm land. A more detailed description of each aquifer follows.

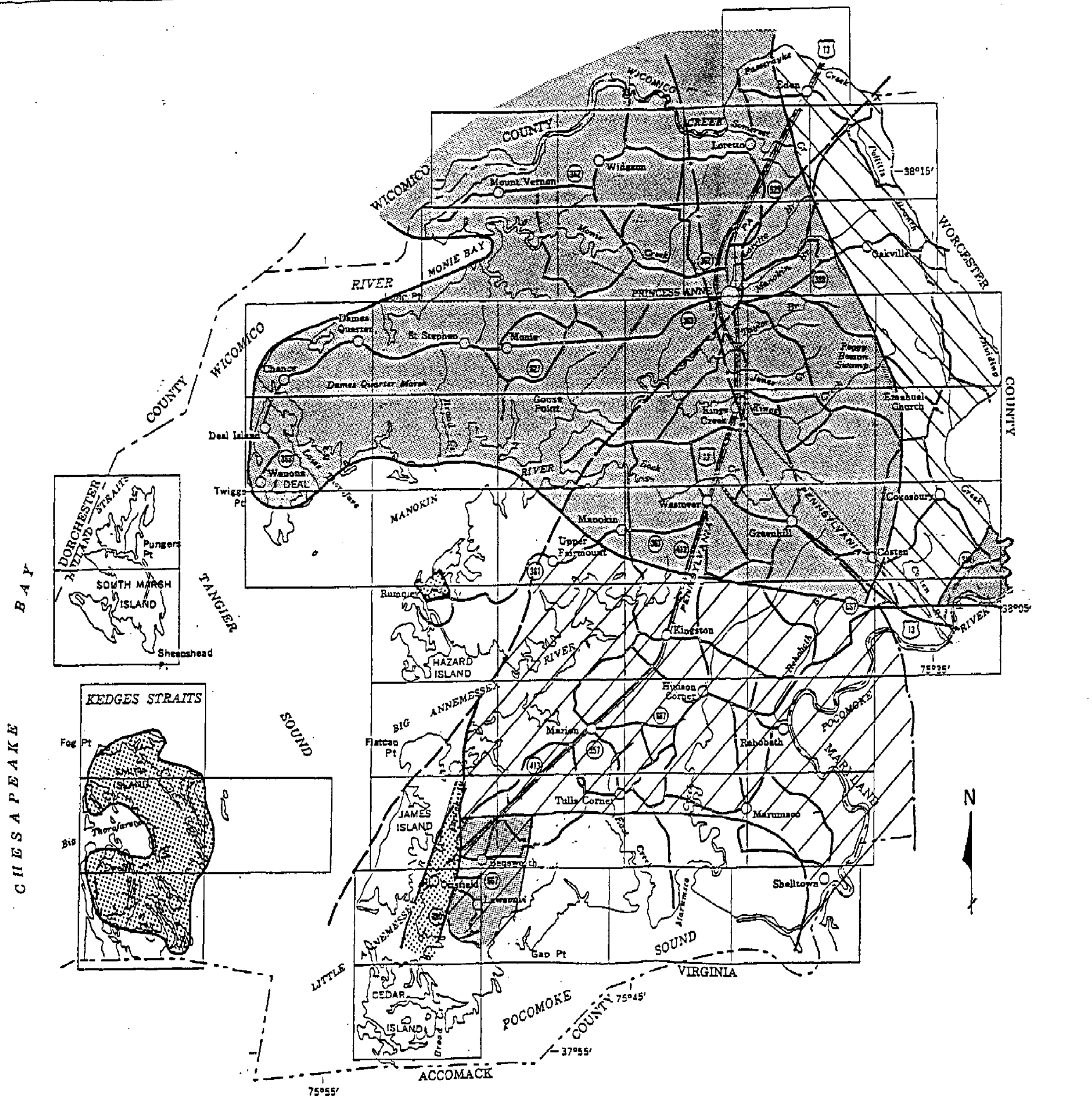

Figure 3-4

PRIMARY AQUIFER USAGE MAP
SOMERSET COUNTY, MARYLAND

Scale 1:190,080

1 0 1 2 3 4 Miles

LEGEND

- COLUMBIA (PLEISTOCENE-PLIOCENE) AQUIFER
- POCOMOKE AQUIFER
- MANOKIN AQUIFER
- CRETACEOUS SERIES
- APPROXIMATE LIMIT OF COLUMBIA (PLEISTOCENE-PLIOCENE) AQUIFER
- APPROXIMATE LIMIT OF POCOMOKE AQUIFER

NOTE: AREAS OF INSUFFICIENT DATA OR VARIABLE DATA FROM WHICH NO PATTERNS COULD BE ESTABLISHED ARE UNSHADED.

3.1 Manokin Aquifer

The Manokin aquifer is considered the primary aquifer in Somerset County (see Figure 3-4). The Manokin is the lower member of the Yorktown and Cohansey Formations of Upper Miocene age. The unit dips slightly to the southeast with its depth below ground surface ranging from less than 50 feet below sea level in the northwest corner to greater than 250 feet in the southeast. The average aquifer thickness is approximately 80 feet (see Exhibit II, Generalized Cross Section Map). The Manokin consists primarily of light gray medium to fine grained sand with some coarse sands and fine gravel occurring locally. Clay and silt stringers may also appear locally.

A laterally extensive confining clay layer termed the Lower Aquiclude, separates the underlying Manokin aquifer from the Pocomoke aquifer. Cross sections show that the Lower Aquiclude is essentially continuous throughout the County and averages nearly 100 feet in thickness. Thus this impervious layer provides protection of the deep Manokin aquifer from any potential infiltration of high ferrous waters of the Pocomoke aquifer, or from any leaching of surficial contaminants where the Pocomoke aquifer is also the surficial aquifer.

The Manokin aquifer is principally used in the northern half of the County as a potable ground water supply. It is also the primary water source for Deal Island. The density of wells that tap the Manokin tends to decrease south of Westover although there is an area around Crisfield which uses the Manokin as a principal water source (see Figure 3-4). The aquifer reportedly yields adequate supplies from wells used for domestic, farming, commercial and industrial purposes. Water quality is generally good, however, chloride concentrations may be elevated. Available well data indicate a considerable range in chloride concentrations from 5 to 800 ppm with an average value of approximately 200 ppm. Table 3-2 displays water quality data for the Manokin and other primary aquifers. Chloride levels generally increase north to south and east to west toward the Pocomoke Sound and Tangier Sound, respectively.

3.2 Pocomoke Aquifer

The Pocomoke aquifer is second only to the Manokin as a major source of potable water for the residents of Somerset County. The Pocomoke is a hydrologic unit within the Yorktown and Cohansey Formations that dip gently to the southeast. The aquifer

TABLE 3-2

WATER QUALITY DATA FOR PRIMARY AQUIFERS

Aquifer	Number of Samples		Concentration (ppm) Range	Average
Columbia	2	NO_3^-	0 - 0.2	0.10
	15	NO_2-NO_3	0.15 - 6.3	0.89
	16	Fe	0.01 - 55	16.0
	16	Cl^-	9.3 - 72	22.5
Pocomoke	2	NO_3^-	0.08 - 0.1	0.09
	15	NO_2-NO_3	0 - 6.5	0.52
	17	Fe	0.01 - 16	5.4
	17	Cl^-	7.7 - 380	65.4
Manokin	15	NO_3^-	0.02 - 0.3	0.10
	42	NO_2-NO_3	0 - 0.1	0.00
	57	Fe	0.01 - 4.1	0.5
	57	Cl^-	5.8 - 792	204.6
Cretaceous Series	7	NO_3^-	0.1 - 3	1.11
	11	NO_2-NO_3	0	0
	16	Fe	0.01 - 0.9	0.1
	19	Cl^-	6.2 - 180	53.6

Note: NO_2-NO_3 values are expressed as nitrogen (N) concentrations in parts per million (ppm) and based on the U.S. standard limit of 10 ppm.

thickness ranges from 0 feet in the northwest to greater than 75 feet in the southeast with an average thickness of nearly 50 feet. The Pocomoke is very similar to the Manokin consisting of gray medium to fine grained sand with coarse sand, shells, fine gravel and clay lenses which occur locally. Stratigraphically, the Pocomoke lies above the Manokin. The two aquifers are separated by the Lower Aquiclude. Overlying the Pocomoke in the southeast is another thick clay deposit called the Upper Aquiclude. This rather impervious layer of silts, clays and fine sands averages 50 feet in thickness and when present is usually encountered within 50 feet from the surface. The Lower and Upper Aquicludes, where present, prevent contamination from infiltrating to the underlying aquifers. Hence, care should be taken to preserve the natural environment protection afforded by the aquicludes. Appendix A lists well data used in the preparation of geologic cross sections (Exhibits I and II) which show the confining layers.

The Pocomoke aquifer is used primarily throughout the southern half of the County (see Figure 3-4). The aquifer generally pinches-out in northcentral and northwestern Somerset County. Most of the wells tapping this water supply throughout the County are used for irrigation purposes especially in the north. A few wells do exist for commercial and industrial use. The Pocomoke is usually not used for domestic water supplies due to the presence of high iron concentrations. Water quality is generally good, except for the iron which ranges from 0.01 to 16 ppm and averages 5.4 ppm. This level exceeds the EPA Drinking Water Standards recommended concentration limit of 0.3 ppm. When the concentration of iron exceeds 0.3 ppm, the taste of the water is impaired and reddish-brown stains to laundry, utensils and fixtures result. There appears to be little nitrate contamination of wells penetrating the Pocomoke although more complete well data might suggest otherwise.

3.3 Columbia Aquifer

For this report, the Pleistocene-Pliocene Series of geologic units producing water are grouped together as the Columbia aquifer. In some of the previously published reports only the Pleistocene Series is associated with the Columbia Group (Bachman, 1984, page 9). The Columbia Group includes: the Parsonburg Sand of Upper Pleistocene age, the Pamlico and the Talbot Formations, and Walston Silt of Middle to Lower Pleistocene age, and the Beaverdam Sand and red gravelly facies of Pliocene age. Owens and Denny (Geologic Map of Somerset County, 1984) refer to the Middle Pleistocene deposits as the Kent Island Formation. These laterally extensive semi-impervious deposits of gravel, sand, silt and clay underlie the majority of Somerset County and are generally less than 30 feet thick. The Kent Island Formation tends to be more silty and clayey in the western half of the County. The Parsonburg Sand, by itself, is generally too thin for use as a water supply source. However, the Beaverdam Sand, which is sometimes associated with the red gravelly facies, reportedly yields moderate to large quantities of ground water to wells. The Beaverdam Sand consists of 0-100 feet of interbedded medium grained sand and silty sand with minor amounts of fine sand and coarse material. It exists only in the northeast area of the County where it gently dips to the southeast. Near the Somerset-Worcester County line the Beaverdam Sand reaches its maximum thickness of about 100 feet. It is important to note that the Walston Silt, which is considered a confining layer comprised of silt, sand and clay, forms an unconformable boundary between the Parsonburg and the Beaverdam Sands above, and may be as thick as 60 feet in some areas. Although this layer provides excellent protection to the deeper sands, its lateral continuity is unknown from available well data. The Talbot and Pamlico Formations (undivided) are interstratified deposits of sand, gravel, silt, and clay up to 80 feet thick which confine the underlying Beaverdam Sand.

A special condition exists with what is termed "carolina bays" (Owens and Denny, 1984) or carolina moons. These sand pockets of the Parsonburg Formation are generally lens-like, or thin and non-extensive with a thickness which varies from 4-20 feet. A number of homes exist on these deposits which reportedly use these sands for a domestic water supply. Most wells are hand dug or point driven. Water levels are known to fluctuate 6 or 7 feet annually. Thus, such wells may become dry. Water quality is unknown though chemical data may indicate poor water quality because the aquifer is at or near the land surface and extremely sensitive to contamination.

General water quality of the Columbia Group is only fair due to the shallow nature of the aquifer. At shallow depths contaminant infiltration is highly possible with the absence of a protective silt and clay layer. This water table aquifer is easily impacted by nitrate loading due to manure and fertilizer applications for farming purposes as well as on-lot septic system effluent. Based upon limited data there appears to be a trend of increasing concentrations of nitrates in the surficial aquifer in the northeast.

Table 3-2 shows two sets of data for nitrate analyses. Nitrate (NO_3-N, or NO_2 + NO_3 where NO_2 is negligible) levels vary from 0.15 - 6.3 ppm and do not reach the EPA recommended maximum concentration of 10 ppm. Concentrations for nitrate as NO_3 relates to the 45 ppm EPA limit.

As mentioned previously, an appreciable amount of chemical data exists on file with the County Health Department. Until time is allotted to review these extensive records general nitrate information has been acquired from County officials. Nitrate-nitrogen (NO_3-N) levels have been detected on a consistent basis between 9 and 12 mg/l in the area near Rehoboth extending southeast toward the Pocomoke area. Levels have been detected as high as 54 mg/l.

3.4 Cretaceous Series

The Cretaceous aquifers (most notably the Magothy) are used almost exclusively in southwestern Somerset County. Most wells tapping this supply are located on Smith Island, and in the area between Crisfield and Hopewell. The town of Rumbley is also supplied by a well in the Magothy which is 1100 feet deep. According to Rasmussen and Slaughter, 1955, one well exists on South Marsh Island which is used as a commercial water supply, even though there are no residences on this island. Wells penetrating this aquifer are generally 800 to 1000 feet below ground surface. The aquifer yields moderate to large quantities of water and almost all the known wells for which data are available are used for public or industrial water supplies. Chemical analyses for this aquifer also reflect fairly good water quality. Rasmussen and Slaughter (1955), however, suggest that water may be mineralized.

4. MANAGEMENT AREA DESIGNATIONS

As an approach to defining separate areas of soil or geo-hydrologic environments throughout Somerset County which may require different standards with regard to design and construction requirements for on-site septic systems and potable water supply wells, two separate Management Area classifications have been established. These two area classifications reflect various natural components or conditions of their environment and provide for the development of guidelines for optimum protection and use of the underlying ground water resource. The two Management Areas established are characterized as follows:

1) Management Area A - A soil or geo-hydrologic environment where it is necessary to employ the highest practical level of protection of the underlying confined deep aquifers as well as the surficial ground water aquifer. The surficial aquifer is a primary drinking water supply in this area and, therefore, a minimum two-foot treatment zone would only be considered where an elevated sand mound system or other comparable system is to be constructed and where soil properties provide a high degree of treatment.

2) Management Area B - A soil or geo-hydrologic environment where a suitable layer of confining material exists between the treatment zone and the underlying potable aquifers. Utilization of the surficial aquifer in this area is minimal to none, and will not be permitted for new drinking water supplies in the future. On-site septic systems with less than two-foot treatment zones or systems that discharge directly to the surficial ground water may be proposed as innovative or alternative systems dependent upon specific local conditions and whether the State would grant a variance for ground water penetration to occur.

Within this report, delineation of the two specific Management Areas defined for Somerset County was based upon interpretation and mapping of available information from a variety of sources. However it should be noted that boundaries of Management Areas A and B as described and delineated herein are general and approximate. For example, isolated subsets of each management area may be characterized in the adjoining area. Site specific data will always be needed for the final designation of an area as either A or B, and periodically the boundary between the two management areas may be redefined based on new data.

4.1 Rationale for Selection

The criteria used for the selection of the two management areas includes the soil type, thickness and drainage properties, as well as the presence and continuity of naturally occurring shallow and deep confining layers. These confining layers would be necessary to provide adequate protection of underlying aquifers of potable water quality, particularly where the surficial aquifer is presently degraded by septic effluent. Therefore, the existing water quality and use of the surficial aquifer is reviewed with regard to the deeper aquifer water supplies. The seasonal high water table elevation is particularly significant because it determines the minimum treatment zone available to a septic disposal system for renovation of the septic wastewater.

Based on the above criteria, generalizations were made in delineating Management Area A and Management Area B. These management areas may be segregated into smaller, more detailed management areas upon review and assessment of future data. A fringe area along the boundary between the two distinct Management Areas (A and B) should also be viewed cautiously as subtle differences or characteristics of the topography, soil, water quality, and water usage could locally alter the mapped Management Area designation.

4.2 Management Area Strategies

A review of the Management Area map (Figure 4-1) indicates that nearly three-quarters of the County can be classified as Management Area B. As previously described, these areas normally experience high water table conditions and are overlain by soils that are poorly drained and have low permeabilities. Isolated areas or subsets within Management Area B may exhibit soil and hydrologic conditions classified as Management Area A. Some of these areas are delineated on Figure 4-1. In general, most of Management Area B is underlain by a thick confining layer or aquiclude which protects the deeper potable ground water aquifers from septic system contamination.

Wells tapping the lower confined aquifer systems are generally safe from contamination provided that well construction procedures prevent surficial aquifer drainage into the borehole. This generally requires the installation of solid well casing through the entire thickness of the aquiclude. The casing is then pressure grouted from the base of the casing to the near surface with concrete or a concrete/bentonite mixture to form an

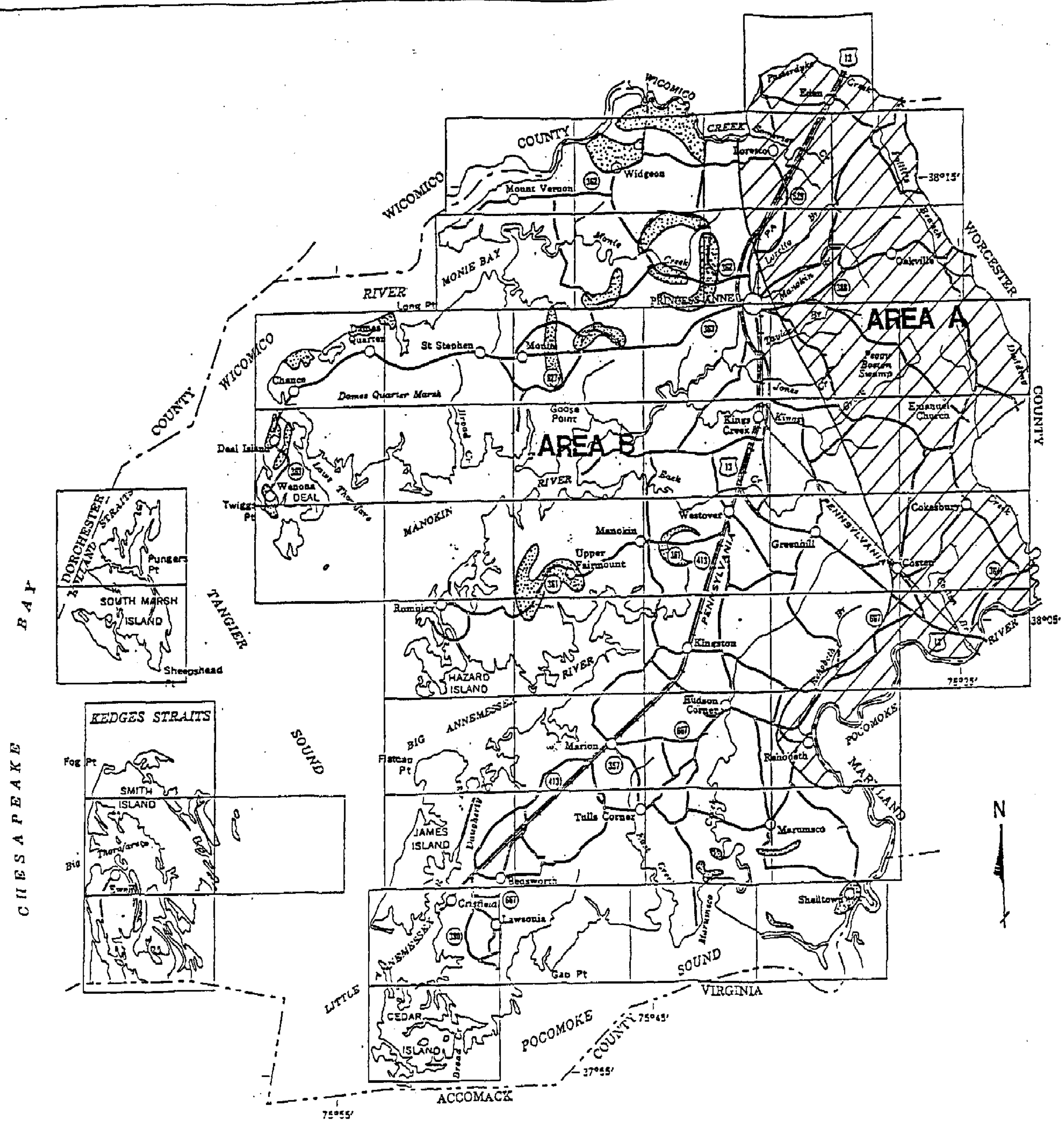

Figure 4-1

MANAGEMENT AREA MAP

SOMERSET COUNTY, MARYLAND

Scale 1:190,080

1 0 1 2 3 4 Miles

LEGEND

MANAGEMENT AREA A: Requires maximum protection of surficial aquifer.

MANAGEMENT AREA B: Permits ground water penetration.

MANAGEMENT AREA A"POCKETS"

effective seal preventing any ground-surface drainage or leakage from reaching the underlying aquifers. Since the underlying material is unconsolidated, solid casing will usually extend through the entire thickness of the aquiclude layer. Below the aquiclude an appropriate section of screen is attached to the solid casing and, if necessary, granular packing material is included.

4.2.1 Management Area A

Within the bounds of Management Area A as defined, some poorly drained soils and seasonally high water table conditions are present which pose severe contamination potential for water supply wells tapping the thin surficial aquifer materials. Although large areas within this management area do have sufficiently low water table elevations which provide for at least a four-foot unsaturated treatment zone, the general lack of confining materials can result in little or no protection to the shallow water supplies. There is some indication, however, that the Pamlico & Talbot Formation and the Walston Silt Formation may act as a semi-aquiclude or semi-confining layer for the underlying Beaverdam Sand. These formations belong to the Columbia surficial aquifer. Until the existence, extent and permeability of such areas is determined, strict controls for the type of sewage disposal systems used in Management Area A are needed to insure maximum protection of the shallow aquifer as a drinking water supply.

In those areas where there is a minimum four foot unsaturated treatment zone in which the soil characteristics provide the necessary degree of treatment based on their texture and percolation rate, conventional sewage disposal systems can be constructed. Regarding construction of the on-site septic system, the seepage trench should be located at such a depth which maximizes the thickness of unsaturated soil beneath the trench. The minimum depth of a seepage trench is 1.5 feet below ground surface unless elevation of the original soil surface (adding 6" of fill) is permitted to meet the 1.5 foot minimum trench depth where the actual depth below grade would be one foot otherwise.

If the treatment zone is between two and four feet thick consisting of suitable soils, an elevated sand mound system would be required. In areas where the water table is less than two feet from the surface and/or the soils do not meet textural and permeability requirements, no innovative or alternative on-site sewage disposal system will be acceptable unless a very detailed study is performed which shows that the shallow aquifer will not be impacted by the proposed system. This system would need to meet

Municipal, County and State approval. One approved option for a potential homeowner located in such an environment would be a packaged on-site treatment plant. This option would be economically viable where cluster-development occurred and several developers could share the cost of a sewage treatment plant.

For areas where STP's are one of the only alternatives for sewage treatment, as in those areas where the water table is less than two feet from ground surface, it is suggested that the State simplify the process by which a safe discharge outfall permit is obtained. This is particularly critical in Management Area B where the only other existing alternative would be numerous ground water penetrating systems with unknown treatment capacities instead of one central and monitored treated effluent outfall.

Currently, some alternative designs which may be considered conventional systems in the future and provide greater options to the developer in this area, are being evaluated to determine their effectiveness of treating and renovating septic effluent. These designs include: 1) alternating two tile fields, 2) low pressure pipe disposal fields, and 3) sand-lined trenches. These three designs are described in the EPA Design Manual: <u>Onsite Wastewater Treatment and Disposal Systems</u>. The source of Table 4-1 is from this manual and it addresses the selection of disposal methods under various site constraints. This table and the design manual provide excellent guidelines for sewage disposal systems in atypical environments. One chapter describes a variety of wastewater reduction options, while another provides detailed information regarding the design, construction and operation of various treatment options such as aerobic treatment units, disinfection units, and nutrient removal systems. The treatment components of an on-site system actually treat the wastewater prior to disposal or discharge. Obviously, there are various treatment and disposal system combinations which may be viable and acceptable alternatives. However, these systems must be evaluated and approved by the County health department and possibly the State.

Generally, for Management Area A the minimum individual lot size will be determined by the hydrogeologic study for those areas where a four-foot treatment zone exists. If a four-foot treatment zone does not exist, a 2 acre minimum lot size is recommended, unless a central treatment system or facility is being employed for a large development or subdivision, in which case, the lot size is dependent on local ordinances. All large developments are required to perform a detailed hydrogeologic study, unless a package treatment plant is utilized. Those developments with less than five lots will be evaluated

TABLE 4-1

SELECTION OF DISPOSAL METHODS UNDER VARIOUS SITE CONSTRAINTS

Method	Site Constraints: Soil Permeability			Depth to Bedrock			Depth to Water table		Slope			Small Lot Size
	Very Rapid	Rapid-Moderate	Slow-Very Slow	Shallow and Porous	Shallow and Nonporous	Deep	Shallow	Deep	0-5%	5-15%	15%	
Trenches		X	X[2]			X		X	X	X	X	X[4]
Beds		X				X		X	X			X
Pits		X				X		X	X	X	X	X
Mounds	X	X	X	X	X	X	X	X	X	X		
Fill Systems	X	X[1]	X[1]	X	X	X	X	X	X	X	X	X[4]
Sand-Lined Trenches or Beds	X	X	X[2]			X		X	X	X[3]	X[3]	X[4]
Artificially Drained Systems		X				X	X		X	X	X[3]	
Evaporation Infiltration Lagoons		X	X[6]			X		X	X			
Evaporation Lagoons (lined)[4,5]	X	X	X	X	X	X	X	X	X			
ET Beds or Trenches (lined)[4,5]	X	X	X	X	X	X	X	X	X	X[6]		
ETA Beds or Trenches[4]		X	X			X		X	X	X	X	X

[1] Only where surface soil can be stripped to expose sand or sandy loam material.

[2] *Construct only during dry soil conditions. Use trench configuration only.*

[3] Trenches only.

[4] Flow reduction suggested.

[5] High Evaporation potential required.

[6] Recommended for south-facing slopes only.

X means system can function effectively with that constraint.

Source: EPA Design Manual: Onsite Wastewater Treatment and Disposal Systems, October, 1980.

by qualified County personnel. All innovative or alternative designs will also require a hydrogeologic study whether it is for a single lot or several lots. Where innovative systems are implemented which require monitoring, a minimum lot size of 4 acres is suggested.

In Management Area A and B, all domestic wells shall penetrate a deep confined aquifer such as the Pocomoke or Manokin aquifers. Water supply wells utilized for Industrial or Commercial purposes can utilize either the shallow or deeper aquifers, providing the water quality is such that it meets processing needs.

The hydrogeologic study determines the potential impact of on-site sewage disposal systems to the ground water system with special attention to downgradient drinking water supplies and surface water bodies which are designated Class I and are presently utilized as a recreational area. The hydrogeologic study will also determine whether an innovative design adequately reduces the septic effluent constituents. The following is a list of those parameters to be addressed in a hydrogeologic study:

a. depth to the water table;

b. hydraulic conductivity of the aquifer;

c. ground water gradient and direction of flow;

d. aquifer thickness and effective mixing thickness;

e. background nitrate-nitrogen concentration of ground water;

f. number of septic systems;

g. present and potential use of aquifer;

h. impact on downgradient users based on a nitrate loading analysis;

i. leakage of contamination to other aquifers;

j. impact to recreational surface waters;

k. present and future land use;

l. number of wells in the aquifer and volume of water pumped;

m. length of flow path to surface discharge areas or downgradient users;

n. average annual ground water recharge rate;

o. estimated sewage flows; and,

p. estimated NO_3-N concentration in the septic effluent.

The results of this hydrogeologic investigation will determine the # acre/lot density allowed, the impact of the sewage disposal system to the ground water, and whether the proposed design is adequate or whether further treatment of the wastewater is necessary prior to disposal.

Generally, when a developer has a hydrogeologic study performed for a new subdivision, both the proposed number of sewage disposal systems and the existing on-lot sewage systems located adjacent to the new subdivision should be addressed in the nitrate loading evaluation to determine the total potential impact to downgradient surficial aquifer water supplies. The nitrate loading evaluation is a combined water budget and mass-balance assessment which considers the natural ground water recharge rate for a specified nitrate concentration and the septic effluent discharge rate at a selected nitrate concentration. Calculations are performed which determine the net effect of the nitrate loading to the ground water system on site. This evaluation also considers dilution effects where upgradient or downgradient areas exist with regard to the septic disposal system. If through this nitrate-loading evaluation it can be demonstrated that a proposed system will not adversely impact nearby water supplies than the proposed septic system may be considered appropriate for construction. Regardless of the system used, all drinking water supply wells within both Management areas should extend below the major confining bed (aquiclude) for the area.

Specific areas within Management Area A which need immediate attention are those which presently practice ground water penetration. Where users of the surficial aquifer exist downgradient of such systems, the County should determine if these existing wells are being impacted. If they are not being impacted at this time, monitoring should continue. If the drinking water supply wells are being impacted the owners of the ground water penetrating system, with assistance of the County Health Department, should alter or replace this system in order to come into compliance with Management Area A sewage disposal system requirements. If enough residences are impacted, the County and/or the Municipality will need to determine whether sewer extensions are a possible alternative.

4.2.2 Management Area B

In Management Area B, ground water penetration of the surficial aquifer is common due to the high ground water table conditions and poor soil characteristics. Specific criteria for septic disposal system designs and construction need to be established for those areas where the ground water table is less than two feet from the surface. Such alternative designs need to satisfy Municipal personnel and County and State health officials. Technically, only in those locations where the thickness and composition of renovating material above the seasonal high water table is adequate should conventional on-lot septic systems be used. However, until Class III aquifers are identified in Management Area B and the impact of ground water penetrating systems to the surficial aquifer is assessed, a variance is requested to be granted by the State for ground water penetrating systems to continue to be permitted within this Management area. The size of these systems as well as the density distribution will need to be determined based on site specific conditions and local ordinances. In addition, if existing water supplies are withdrawing water from the shallow aquifer within proximity of a proposed system location, a careful evaluation of the potential for contaminant migration from this system to the well should be made by the County health department or a consulting hydrogeologist.

Eventually, the surficial aquifer will be utilized as a drinking water supply in only very limited areas due to the ongoing occurrence of ground water penetration and the classification of areas within Management Area B as a Type III aquifer. Therefore, impacts to the surficial aquifer by sewage disposal systems will not be as sensitive an issue and innovative and alternative systems may be approved more readily. However, steps should be taken by the County Health Department to ensure that the shallow aquifer will not be used for a potable water supply currently or in the future.

Generally, within Management Area B conventional septic systems should be considered as an alternative system in areas where there is a 2 to 4 foot unsaturated treatment zone which consists of acceptable soils based on COMAR regulations. For these conventional systems, generally a minimum two (2) foot thick treatment zone of loam or finer textured soils with a moderate percolation rate (30 to 60 minutes/inch) is sufficient, provided appropriate design and septic loading specifications are met. Where minimum conditions are present, modification of a conventional gravity system to include a dosing tank will aid in attaining the desired attenuation of septic effluent constituents, such as nitrates.

Elevated sand mounds with pressure dosing systems may also be constructed in such an environment. It is important that the design of these sand mounds are sized in accordance with applicable COMAR criteria and be constructed with allowance for adequate quantities of moderately permeable renovating material. Special modifications to the basic design to alleviate the effects of high head pressures from pumping wells may be appropriate for some locations. For example, impermeable material linings and/or capping can limit the amount of direct infiltration from septic seepage.

The bermed infiltration pond (BIP) is presently an innovative system, though it is presently being evaluated as a possible conventional system for the future. Due to its construction requirement of a three-foot thick overlying impermeable layer, it has limited application. However, if a modified BIP, not requiring the impermeable layer, would be approved, its application would be critical to areas where the water table is less than two feet below grade.

All innovative systems shall have a minimal horizontal isolation distance from a water supply well of 150 feet. Monitoring will also be required of such systems as per COMAR regulations.

Existing sites of ground water penetration in Management Area B may continue until it is determined to be impacting the ground water system, at which time a more suitable treatment system, such as a sand lined trench or bermed infiltration pond, must be constructed. A community system would be advantageous in such areas to minimize the monetary impact to individual residents. When and if the State would grant an overall variance for ground water penetration to occur within specified areas of Management Area B, drinking supply wells which exist within those areas and utilizing the surficial aquifer will be required to be drilled deeper into one of the lower confined aquifers. Appropriate well construction, as previously discussed, which prevents leakage from the surficial aquifer into the borehole is imperative.

5. RECOMMENDATIONS

The following recommendations need to be addressed in order to provide Somerset County with a more detailed and complete Ground Water Protection Report as well as the staff to implement the numerous tasks required by the report. This report will serve as a reference document to Municipal, County and State officials as well as consultants who may be designing sewage disposal systems or performing hydrogeologic studies in Somerset County, Maryland.

- It is recommended that a variance be granted for "conventional" ground water penetrating systems to be permitted in Management Area B until that time in which Class III waters are identified throughout Area B and/or the actual impact of such systems to the ground water is assessed. Based on the existing surficial water quality data, impact to the surficial aquifer as a result of such systems has not been verified.

- Where a Type III Aquifer exists, criteria need to be established with regard to the extent to which the aquifer can be contaminated by sewage effluent. A specific parameter at a predetermined maximum concentration level needs to be chosen as such a criteria. It is likely that NO_3-N, which is a parameter commonly used in conventional conditions, would not be the criteria where ground water pentration occurs since it is not generated in anaerobic environments.

- Computerization of water quality data for the various aquifers, by location throughout the County, in order to delineate areas which may be designated as Type III waters e.g., Deal Island, and portions of Management Area B.

- Research literature for information regarding pathogen, phosphorous and nitrogen concentrations in septic effluent and their subsequent degree of removal in various soil types and thicknesses, and water table conditions. Based on this data, appropriate innovative system designs and potential densities can be evaluated which best meet the specific site conditions; site conditions are extremely variable throughout Somerset County, Maryland.

- Additional staff at the local health department should be provided to help monitor innovative as well as alternative sewage disposal systems, perform the hydrogeologic assessments for development with less than five lots, and to organize a data base for the aquifers being used, the aquifers' water quality, and depth to water across the County.

- Perform a general inventory and location of major known and potential sources of contamination to the surficial aquifer. This would include discharges from agricultural waste ponds or industrial waste ponds or point sources; all of these discharges should be permitted.

- Determine the water availability of each aquifer as this may also limit density requirements where the aquifer is heavily used by commercial and/or industrial purposes as well as a drinking water supplies.

- Computerize the extensive amount of soils and well log data in order to determine where further data may be necessary.

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APPENDIX A
WELL DATA SUMMARY

APPENDIX A

WELL DATA SUMMARY

	Well No.	Total Depth (ft)	Ground Elevation (ft)	Soil Thickness (ft)	Depth to Confining Layer(s)	Confining Layer Thickness	Water Level	Aquifer	Well Usage
Ae	14	121	20	21	0, 28	21, 12	1	Manokin	Domestic
Bd	4	107	5	10	13	82	-	Manokin	Domestic
	6	101	5	22	25	62	6	Manokin	Domestic
	7	94	4	17	17, 45	23, 33	2	Manokin	Domestic
	10	122	4	13	22	63	1.5	Manokin	Domestic
	11	178	9	-	0, 10	7, 20	2.8	Manokin	Unused
	12	179	9	-	0, 26	6, 114	1.5	Manokin	Domestic
	13	145	5	12	12	112	0.5	Manokin	Domestic
Be	2	103	18	-	18	7	14	Pleist	Public
	5	151	10	19	*	-	1	Manokin	Domestic; Farming
	9	203	10	10	12	23	3	Manokin	Domestic; Farming
	10	194	10	25	*	-	3	Manokin	Domestic; Farming
	17	180	17	-	35	10	-	Manokin	Domestic; Commercial
	43	203	18	-	40	10	6	Manokin	Domestic; Farming
	48	188	10	-	-	-	3	Manokin	Domestic
	50	455	18	2	23	2	-	Calvert (?)	Test Hole
	52	77	18	2	23	2	13	Pleist	Public

* Deeper Than 50 Ft.

APPENDIX A (Continued)

	Well No.	Total Depth (ft)	Ground Elevation (ft)	Soil Thickness (ft)	Depth to Confining Layer(s)	Confining Layer Thickness	Water Level	Aquifer	Well Usage
Bf	1	232	28	-	0, 18	10, 2	14	Manokin	Domestic; Farming
Cd	4	193	8	-	23	37	0	Manokin	Domestic; Farming
Ce	9	238	14	-	0	8	4	Manokin	Domestic
	10	222	14	2	*	-	1.5	Manokin	Domestic; Farming
	14	233	14	-	*	-	3	Manokin	Industrial
	15	190	10	-	0, 9	4, 3	0.6	Manokin	Domestic; Farming
Cf	6	256	20	-	*	-	6	Manokin	Domestic; Farming
Dd	1	201	5	-	35	40	8	Manokin	Domestic
	5	86	9	20	20	45	7	Pocomoke	Domestic
	15	72	8	-	25	35	3	Pocomoke	Domestic; Farming
	22	220	7	-	12	29	5	Manokin	Domestic; Farming
	25	155	4	-	18	17	4	Y-C	Domestic; Farming
De	1	420	12	6	10	60	-	St. Mary (?)	Unused
	7	118	8	18	50	35	2	Pocomoke	Domestic
	8	117	8	8	12	48	3	Pocomoke	Domestic; Farming
	16	87	8	10	14	47	4	Pocomoke	Domestic; Farming
Ed	1	144	4	-	22	53	3	Y-C	Domestic; Farming
	32	54	4	18	-	-	5	Pocomoke	Unused

* Deeper Than 50 Ft.