ANCHORAGE HOUSTON
ATLANTA LOS ANGELES
CHICAGO NEW YORK
CINCINNATI PORTLAND
DENVER SALT LAKE CITY
KHARTOUM SAN FRANCISCO
HONOLULU SEATTLE
WASHINGTON, D. C.

DAMES & MOORE

CONSULTING ENGINEERS IN THE APPLIED EARTH SCIENCES

CALGARY SEOUL
DJAKARTA SINGAPORE
GUAM SYDNEY
LAGOS TEHRAN
LONDON TORONTO
MADRID TRIPOLI
PERTH VANCOUVER, B.C.

14 COMMERCE DRIVE · CRANFORD, NEW JERSEY 07016 · (201) 272-8300
CABLE: DAMEMORE TWX: 710-996-5959

August 19, 1974

Freehold Township Environmental Commission
Freehold Township Municipal Building
Schanck Road
Freehold Township, New Jersey 07728

Attention: Mrs. Rodna Hurewitz

Gentlemen:

We are pleased to submit our Report "Natural Resources Inventory of Freehold Township, Monmouth County, New Jersey". In addition to the enclosed text we have submitted the following:

A series of reproducible mylar Factor Maps of Freehold Township at a scale of 1"=800'.

An existing Land Use Map of Freehold Township at a scale of 1"=800'.

Aerial photographs of Freehold Township at a scale of 1"=1500' with a corresponding index map at a scale of 1"=800'.

We appreciate the cooperation extended to us by the Environmental Commission, Planning Board and Master Plan Commission during the course of our work.

Respectfully,

DAMES & MOORE

James V. Toto, P.E.
State of New Jersey
P.E. Registration No. 17265
Partner

Jack Koczan
Associate

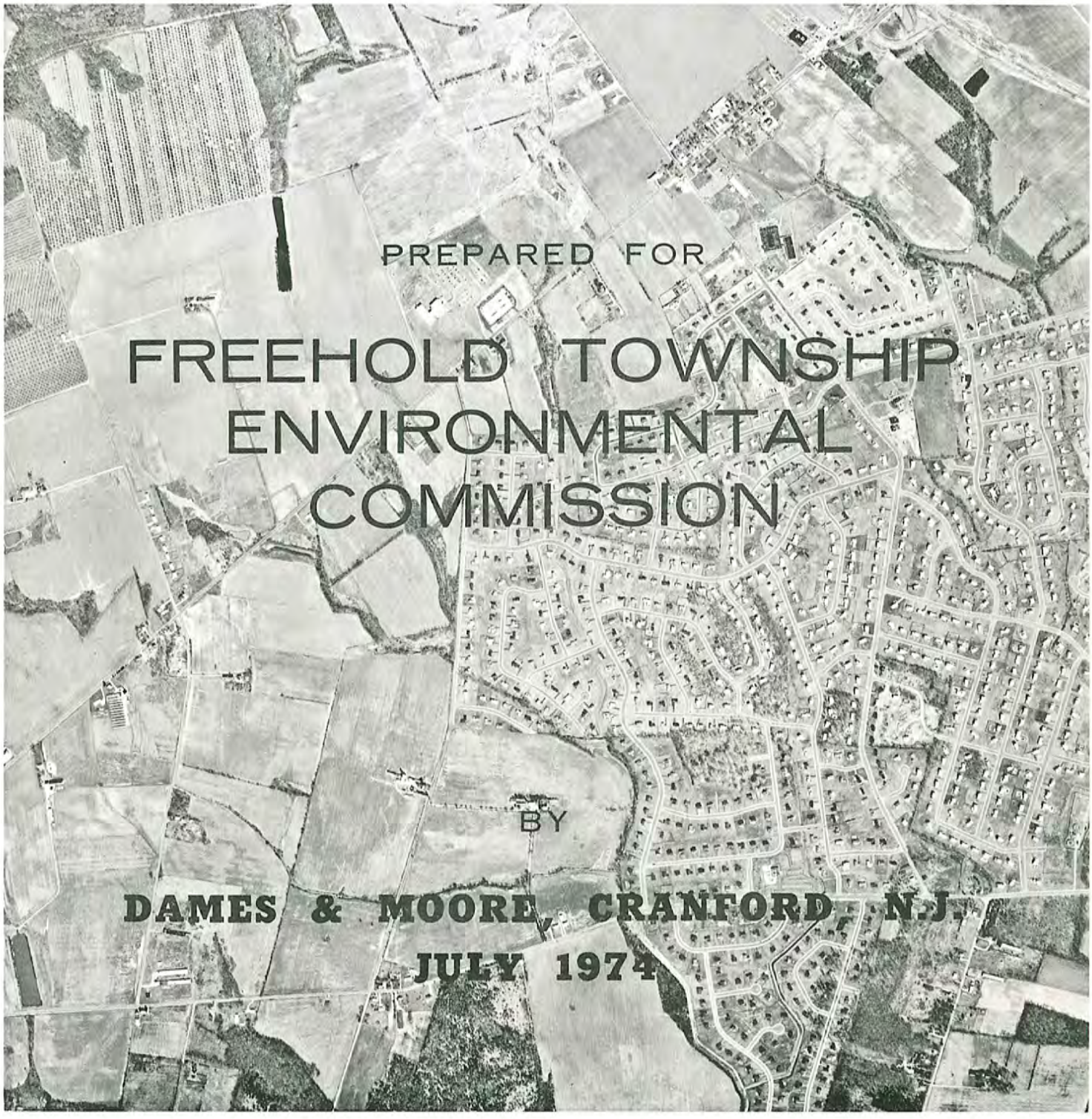
JVT/JAK/BH;hjc

NATURAL RESOURCES INVENTORY
For
FREEHOLD TOWNSHIP, MONMOUTH COUNTY, N.J.
Prepared For
FREEHOLD TOWNSHIP ENVIR0NMENTAL COMMISSION

NATURAL RESOURCES INVENTORY

FOR

FREEHOLD TOWNSHIP, MONMOUTH COUNTY, N.J.



PREPARED FOR

FREEHOLD TOWNSHIP ENVIRONMENTAL COMMISSION

BY

DAMES & MOORE, CRANFORD, N.J.

JULY 1974

TABLE OF CONTENTS

	PAGE
LETTER OF TRANSMITTAL	
INTRODUCTION	
General	1
Natural Resources Inventory	1
LAND USE	
General	5
Land Use Survey	6
TOPOGRAPHY	
General	12
Topography	12
Drainage Basins	13
Flood Plain Inventory	14
GEOLOGY	
General	16
General Stratigraphy	19
Cretaceous Formations	19
Raritan-Magothy Formation	19
Merchantville and Woodbury Clay	21
Englishtown	21
Marshalltown	22
Mount Laurel and Wenonah	22
Navesink	22
Red Bank	23
Tertiary Formations	23
Hornerstown	24
Vincentown	24
Manasquan	24
Kirkwood	25
Quaternary Formations	25
Cohansey Sand	25
Recent Alluvium	25

TABLE OF CONTENTS (Con't)

	PAGE
WATER RESOURCES	
General	26
Ground Water Resources	26
Cretaceous Formations	27
Raritan-Magothy	27
Merchantville	27
Englishtown	28
Marshalltown	28
Mount Laurel and Wenonah	28
Navesink	29
Red Bank	29
Tertiary Formations	29
Hornerstown	29
Vincentown	30
Kirkwood	30
Quaternary Formations	31
Cohansey Sand and Quaternary Deposits	31
Boring Logs and Township Well Fields	31
Surface Water	36
Summary	39
VEGETATION	
General	42
Flora	43
Fauna	50
Semi-Aquatic Habitats	50
Aquatic Habitats	50
Rare and Endangered Species	50
HISTORIC AND AESTHETIC SITES	
General	53
Historic Sites	53
Archaeological Sites	57
Aesthetic Sites	57

TABLE OF CONTENTS (Con't)

	PAGE
CLIMATOLOGY	
General	58
Introduction	58
Frontal Activity	60
Temperature	60
Precipitation	63
Storms	63
Winds	64
Air Quality	64
SOILS	
General	68
Introduction	68
Soil Characteristics	75
Soil Identification	77
Slope	78
Septic Suitability	78
Foundation Limitation	79
Average Depth to Water Table	79
LIST OF TABLES	iv
LIST OF ILLUSTRATIONS	v
REFERENCES	80

LIST OF TABLES

	TABLE #	PAGE #
Stratagraphic Column	1	20
Representative Wells	2	32
Selected Water Quality Parameters for the Manasquan River and Tributaries: Summer 1973	3	38
Population Growth Within Freehold Township	4	40
Population Projections for Freehold Township	5	41
Principle Vegetation of the Freehold Township Region	6	45
Some Common Birds of the Freehold Township Region	7	46
Some Common Mammals of the Freehold Township Region	8	47
Common Amphibians and Reptiles of the Freehold Township Region	9	48
Common Fish of the Freehold Township Region	10	49
Historic Sites	11	51
Aesthetic Sites	12	59
Mean Monthly Occurrences of Frontal Passages	13	61
Climatological Summary	14	62
Mean Percentage of Annual Wind Speeds, by Direction	15	65
Air Quality Values for Freehold Township	16	69
Description of Soil Series and Types	17	71
Identification of Soil Texture, Slope and Erosion	18	73

LIST OF ILLUSTRATIONS

LIST OF FIGURES

	FIGURE #	PAGE #
Existing Land Use	1	7
Geohydrologic Cross Section	2	18
Annual Frequency of Occurrence and Wind Direction	3	67
Soil Profiles	4	76

LIST OF FACTOR MAPS

TITLE	FACTOR MAP NUMBER
Topography (N)	1
Topography (S)	2
Flood Plains (N)	3
Flood Plains (S)	4
Geology (N)	5
Geology (S)	6
Soils (N)	7
Soils (S)	8
Slope (N)	9
Slope (S)	10
Septic Suitability (N)	11
Septic Suitability (S)	12
Foundation Limitation (N)	13
Foundation Limitation (S)	14
Vegetation (N)	15
Vegetation (S)	16
Historic and Aesthetic Sites (N)	17

LIST OF FACTOR MAPS (Continued)

TITLE	FACTOR MAP NUMBER
Historic and Aesthetic Sites (S)	18
Average Depth to Water Table (N)	19
Average Depth to Water Table (S)	20

INTRODUCTION

INTRODUCTION

General

This report presents the Natural Resource Inventory (NRI) for Freehold Township, Monmouth County, New Jersey. Selected Natural Resources existing within the Township have been surveyed and compiled in a series of Factor Maps and supportive text. Specific factors considered in the study were topography, geology, hydrology, vegetation, soils, air quality, and aesthetic areas. In addition an existing land use map was prepared.

The scope of work performed in this study was planned in conjunction with the Freehold Township Environmental Commission and Mayor Arthur Kondrup. This study included research of appropriate literature and analysis of aerial photography to evaluate ecological factors existing within Freehold Township. Certain field surveys were performed to verify land use and vegetation data. Included in this submission are:

(1) Natural Resource Inventory Report

(2) Twenty Factor Maps at a scale of 1"=800" and,

(3) Indexed aerial photographs (scale 1:18000) of the Township flown in March 1974.

Natural Resource Inventory

A Natural Resource Inventory provides basic environmental data useful as a guide in future land use planning and informs the public of resources within their community. The NRI should:

(A) Aid in decisions concerning land use and evaluating suitability of both existing and future land use with respect to the intrinsic capability of the land.

(B) Serve as a basis for preparing Environmental Impact Statements (EIS).

It is anticipated that the Natural Resource Inventory will be utilized in the following manner. For environmental analysis and planning purposes we have prepared Factor Maps which illustrate the regional aspects of selected resources.

Sources of information presented in this report varied from U.S. Soil Conservation Service Maps prepared in 1948 and subsequent soil surveys prepared by Rutgers University in 1955 to more recent data presented on U.S. Geologic Survey Topographic Maps which were updated in 1970. Existing land use and vegetation patterns were interpreted from aerial photography taken in March 1974. These various data were photographically reduced or enlarged to a common scale for graphic presentation. Maps are mylar overlays of the regional topographic map which shows the location of existing landforms and land use.

Factor Maps prepared in our study include:

LIST OF FACTOR MAPS

TITLE	FACTOR MAP NUMBER
Topography (N)	1
Topography (S)	2
Flood Plains (N)	3
Flood Plains (S)	4
Geology (N)	5
Geology (S)	6
Soils (N)	7
Soils (S)	8
Slope (N)	9
Slope (S)	10

LIST OF FACTOR MAPS (Con't)

TITLE	FACTOR MAP NUMBER
Septic Suitability (N)	11
Septic Suitability (S)	12
Foundation Limitation (N)	13
Foundation Limitation (S)	14
Vegetation (N)	15
Vegetation (S)	16
Historic and Aesthetic Sites (N)	17
Historic and Aesthetic Sites (S)	18
Average Depth to Water Table (N)	19
Average Depth to Water Table (S)	20

Reduced copies of maps are presented in the illustration section of this report.

During planning stages of this report, the Township requested that these maps be prepared on a scale of 1" to 800' to be compatible with other planning and engineering drawings. In this scale, single sheets illustrating the entire Township were rather large. To facilitate handling and use, we have divided the maps into two sections, north and south. Thus, there are two sheets for each factor.

To assess the environmental impact of land use proposals, the project should be located on the topographic map, then each factor map placed over the site location. By reviewing the environmental conditions for each factor at the site and analysis of other data available to the Township potential environmental impacts of proposed projects can be evaluated. It must be emphasized that the NRI is not intended to replace

specific data provided by test borings, site inspections, percolation tests. The NRI is,however,presenting the regional environmental characteristic and should be considered in preliminary planning decisions. It is anticipated that applicant or developers will provide detailed information describing the proposed construction, site conditions and measures to minimize environmental impact. In addition to site inspections, review of plans and other evaluations will be performed by local county and state officials as required by each project.

The environment is a very dynamic, complex, and intra-related eco-system. No one eco-factor is wholly independent of another eco-factor and a disruption of one factor often causes resultant changes in other factors. As a forested tract of land may be replaced by a landscaped residential or commercial development, irreparable impacts can result such as the loss of wildlife feeding, breeding, and nesting habitats, a change in micro-climatic conditions, increased runoff and higher stream flows due to less infiltration of water into the ground, and greater erosion and stream siltation from more rapid runoff. Increased land use also impacts water resources. Wastewater discharge may degrade groundwater and surface water quality and groundwater supplies may be over mined creating water supply deficiencies.

Considering such composite effects associated with the proposed action the Environmental Commission, the Planning Board and other Township officials can formulate recommendations regarding:

(1) The compatability and suitability of the project with respect to existing environmental conditions and land use; and

(2) Procedures to minimize environmental impact associated with siting, construction, and operation of the proposed project.

Subsequent sections of this report present detailed environmental data compiled and analyzed to prepare the Factor Maps, Land Use Map and Climatology data. Appropriate explanation and documentation of the data are provided. This text should be used in conjunction with the Factor Maps to provide comprehensive interpretations of site conditions.

LAND USE

General

Freehold Township, Monmouth County, is located in central New Jersey, approximately 50 miles southwest of New York City. In the past, the Township was a rural agricultural area. More recently, it has experienced increasing residential development pressures from the outward expansion of the New York City metropolitan area. This suburbanization is intensified by the dualization of State Highway 9, the completion of State Highway 18 and the proximity of the Garden State Parkway. In the near future, further development can be expected to occur due to the proposed Alfred Driscoll Expressway and the completion of Interstate I-195.

Townships surrounding Freehold Township are: Millstone to the southwest, Manalapan to the west, Marlboro to the north, Colts Neck to the northeast, Howell to the east and Jackson in Ocean County to the south. This area is a developing region primarily characterized by low density residential land use. The major local population center is Freehold Borough which is located within north central Freehold Township. Local commercial development is concentrated adjacent to the major thoroughfares, Routes 9 and 33, that traverse this area.

Land Use Survey

A land use survey comprises one of the most essential components of a natural resources inventory by serving as the basis for a comprehensive land use plan. Such a plan should provide the optimum environment for the township's residents through the preservation of open space, flood plain areas, and natural resources while accomodating necessary residential and municipal facilities. Ultimately, all municipalities utilize a comprehensive land use plan in an effort to achieve that delicate balance between natural resources preservation and urbanization.

To update the existing Land Use Map, Dames & Moore performed a land use survey. Using aerial photographs on a scale of 1:18000, land use patterns were interpreted and mapped. The Freehold Township Environmental Commission assisted Dames & Moore in field verification of the data.

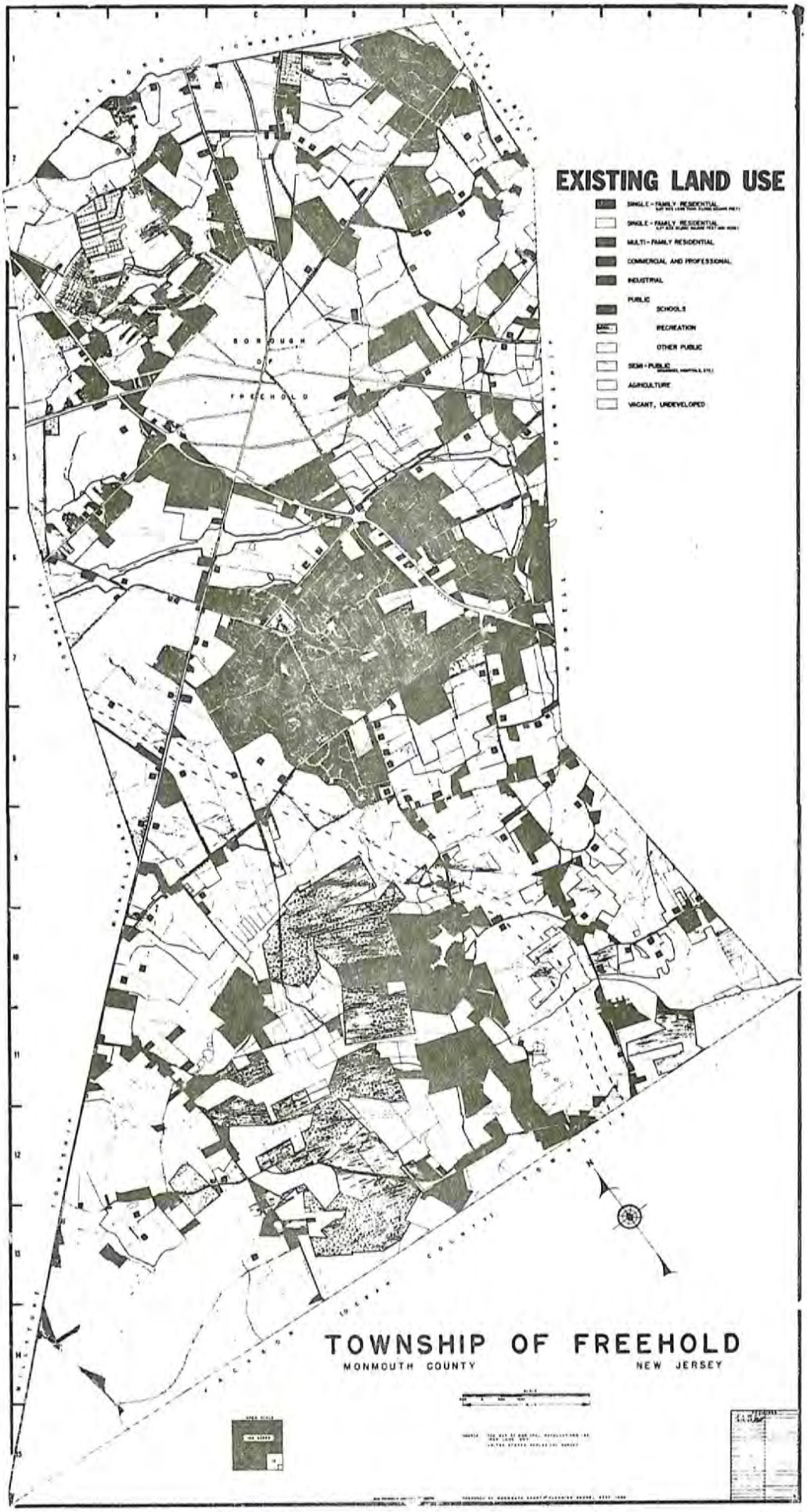
The results of a land use survey are presented in a graphic form (Figure #1). The Land Use Map included in the Freehold Township Natural Resources Inventory classified land use by color within Freehold Township into the following categories:

Single-Family Residential (lot size less than 20,000 sq. ft.)

Single-Family Residential (lot size greater than 20,000 sq. ft.)

Multi-Family Residential - Includes apartments and other multi-unit structures.

Commercial and Professional - Commercial includes service industries (for example, food, personal and repair services) and amusements. Professional includes banking, insurance, medical, etc. services.


EXISTING LAND USE
SINGLE - FAMILY RESIDENTIAL
SINGLE - FAMILY RESIDENTIAL
MULTI - FAMILY RESIDENTIAL
COMMERCIAL AND PROFESSIONAL
INDUSTRIAL
PUBLIC
SCHOOLS
RECREATION
OTHER PUBLIC
SEMI - PUBLIC
AGRICULTURE
VACANT, UNDEVELOPED
BOROUGH OF FREEHOLD
TOWNSHIP OF FREEHOLD
MONMOUTH COUNTY
NEW JERSEY

Industrial - Includes all manufacturing and warehouse facilities.

Public:

Schools - Includes all regional and township public and private schools.

Recreation - Includes parks, playgrounds and conservation areas on township, county and state levels.

Other Public:

Includes all other township, county and state offices and services.

Semi-Public (churches, hospitals, etc.)

Agriculture - Includes all farmland and orchards.

Vacant, Undeveloped - Includes all vacant and undisturbed areas.

The patterns, trends and implications for physical development of each land use classification in Freehold Township are discussed under the following headings:

Single-Family Residential (lot size less than 20,000 sq. ft.)

In Freehold Township, most of the homes in this category were built as the result of residential expansion along the major highway corridors on the north and south sides of Freehold Boro. These homes, for the most part, are ranches built on small plots of land. A recent medium density development, the Silvermead Mobil Home Park, is located in the east central portion of the Township.

Single-Family Residential (lot size greater than 20,000 sq. ft.)

The majority of homes in Freehold Township are in this category. Developments range from large subdivisions in the northern and central portions of the Township to individual homes located throughout the

Township. The former category represents recent residential developments. This category would appear to be the most viable growth category since the greater part of Freehold Township is zoned for this low density housing.

The individual homes, for the most part, are older homes. Many of these homes are found in small clusters at the junction of minor and major roads throughout the Township.

Multi-Family Residential

The high density residential in Freehold Township is found in two medium-sized garden apartment complexes. They are located near the intersection of Route 9 and Schanck Road and along Route 537 in the northeastern section of the Township, (Chesterfield Gardens). A planned adult community in the west central portion of the Township has incorporated a mixture of both low and high density housing.

Commercial and Professional

Commercial and professional facilities are concentrated almost exclusively on the major highway arteries of Routes 9, 33 and 79. Most of the development on Route 9 and 33 is recent strip development, an outgrowth of suburban living. Although the Township offers a wide range of commercial and professional services, Freehold boro is the central business district (CBD) for the Township.

A major commercial operation in the Township is Freehold Raceway, located at the junction of Routes 9 and 33. While the major tract is located in Freehold boro, the bulk of towing and stable facilities are located in Freehold Township.

Most commercial development in the Township is of the shopping center variety. Facilities range from food stores to specialty shops and a full scope of banking, insurance and medical services are provided.

On Routes 9 and 33, several large professional and utility complexes have recently been built, indicative of the area's growing market potential.

Industrial

At the present time, there are several major industries in Freehold Township. The leading industries of the Freehold area are located in the east central section of the Township which has been zoned industrial. Upon completion of Routes 18 and 33, excellent access will be provided to the industrial zone.

Public

Schools - There are 7 public schools interspersed throughout the Township. A regional high school, 2 intermediate schools and 4 grammar schools.

Recreation - Freehold Township has a variety of open space. On the State level, the Turkey Swamp Hunting and Fishing Ground (1856 acres), a largely undeveloped tract of land in the southern portion of the Township, is open to the public for hunting and fishing during the appropriate seasons. A large portion of Monmouth Battlefield, a State historic site, is located in the northwest section.

There are three tracts of open space maintained by the county in Freehold Township; Turkey Swamp Park, adjacent to the Turkey Swamp Hunting and Fishing Grounds offers excellent camping and picnicking facilities. In the northeastern portion of the Township, two natural areas have been preserved by Monmuuth County, the Baysholm and Durand Conservation Areas. They are presently in their natural state. In addition, there is the County Horse Show site, East Freehold Park, adjacent to the Monmouth County Administrative Complex.

The Township of Freehold has excellent municipal recreation facilities as well. Lake Topanemus Park, belonging to the Boro of Freehold, located along the McGellairds Brook, offers picnicking and fishing facilities. The remaining recreation areas function basically as playgrounds. The school system also offers athletic facilities to complement the other recreation areas.

Other Public

Freehold Township's proximity to the county seat, Freehold Boro, has induced the expansion of Monmouth County facilities into the Township. Such county facilities include: Monmouth County Youth Detention Center; Monmouth County Radio Center; Monmouth County Correctional Institution and the John L. Montgomery Nursing Home. The County owns land along East Freehold Road that will be developed into an Administrative Complex.

On the Township level, Freehold has developed facilities to provide municipal services for its citizens. A town hall, public works building and a fire house have been built in recent years to handle the growing demand for municipal services.

Semi-Public

There are a number of semi-public facilities located in Freehold Township, including the Freehold Area Hospital. Most other facilities are church or recreation oriented.

Recreation areas include Camp Nomoco Girl Scout camp and the YMCA camp (Camp Hepburn). A YMCA complex is located along East Freehold Road and has indoor facilities presently under construction.

Agriculture

The central portion of Freehold Township is a well developed residential area. On the outskirts of the residential area the land use

is basically farming. While the area is a viable farming area, it appears that many of the farms have been sold for other purposes in recent years. A combination of increased land value, increased taxes and pressures to develop residential areas have created change in the amount of agricultural land area in Freehold Township.

Vacant, Undeveloped

This category encompasses the largest percentage of land area in Freehold Township. In the northern half of the Township, much of the undeveloped land is farmland. In the southern half of the Township, the land is virtually undeveloped forest and open space preserves with some residential.

TOPOGRAPHY

General

Topographic information for Freehold Township is present on Factor Maps 1 and 2 and illustrates landforms, elevation, and cultural data. These maps are reproductions of U.S. Geologic Survey Topographic Maps which were updated in 1970. Subsequent development, therefore, are not indicated.

In summary, this section of the report outlines the topographic characteristics delineated on the 1970 maps, and also presents a floodplain inventory developed by Dames & Moore and by other studies completed by U.S. Department of Housing and Urban Development and the New Jersey Department of Environmental Protection.

Topography

Freehold Township is located within the Coastal Plain Physiographic Province. The area is characterized by broad lowlands and gently rolling hills formed on unconsolidated and semi-consolidated marine and

terrestrial sediments. These sediments are comprised of sands, silts and clays with some gravel.

Topographic relief within Freehold Township ranges from a high of approximately 250 feet in the southwestern portion of the Township, to elevations less than 100 feet in various eastern locations. Local topographic highs are associated with remnants of Quaternary deposits. Turkey Swamp Park in the south-central portion of the Township, is the site of an extensive freshwater marsh area.

Drainage Basins

A low range of hills extend southwestward across Monmouth County from Raritan Bay that forms a divide between westward drainage to the Delaware River and eastern and northeastern drainage to the Atlantic Ocean. Freehold Township is located on this drainage divide and, thus, drains via seven drainage basins: Swimming River, Manasquan River, Metedeconk River (North and South Branches), Toms River, Manalapan Brook, Weamaconk Brook, and McGellairds Brook. The streams that comprise these basins exhibit a dendritic pattern. Swimming River drains the northeastern tip of Freehold Township via the Navesink River to the Atlantic Ocean; Manasquan River the central segment to the Atlantic; North Branch Metedeconk River to the Atlantic Ocean; Toms River the southwestern tip to Barnegat Bay; Manalapan Brook, Weamaconk Brook and McGellairds Brook the western and northwestern segment to the Raritan River.

Floodplain Inventory

In recent years, forward-looking state and local governments have begun to recognize the fact that floodplains are a valuable natural resource, serving both to minimize the extent of flooding and to maximize the amount of groundwater recharge. The first step in planning for resource protection and utilization is to prepare an inventory. Factor Maps 3 and 4 illustrate floodplains and flood hazard areas mapped within Freehold Township.

Sources of information for the floodplain maps included:

(1) U.S. Soil and Conservation Service Maps

(2) Aerial Photographs, March 1974, Flown by Aero Service, Philadelphia, Pa.

(3) N.J. Department of Environmental Protection, Flood Hazard Report #17, Matchaponix Brook System, Delineation of Flood Hazard Areas - Raritan River Basin, State of New Jersey, Division of Water Resources, March 1973.

(4) U.S. Geologic Survey Topographic Maps

Floodplains are "that portion of a river valley, adjacent to the river channel, which is built of sediments (deposited) during the present regimen of the stream and which is covered with water when the river overflows its banks at flood stages". This definition is both natural and genetic, in that it describes an evolutionary process which forms natural phenomenon -- a tabular, elongated body of alluvium -- that is easily observable on the ground and on topographic maps and aerial photographs. The general extent of the floodplain therefore can be correlated with recent alluvial soils and with topographic information.

To survey the Freehold floodplains, the method of analysis was to systematically examine the aerial photos using a magnifying, reflecting

stereoscope. By stereoscopically exaggerating topographic expression, floodplain characteristics were emphasized. In most cases, the floodplain was identified on the evidence of landform, but occasionally the expression of landform was weak, and it was necessary to utilize corroborative evidence such as topographic position, land use, associated geomorphic features, and micro-drainage.

In many instances, the watercourse originated in a wetland, and in these cases, the wetland was included in the floodplain delineation. It was decided to make this inclusion for two reasons: 1) the boundary between wetland and floodplain is gradational, so that any line separating the two must be arbitrary; and 2) wetland and floodplain function as a single hydrogeological entity, in that both are co-extensive areas of flooding and of flood control and both serve to recharge the groundwater and to maintain stream flow during dry periods.

The floodplains were delineated on transparent overlays to the aerial photographs. When the inventory was complete, the delineations were transferred to the base map scale by means of a transferscope, which enlarges and optically superimposes the overlay onto the base map. This technique was used for the major portions of the Township.

Floodplain delineations developed by computational procedures have been performed by Anderson Nicholas Company for the New Jersey Department of Environmental Protection, using procedures outlined in the U.S. Army Corp of Engineers Manual 1110-2-1409, "Backwater Curves in River Channels". Floodplain areas delineated in this manner are indicated as Flood Hazard Area Limit on the Factor Maps and are located in the northern half of the Township.

Explanations of various floodplain and flood hazard areas presented in the Factor Maps are as follows:

Flood Hazard Area Limit (NJDEP): is the overbank area which during flood periods is utilized to carry the flood flows. (New Jersey Department of Environmental Protection Match ponix Brook System, Report #17, P.5, March 1973.)

Special Flood Hazard Area (HUD): that area adjacent to a stream which is inundated by a 100 year flood, using approximate methods without base flood elevations determined as defined by U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study Guidelines, p. 11, 1974.

Floodplain Boundary (Dames & Moore): area which is classified as a floodplain based on vegetation, geomorphic features, micro drainage and land use by a photogrammetrist using stereo aerial photographs that were flown in March 1974. These delineations were developed by Dames & Moore.

GEOLOGY

General

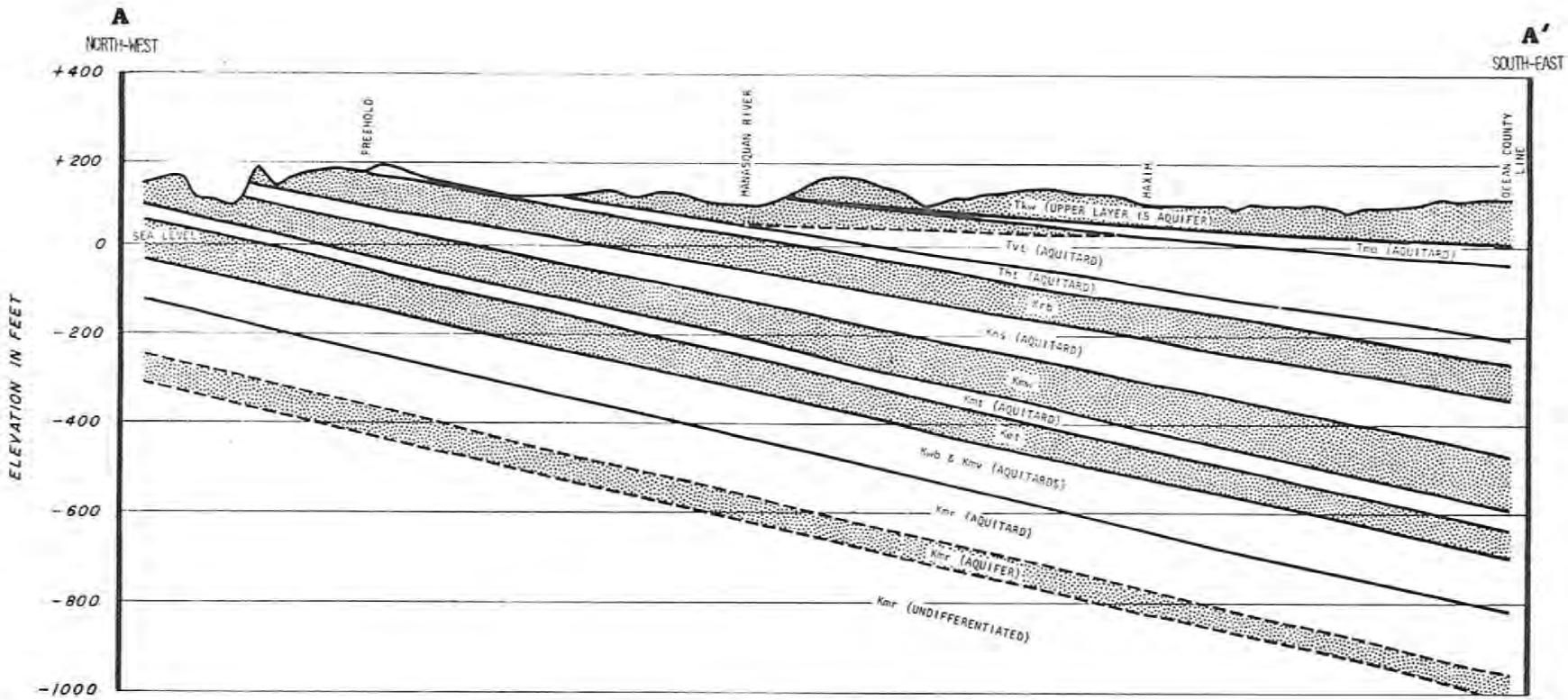
Geologic information presented in this section summarizes the origin, outcrop area, and subsurface expression of various formations mapped in Freehold Township. Each formation is described in regard to thickness and lithology.

A geohydrologic cross section, Figure 2 illustrates the subsurface conditions from northwest to southeast across Monmouth County. Within this section,various aquifers are mapped to illustrate sources of groundwater for the region.

Outcrop areas for the formations in Freehold Township are shown on Factor Maps 5 and 6. The surficial extent of each formation correlate with various soil conditions mapped in the area. This map is helpful, therefore,in extrapolating geologic data within the Township. Relative permeability, water table conditions, bearing capacity, and aquifer rechange areas can be related to each formation.

As an example, the Tinton Formation crops out in the northern portion of Freehold Township. This formation is a green clayey sand with crystalline siderite cementing the individual grains,forming a compact hard sandstone. This sandstone is difficult to excavate and often results in higher costs for foundation and pipeline installation.

Another soil property associated with particular formations in Freehold Township is corrosion potential. Several Coastal Plain sediments contain traces of pyrite (iron sulfide) and lignite (organic material), which affect the chemical properties of the soil and ground water. The pyrite was eroded from a metamorphic phase of igneous rock found in the upland areas of the New Jersey Piedmont Province to the north. Above the ground water table,pyrite could oxidize with downward percolating water to form iron sulfate and sulphuric acid. This reaction would normally not occur below the water table because free oxygen is not present. Lignite, the organic matter in swamp areas formed during the advances and retreats of the sea, could also oxidize in the presence of downward



GEO-HYDROLOGIC CROSS-SECTION

FROM FREEHOLD TO OCEAN COUNTY LINE

REFERENCE:

JABLONSKY, L.A., 1968, GROUND-WATER RESOURCES OF MONMOUTH COUNTY, NEW JERSEY: SPECIAL REPORT #23, DIVISION OF WATER POLICY AND SUPPLIES, STATE OF NEW JERSEY DEPT. OF CONSERVATION AND ECONOMIC DEVELOPMENT.

MILES

2 0 2 4

SCALE

GEOLOGIC FORMATIONS:

Tkw	KIRKWOOD FORMATION
Tmq	MANASQUAN AND SHARK RIVER FORMATIONS
Tvt	VINCENTOWN FORMATION
Tht	HORNERSTOWN FORMATION
Krb	RED BANK SAND
Kns	NAVESINK FORMATION
Kmw	WENONAH FORMATION AND MOUNT LAUREL SAND
Kmt	MARSHALLTOWN FORMATION
Ket	ENGLISHTOWN FORMATION
Kwb	WOODBURY CLAY
Kmv	MERCHANTVILLE FORMATION
Kmr	MAGOTHY AND RARITAN FORMATIONS

KEY

AQUIFER

percolating water to form sulphuric acid. In sufficient quantity this acid could be corrosive. The sulphur and products of these reactions percolate into and lower the pH of the groundwater because of the absence of calcareous materials, which normally act as a buffering agent.

General Stratigraphy

The lowlands and gently rolling hills that characterize the Township are underlain by Cretaceous and Tertiary Aged Coastal Plain sediments comprised of sand, silt and clay with some gravel. A stratigraphic column is presented in Table 1. Formations in the area dip gently to the southeast at an angle of less than one degree as shown on Figure 2.

The older formations (Cretaceous Age) outcrop in the northwest with progressively younger (Tertiary and Quaternary Age) units exposed to the southeast in the Township. Sediment are mainly marine and represent transgressive and regressive units deposited during alternating periods of sea level changes. The total thickness of the Coastal Plain sediments increases toward the southeast. Some younger terrace deposits, consisting of sand, clay, and gravel, overlie these sediments and are erosional remnants of a once more extensive blanket of Pleistocene Aged terrace material.

Cretaceous Formations

Raritan and Magothy

The Raritan-Magothy Formations are believed to be interconnected and function as a single aquifer. The Raritan Formation lies unconformably on eroded bedrock surface of gneiss and schist of late Precambrian age and is unconformally overlain by the Magothy Formation. The Magothy Formation

TABLE #1

STRATIGRAPHIC COLUMN

Era	*System*	*Series*	*Subdivision*	*Water-bearing properties*	*Dip (feet per mile, southeast)*[1]	*Thickness penetrated (feet)*	*Average strike of beds (northeast)*[1]
CENOZOIC	Quaternary	Recent	Alluvium and beach sand and gravel	A relatively poor aquifer. No drilled wells reported in this material.	—	0-30	—
		Pleistocene	Cape May, Pensauken, and Bridgeton Formations (undifferentiated)	Yields up to 6 gpm (gallons per minute) to domestic wells.	—	0-60	—
	Tertiary	Miocene(?) and Pliocene(?)	Cohansey Sand (series is debatable)	No wells reported in this formation.	10	0-30	70°
		Miocene	Kirkwood Formation	Yields range from 15-1,200 gpm from wells; water usually contains iron, sulfide, and is acid.	20	60-100	70°
		Eocene	Manasquan Formation and Shark River Marl	A poor aquifer; yields up to 12 gpm to domestic wells.	25	25-100	55°
		Paleocene	Vincentown Formation	Numerous domestic wells tap this sand; yields range 10-50 gpm to domestic wells.	27	10-130	55°
			Hornerstown Sand	A poor aquifer; yields up to 5 gpm to domestic wells.	50	30-100	55°
MESOZOIC	Cretaceous	Upper Cretaceous	Red Bank Sand (includes the Tinton Formation at the top)	Yields range from 3-30 gpm to domestic wells.	33	30-135	50°
			Navesink Formation	Important to domestic consumers. Wells yield 10 gpm or less.	35	10-45	50°
			Mount Laurel Sand Wenonah Formation	A single aquifer. Average yield 10 gpm. Maximum yield reported was 335 gpm.	35	15-85	50°
			Marshalltown Formation	Not considered water-bearing in the county.	37	30-50	45°
			Englishtown Formation	Average yield 25 gpm. Maximum yield reported 640 gpm. Average yield to large-capacity wells 410 gpm.	39	36-150	45°
			Woodbury Clay Merchantville Formation	Both formations act as a single aquiclude. Not water-bearing.	41 42	50 50-60+	45° 45°
			Magothy Formation	Sands are discontinuous, and thickness variable. Maximum yield reported 250 gpm.	40-45	25-175	40°
			Raritan Formation	Contains most important aquifers. Yields range 100-1,400 gpm to large-diameter wells.	45-52	150-400+	—
PRE-CAMBRIAN	Late Pre-cambrian(?)		Wissahickon Formation	No wells in this formation.	62	—	—

[1]Minard and [illegible]s, 1960, p. 9.

has outcrop area of 1.6 square miles in Monmouth County while the Raritan does not outcrop in Monmouth County. In Middlesex County, the Raritan-Magothy Formation outcrop covers about 54 square miles and, as a result, aquifer recharge occurs west of Freehold Township.

The members of the Raritan Formation are composed of medium to coarse-grained quartzone sand or clay containing varying amounts of lignite and pyrite. The sand is white to light gray and the clay is white with different color spots or streaks. The Magothy consists in outcrop of alternating beds of dark gray or black clay and white micaceous fine grained sand. A layer of white sand 40' thick, occurs locally near the top of this formation. An ironstone bed generally marks the upper limit of the Magothy formation.

Merchantville and Woodbury Clay

The Merchantville Formation and Woodbury Clay function together as a confining layer, separating the aquifer in the Raritan and Magothy Formations from the overlying aquifers. The Merchantville Formation is about 50' thick and consists of dark grayish-black micaceous clay, clayey silt and includes beds and lenses of glauconitic sand. The Woodbury Clay is massive dark grayish-black micaceous clay and is also about 50' thick. The lower part of the formation has small amounts of glauconite and the upper part is usually laminated and may contain glauconite.

Englishtown

The Englishtown Formation characteristically has large concentrations of quartz sand. However, the Englishtown Formation changes from a quartzose sand, 150 feet in thickness, to a series of silt or clay and

sand layers, 50 feet in thickness, northeast to southwest along the outcrop area shown on Figure #2. Downdip, the formation also consists of layers of clay, sand and silt, with a combined thickness in some places of 120 feet.

Marshalltown

The Marshalltown Formation is not considered water bearing and has wide textured variations. Generally, it is a thin (15"-20") dark grayish-black bed of micaceous, silty glauconitic sand. The formation is extensively burrowed and many borings are filled with glauconitic sand and typically the formation is mottled.

Mount Laurel and Wenonah

The Wenonah Formation and Mount Laurel Sand, although distinct formations, will be considered as one unit since they are hydraulically connected and function as a single aquifer. The Wenonah Formation contains dark gray, micaceous, quartz silt and fine-grained sand, locally interbedded with clay lenses. The overlying Mount Laurel Sand is generally a greenish-gray, glauconitic, clayey quartz sand. The contacts of these formations are conformable,dipping to the southeast at 35 feet per mile. Their combined thickness ranges from 15 to 85 feet near the outcrop.

Navesink

The Navesink Formation consists of a dark greyish-black clayey glauconitic sand that conformably overlies Mount Laurel Sand. The formation is of a fairly uniform thickness of 25 feet and dips to the southeast at 35 feet per mile. A shell zone occurs at the base of this formation and forms a marker horizon. This shell zone locallly may be considered as part of the aquifer in the Wenonah Formation and Mount Laurel sand. Except for the shell zone, the Navesink Formation, in

conjunction with the basal clay member of the overlying Red Bank Sand, forms a confining layer between the Mount Laurel Sand and the overlying formations.

Red Bank

The Red Bank Sand consists of two members -- an upper member of slightly clayey, medium to coarse grained quartz sand with minor amounts of mica and glauconite, and a lower member composed of medium to fine-grained, very micaceous, clayey glauconite sand. The upper member thins in the subsurface toward the southeast and is absent more than 4 to 6 miles from the outcrop.

Tinton Sand is usually included in the Red Bank Formation, but it is as a member scattered and not always present. Tinton Sand is green clayey sand and sandy clay. Outcrops are small and 10 to 20 feet thick. Pebbles as much as one quarter inch in diameter and coarse sand are abundant in this member. Another feature of this formation is its widespread cementation by finely crystalline siderite (a mineral, $FeCO_3$, Ferric Carbonate, commonly containing also Mg, Magnesium and Mn, Manganese). Tinton is a compact hard sandstone that is so resistant to erosion that at the type locality a small waterfall is developed on it. The Red Bank Sand ranges from 30-140 feet in thickness. The thinning of the formation downdip is due to erosion,prior to the Hornerstone being deposited as evidenced by a difference in strike and dip between the two formations.

Tertiary Formations

Freehold Township is underlain by 7 sedimentary units; four of which are Tertiary aged. The Tertiary units comprise Hornerstown Marl,

Vincentown Formation, Manasquan and Kirkwood Formations.

Hornerstown

The Hornerstown Sand unconformably overlies the Red Bank and dips to the southeast at 50-60 feet per mile. It is a dark-green, clayey glauconite sand with fine to very coarse grained quartz sand distributed throughout the unit. The basal part of the formation may contain as much as 50 percent quartz sand where it overlies the upper part of the Red Bank Sand. Pyrite nodules, apatite pellets, and organic debris are common locally in the basal part of the unit.

Vincentown

The Vincentown Formation lies unconformably on the Hornerstown Sand and dips to the southeast at 27 feet per mile. It contains two members in Monmouth County. The upper member ranges from a fine or medium grained quartz sand to a sandy, clayey limestone. The sand is micaceous, clayey, glauconitic, calcareous, and fossiliferous. The lower member consists of greenish-gray, micaceous, clayey, glauconitic, fine to medium grained sand. Unlike many of the Coastal Plain formations, the Vincentown decreases in thickness toward the southeast -- from 100 feet near the outcrop to less than 10 feet about six miles to the southeast.

Manasquan Formation

The Manasquan Formation is composed of two layers. The lower is dark colored,poorly sorted quartz sand. The upper layer is green and very clayey glauconitic sand. This formation is the combined Manasquan and Shark River Marl of earlier reports. Being clayey, the Manasquan acts as an aquiclude between the Vincentown and Kirkwood formation. Where the Vincentown is absent downdip the Manasquan acts in conjunction with

underlying formations to separate the Wenonah and Mt. Laurel aquifer from the overlying Kirkwood Formation. A unique feature of the Manasquan, is large outcrops of pale gray silty clay containing sparsely distributed glauconite and quartz sand throughout. However, the Manasquan is exposed only at a few localities in the New Jersey Coastal Plain.

Kirkwood Formation

The Kirkwood Formation unconformably overlies the Manasquan formation, and locally, the Vincentown Formation and Hornerstown Sand. The Kirkwood attains a maximum thickness of 100 feet in Monmouth County and dips to the southeast about 20 feet per mile. It consists of two units: a basal unit composed of pebbly quartz sand or brown lignitic quartz silt to very fine grained quartz sand, and an upper unit of very fine grained quartz sand containing quartz granules and small pebbles. Trace amounts of pyrite and considerable reworked glauconite occur near the base of the formation.

Quaternary Formations

Cohansey Sand

The Cohansey Sand caps low hills which are erosional remnants of a Pleistocene Formation. This sand is composed of medium to very coarse grained ilmenitic quartz sand with thin beds of light red to very light gray clay. Pebbles are present throughout the formation and it characteristically exhibits well defined stratification, especially cross-stratification.

Recent Alluvium

Sediments eroded from older strata have been deposited in stream beds in the Township. These deposits are usually mapped as floodplain soils

and overlay the older Formations. Foundation and septic tank limitations are associated with these deposits.

WATER RESOURCES

General

This section describes both the groundwater and the surface water resources of Freehold Township. Groundwater data include descriptions of aquifers and recharge areas within the Township. Projections of total groundwater flow are compared with long term needs. In the Surface Water Section, the unique drainage characteristics of Freehold Township, flow data, U.S.G.S. gaging stations and local water quality information is presented.

Groundwater Resources

Groundwater information presented here compliments the Geology Factor Maps 5 and 6. On these Factor Maps areas of regional and local aquifers are indicated. Approximately, the northern third of Freehold Township is shown as a local aquifer recharge region and approximately, the southern third of the Township is shown as a regional aquifer recharge area. Outcrops in the central third of the Township are identified as the Tertiary Hornerstown Formation, which is an aquiclude. For more detailed information (coefficients of transmissibility, permeability, etc.), the reader is directed to the publication "Groundwater Resources of Monmouth County, New Jersey" (Jablonski, 1968).

General

The Geohydrologic cross section shown in Figure #2, illustrates the oldest (Magothy-Raritan Formations) to the youngest (Kirkwood and Cohansey Formations) aquifers, and aquitards in the Freehold Township area.

The aquifers that provide major water supplies to the region are Cretaceous and Tertiary age. The Cretaceous age aquifers comprise Raritan-Magothy, Englishtown, Mount Laurel-Wenonah, and Red Bank. (The Navesink Formation is locally considered part of the Mount Laurel-Wenonah Formation). Detailed information on each aquifer is described below.

Cretaceous

Raritan-Magothy

The Raritan-Magothy Formation is the major aquifer in the region and provides approximately 57% of the ground water in Monmouth County, (Jablonski).

The Raritan and Magothy aquifers are the deepest aquifers (greater than 600') in Freehold Township and are hydraulically interconnected thus acting as a single aquifer. Recorded well yields in the county range from 100 to 1,400 gallons per minute, (gpm). Estimated daily pumpage is 12.3 million gallons per day, (mgd). Salt water intrusion into these aquifers in the region has not been reported. It is believed that the salt water-fresh water interface lies a few miles east of the coastline of Monmouth County.

Merchantville

The Merchantville Formation (micaceous clay and clayey silt) and the Woodbury Clay overlie the Magothy Formation and have a combined thickness of about 100 feet. These act as a single aquiclude, separating the Raritan and Magothy aquifers from the Englishtown aquifer as shown on Figure 2.

Englishtown

Above the Merchantville Formation is the Englishtown Formation an important aquifer in Monmouth County. Outside of Monmouth County this formation is a very poor aquifer. Its hydraulic connections with salt water in Sandy Hook Bay or the Atlantic Ocean are not known. The average yield of wells tapping the aquifer is reported at 25 gpm, but a few large capacity wells in the county have been reported to yield 400 to 600 gpm. In 1958,it supplied 20% (4 million gallons per day) of all the groundwater used in Monmouth County. This aquifer is overstressed,as indicated by water level declines recorded in the last ten years. New well development is,therefore,not recommended.

Marshalltown

Overlying the Englishtown conformably is the Marshalltown Formation,which consists of a 30 to 80 feet thick sandy clay or very clayey sand layer. Together with the clayey portion of the overlying Wenonah Formation, the Marshalltown acts as a confining layer separating the Englishtown aquifer below from the Mount Laurel-Wenonah aquifer above.

Mount Laurel and Wenonah

The Mount Laurel and Wenonah aquifers are hydraulically interconnected and are treated as a single aquifer,although they are distinct formations. Yields average 10 gpm,per well,with maximum yields of approximately 300 gpm. Even though this aquifer has a relatively low capacity for transmitting water its uniform thickness, lithology and good quality of water make it an important aquifer. Pumpage from the Mt. Laurel and Wenonah represents about 3% (0.65 mgd) of the total groundwater withdrawal in Monmouth County for 1958.

Navesink

The Navesink Formation is a dark clayey sand and conformably overlies the Mt. Laurel sand. A shell zone usually occurs at the bottom of this formation and forms a very good marker horizon. Except for this shell zone, the Navesink Formation, in conjunction with the basal clay member of the overlying Red Bank Sand, forms a confining layer between the Mount Laurel Sand and the overlying formations.

Only a few domestic wells top the shell zone and yield up to 15 gallons per minute of water of excellent quality.

Red Bank

The Red Bank aquifer consists of a sand unit which is the upper member of the Red Bank Formation. It is separated hydraulically from the Mount Laurel-Wenonah aquifer by the clayey sand of the intervening Navesink Formation and by the lower clayey sand member of the Red Bank Sand. The Red Bank aquifer thins toward the southeast and is absent 4 to 6 miles from the outcrop. The Red Bank Formation is a minor aquifer that is acidic and has a high iron content. However,many domestic wells in the outcrop area of northern Freehold Township tap the upper member of this formation. Reported well yields range from 2 to 25 gallons per minute.

Tertiary Formations

Hornerstown

The Tertiary age aquifers that supply water to the Freehold Township area consist of the Vincentown aquifer and the Kirkwood aquifer. The Hornerstown Formation is considered an aquiclude,although it may yield enough water in some parts of the outcrop area to satisfy small domestic needs.

Vincentown

The Vincentown aquifer is generally very thin, discontinuous, and yields only a few gpm to domestic wells. Less than 1% of the ground water in 1958 in Monmouth County was taken from this aquifer. The clayey sand that constitutes the Hornerstown Sand which underlies the Vincentown Formation, serves as a confining bed for the Red Bank aquifer. The Vincentown aquifer thins rapidly in the subsurface from 100 feet to a few feet 15 miles downdip. Thus, pumpage from the aquifer is limited mainly to the thicker deposits near the outcrop area. It produces less than one percent of the ground water diversion in Monmouth County. Yields in Monmouth County are reported to range from 10 to 50 gpm.

Kirkwood

The Kirkwood is exposed at the surface over a large area in Monmouth County, the total area extent is 140 square miles. Locally it is overlain by patches of Cohansey Sand and Pleistocene deposits. It is underlain by the Manasquan Formation (25 to 100 feet thick) which acts to separate the Kirkwood from the underlying aquifers, either the Vincentown or the Mount Laurel-Wenonah aquifer. The lower unit of the Kirkwood appears to be chiefly brown silt in Monmouth County and so may also act as a confining layer along with the Manasquan Formation. The upper unit of the Kirkwood is composed of fine quartz sand and serves as the aquifer. The aquifer ranges in thickness from a few feet to about 80 feet in the region. The Kirkwood aquifer is reported to account for about 7 percent, or 1.5 mgd of ground water diversion in the county. Ground water flow in the aquifer is toward the Manasquan and Shark Rivers and southward toward Ocean County. Yields in Monmouth County range from 15 to 1,200 gpm.

Quaternary Formations

Cohansey Sand and Quaternary Deposits

Post-Kirkwood aquifers include the Cohansey Sand and Quaternary alluvium and terrace deposits. These units are generally thin and discontinuous and are not important aquifers. Locally, they provide low yields to small domestic wells.

Boring Logs and Township Well Fields

Three boring logs of selected wells in Freehold Township are presented in Table #2. These wells are considerably deeper than residential wells and they demonstrate the thickness and depth of the various geologic formations underlying Freehold Township.

Freehold Township operates two well fields to supply potable water. One well field is located in the northern portion of the Township on Edwards Drive, (Factor Map #1). Here, well numbers 6 and 7 are located and sized 6" and 12" in diameter, respectively. These wells tap the Raritan-Magothy aquifer at 656' and 802', respectively.

Another Township well field is located in the central portion of the Township off Koenig Lane, (Factor Map #1). These well numbers 1 and 4 are sized 8" and 12" in diameter respectively. They tap the Raritan-Magothy aquifer at 670' and 683' respectively. Also in this well field, is a well in the Englishtown Formation; well number 3. This well is 12" in diameter and only 210' deep, (Zimmerman-Personal Communication).

TABLE # 2

Representative Wells

Well 1, Freehold

	Thickness (feet)	Depth (feet)
Tertiary:		
Hornerstown Sand:		
Clay, light brown, sandy, glauconitic.....	15	15
Cretaceous:		
Red Bank Sand:		
Sand, greenish brown, clayey, glauconitic.....	25	40
Sand, gray green, fine to coarse, glauconitic.....	65	105
Navesink Formation:		
Clay, gray, glauconitic, shell fragments.....	30	135
Wenonah Formation and Mount Laurel Sand:		
Clay, gray, sandy, glauconitic.....	35	170
Sand, fine, slightly clayey and micaceous.....	10	180
Sand, gray, very fine, clayey.....	10	190
Marshalltown Formation:		
Clay, dark gray, micaceous, shell fragments.....	35	225
Englishtown Formation:		
Clay, gray, sandy, glauconitic.....	5	230
Clay, dark gray, contains limestone nodules.....	10	240
Sand, gray, fine, clayey.....	20	260
Clay, gray, and alternating thin laminae of sand...	40	300
Sand, gray, fine, sparsely glauconitic.....	20	320
Clay, gray, lignitic, sandy, contains limestone nodules.....	35	355
Woodbury Clay:		
Clay, gray, contains limestone nodules.....	55	410
Clay, gray, contains shell fragments.....	15	425
Merchantville Formation:		
Clay, gray, glauconitic and micaceous, contains shell fragments.....	5	430
Clay, gray, micaceous and glauconitic.....	40	470
Clay, gray, sandy, slightly micaceous and glauconitic.....	20	490
Clay, gray, micaceous.....	10	500
Clay, greenish-gray, contains limestone nodules....	10	510
Magothy (?) Formation:		
Clay, gray.....	10	520
Clay, gray, sandy.....	10	530

Source: Jablonski, 1968

TABLE #2 (CONTINUED)

Well 2, Freehold

	Thickness (feet)	Depth (feet)
Unnamed:		
Topsoil	6	6
Cretaceous:		
Navesink Formation:		
Clay, hard	23	29
Wenonah Formation and Mount Laurel Sand:		
Sand, and soft clay	38	67
Sand, black, fine	21	88
Marshalltown Formation:		
Clay	8	96
Sand	12	108
Clay, tough	28	136
Englishtown Formation:		
Sand	13	149
Clay	23	172
Sand	18	190
Sand, contains pods of white clay	16	206
Clay, and thin seams of sand	13	219
Merchantville Formation and Woodbury Clay:		
Clay, hard	96	315
Raritan and Magothy Formations:		
Limestone	2	317
Clay	96	413
Sand	6	419
Clay	12	431
Lime (?)	1	432
Clay, tough	9	441
Sand, gray, fine	59	500

Source: Jablonski, 1968

TABLE # 2 (CONTINUED)

Well 3, Freehold

	Thickness (feet)	Depth (feet)
Cretaceous:		
Red Bank (?) Sand:		
Sand, brown, clayey, glauconitic.....	10	10
Sand, brown, clayey, indurated, glauconitic.....	15	25
Red Bank Sand:		
Sand, reddish-brown, fine to coarse, slightly clayey.....	35	60
Sand, greenish-gray, fine to medium, clayey, slightly glauconitic and micaceous.....	65	125
Clay (?), gray, sandy, glauconitic, very fossiliferous.....	35	160
Clay, greenish-gray, very glauconitic.....	5	165
Wenonah Formation and Mount Laurel Sand:		
Sand, fine, micaceous, clayey.....	35	200
Sand, and clay, gray, fine.....	10	210
Sand, gray, fine, clayey, micaceous and glauconitic.....	30	240
Wenonah (?) Formation:		
Clay, gray, contains thin laminae of fine sand....	5	245
Clay, gray, sandy.....	15	260
Clay, gray, sandy, micaceous.....	20	280
Marshalltown Formation:		
Clay, gray, contains thin laminae of fine sand....	20	300
Clay, sandy, contains shell fragments.....	10	310
Englishtown (?) Formation:		
Clay and sand. Sand is fine and micaceous.....	20	330
Englishtown Formation:		
Sand, gray, very fine to medium, slightly clayey..	20	350
Englishtown (?) Formation:		
Clay, slightly sandy.....	50	400
Woodbury Clay:		
Clay, gray, micaceous, contains shell fragments...	50	450
Clay, greenish-gray, micaceous.....	24	474
Merchantville Formation:		
Sand, gray, fine, contains pyrite and limonite....	6	480
Clay, greenish-gray, sandy, micaceous, slightly fossiliferous.....	40	520
Clay, greenish-gray.....	30	550
Merchantville (?) Formation:		
Clay, greenish-gray, slightly sandy, glauconitic and fossiliferous.....	20	570

TABLE # 2(CONTINUED)

Well 3, Freehold (Continued)

	Thickness (feet)	Depth (feet)
Magothy Formation:		
Clay, gray, sandy.....	40	610
Sand and clay in alternating layers; sand is fine gray, and micaceous.....	20	630
Sand, light gray, very fine.....	20	650
Sand and clay, interbedded; sand is gray, very fine and micaceous.....	30	680

Source: Jablonski, 1968

Surface Waters

The surface waters of Freehold Township are unique because they are all headwaters, draining away from the municipality (generally toward the Atlantic Ocean). No water flows into or through the Township from outside (the municipal boundary lines). McGellaird's Brook, Weamaconk Brook, and Manalapan Brook drain the northwestern portion of Freehold Township, flowing northwest into the South River, which is a primary tributary of the Raritan River. The headwaters of the Swimming River (which feeds the Monmouth Consolidated reservoir of the same name, downstream in Colts Neck and Holmdel Townships) originate in the northeastern corner of the Township. The upper reaches of the Manasquan River drain the east central portion of Freehold Township, flowing generally southeast to the Atlantic Ocean, and constitutes the largest hydrologic drainage area in the municipality. The North Branch of the Metedeconk River originates in the lower third of the municipality and also flows southeast to the Atlantic Ocean. Small portions of the headwaters of both the Toms River and the South Branch of the Metedeconk River occur in the southwestern corner of Freehold Township. They flow south and southeast, respectively.

There is no historical flow data available for any of these surface waters within Freehold Township. The nearest stream gage (U.S.G.S., No. 4080) is located outside the Township, downstream on the Manasquan River at Squankum in Farmingdale. Using this gage as a basis, Elson T. Killam Associates projected a low flow frequency curve for the Manasquan upstream at the "Villages" (drainage area = 24.30 sq. mi.) just west of Havens Bridge Road in Howell Township. This location is quite

close to the eastern boundary of Freehold Township. The once in ten years, seven-day consecutive low flow here is estimated to be 9.8 cubic feet per second or 6.4 million gallons per day.

There is extensive and current (summer, 1973) water quality data available from the U.S. Geological Survey for the Manasquan River and Debois Creek within Freehold Township. The Manasquan Basin sampling sites include three (3) U.S.G.S. stations on the main stem of the Manasquan at Burke Road (No. 1407810), Georgia Rd. (No. 1407821), and Route 9 (No. 1407870), downstream, respectively; and two (2) U.S.G.S. stations on Debois Creek at Route 33 (No. 1407836) and Strickland Rd. (No. 1407862), downstream, respectively.

The water quality in Debois Creek appears especially poor, as shown in Table #3. In the summer of 1973, the BOD_5 was far above recommended background limits (5 mg/l) and the dissolved oxygen concentration was below the minimum NJDEP criterion (4.0 mg/l) for FW-2 water. Ammonia nitrogen (NH_3-N), Kjeldahl nitrogen and total phosphorous all exceeded recognized limits for average (mean) stream concentrations (these would be 1.0, 1.5, and 0.100 mg/l, respectively). These pollutants can all be considered indicators of sewage contamination originating from the several sewage treatment plants discharging to the creek.

At the very headwaters of the Manasquan River at Burke Rd., the water quality appeared to be slightly impaired (summer, 1973), The primary problem is low mean dissolved oxygen concentration (2.7 mg/l) and an above average total phosphorous concentration (0.71 mg/l as compared to recommended 0.100 mg/l). The water quality of the main stem Manasquan River improved downstream at Georgia Rd (U.S.G.S. No. 1407821) and

TABLE # 3

SELECTED WATER QUALITY PARAMETERS FOR THE MANASQUAN RIVER AND TRIBUTARIES: SUMMER 1973

USGS STATION #*	RANGE	Temp (Deg. C)	DO (mg/l)	BOD_5 (mg/l)	PH (Units)	NH_5-N (mg/l)	NO_3-N (mg/l)	KJELDANL NITROGEN (mg/l)	TOTAL PHOSPHORUS (mg/l)
	Min	6.8	0.0	2.7	3.8	0.05	0.00	0.50	0.33
01407810	Mean	11.5	2.7	5.9	5.6	0.23	0.10	0.68	0.71
	Max	16.9	6.6	11.4	6.6	0.70	0.19	1.1	1.1
	Min	6.4	7.1	3.8	5.4	0.08	0.89	0.47	0.25
01407821	Mean	12.2	8.0	5.1	6.6	0.31	1.1	0.72	0.33
	Max	18.7	9.6	10.0	6.0	0.71	1.2	0.84	0.41
	Min	15.8	0.4	3.4	6.2	0.13	0.1	1.7	1.1
01407836	Mean	20.4	1.7	25.8	6.5	3.2	1.6	3.8	1.4
	Max	22.4	4.2	9.1	6.8	4.2	4.9	4.5	2.2
	Min	13.8	0.6	3.6	6.1	0.1	0.0	1.7	0.49
01407862	Mean	18.0	2.9	15.3	6.3	2.9	1.1	3.6	0.81
	Max	21.3	5.1	5.6	6.8	4.0	4.1	4.9	1.2
	Min	13.5	2.3	3.2	6.1	0.1	0.64	1.7	0.51
01407870	Mean	17.0	5.4	5.6	6.3	1.9	1.5	2.7	0.64
	Max	20.4	6.4	8.8	6.9	2.9	3.7	3.2	1.1

Source: Unpublished records, the U.S. Geological Survey, Trenton, N.J.

The following are the USGS Station locations:

USGS STATION NO.	SAMPLING LOCATION
01407810	Manasquan River at Burke Rd., Freehold Township
01407821	Manasquan River at Georgia Rd., Freehold Township
01407936	Debois Creek at Route 33, Freehold Township
01407836	Debois Creek at Strickland Rd., Freehold Township
01407870	Manasquan River at Route 9, Howell Township

Route 9 (U.S.G.S. No. 1407870).

The total phosphorous concentration at all five sampling stations greatly exceeded the recommended limit of 0.100 mg/l. This concentration is inadequate to permit eutrophication in the Manasquan mainstem under low flow conditions. There also appears to be adequate ammonia-nitrogen for nitrification which cause further deoxygenation, beyond carbonaceous oxidation.

Regional Water Supply (Summary)

Freehold Township today is experiencing a rapid increase in population. Between 1960-1970 the population increased from 4,779 to 13,185 for a 175.9% increase (Table #4). The population of the Township as of 1/1/74 was estimated by the Monmouth County Planning Board to be 18,320 people. Population increases are expected to continue but at a slower rate as indicated in Table 5 which contains Township projections by various agencies. A similar increase in the withdrawal of ground water has occurred during this time period. In Monmouth County, ground water withdrawal is expected to increase from 44 million gallons per day (mgd) in 1958 to 92 mgd in 1975 and to 333 mgd in the year 2000 (MCPB-1958). The Artesian aquifers, Raritan-Magothy, Englishtown, Mt. Laurel-Wenonah, and the Vincentown and Kirkwood account for the majority of this water. The recharge of these aquifers occur mainly at the areas of outcropping. The Raritan-Magothy formation outcrops and is recharged entirely outside of Freehold Township in Middlesex County to the north. The outcropping and recharge area of the Englishtown and Mt. Laurel-Wenonah aquifers extend across the boundary between Middlesex and Monmouth County and just crosses the northwest corner of Freehold Township. The Vincentown and Kirkwood aquifers outcrop within the central portion of the Township.

TABLE # 4

POPULATION GROWTH WITHIN FREEHOLD TOWNSHIP

	1940	1950	1960	1970	1/1/73	1/1/74
Freehold Township	2,459	3,442	4,779	13,185	16,850	18,320

Sources: U.S. Census
Monmouth County Planning Board (MCPB)

TABLE # 5

POPULATION PROJECTIONS FOR FREEHOLD TOWNSHIP

	1975	1980	1985	1990	2000
E.T. Killam	17,000	21,500	28,000	35,000	55,000
MCPB - 1968	----	----	28,160	----	57,200
MCPB - 1973	----	----	26,928	----	42,240
MCPB - NJDED-1973	15,141	19,025	23,622	27,159	35,038

Source:

E.T. Killam, 1968 - MCPB, 1968 - Monmouth County Planning Board - General Plan 1969 - 1985, October 1969.

MCPB, 1973 - Monmouth County Planning Board - Preliminary Municipal Distribution - Revised Monmouth Co. Population Projections-June 1973. Subject to adjustment.

MCPB - NJDED-1973 - Data based on N.J. Division of Ecomomic Development, State Projections by County, June, 1973, Municipal distribution of county population based on MCPB - 1973 projections.

Recharge areas are being reduced as a result of urbanization. This, combined with the projected increases in pumpage,may overstress the total ground water reservoir.

There are,at present,no surface water impoundments for public water supply in Freehold Township. However,there are two planned reservoirs for the southern part of Monmouth County. One,near Allaire State Park and another near Oak Glenn in Howell Township. Construction of these surface water supply systems is scheduled for the 1980's and 1990's, respectively.

Data from the United States Geological Survey office in Trenton indicates that the Englishtown and probably the Mt. Laurel-Wenonah aquifers are severely stressed in Monmouth County. A piezometric level at an observation well in the Englishtown aquifer at nearby Allaire State Park dropped 42' from August 1965 to August 1969. At a Toms River observation well, also in the Englishtown formation, the water level dropped over 40' from 1910 to 1967. According to Jablonski,the deepest aquifer in the region, the Raritan-Magothy, may also be stressed.

The continued reliance on ground water, with a significant portion originating outside the Township, coupled with a continued increase in population and consumption,may result in a regional deficit where alternative water supplies will be required (Dames & Moore, 1973).

VEGETATION

General

The various habitats within the Township are described and the principle inhabitants are identified in this section. Also described are the flora and fauna found within the Township.

Vegetation Factor Maps 15 & 16 show four categories (wooded, semi-wooded, agriculture and other) that are found in Freehold Township. In general,the southern portion is heavily forested (Turkey Swamp Park and Hunting Grounds) and the northern portion divided between agriculture, residential wooded and semi-wooded.

The fauna of an area is particularly sensitive to drastic alterations of native flora. For example, as an area develops, the composition of bird species inhabiting the area changes. Field and woodland species decline while those bird species that utilize shrubs and lawns increase. Bird population studies have shown that such habitat changes cause the diversity of bird species to decline, while the total number of birds increase (largely due to the influx of birds such as starlings and house sparrows).

The effects of a proposed project should be examined not only as it relates to one factor but also as it relates to all factors, (topography, geology, soils, etc.). The intelligent use of natural resources can alleviate the impact of more intensive land use. With respect to the example of wildlife, this intelligent land use would allow some areas of appropriate flora to develop and to provide a diversity of habitats for varied species propagation.

Flora

An Inventory of the fauna and flora of the Freehold area entails the categorizing of land into terrestrial, semi-aquatic (semi-terrestrial), and aquatic habitats. The terrestrial habitat of the Township comprises forests, grasslands, farmlands and orchards, etc. The wooded areas exhibit a transition from the Appalachian Oak forest type

to the Pine Barrens environment of the Northeastern Oak Pine forest type. The predominant forest species are oaks, maples, American beech and tulip or yellow poplar. Sandier soils support pitch pine, scrub oak, white and red oak, sweet gum, sour gum and Atlantic white cedar. Where the forests are in the initial stages of plant succession, wild cherries, gray birch, aspen and the gums are the main recovery species. Grasslands, farmlands and orchards comprise the understory and ground cover vegetation. The principal species of vegetation in Freehold Township are listed in Table #6.

The defoliation of trees by the gypsy moth caterpillar is a serious problem of this area in recent years. The gypsy moth (Porthetria dispar) was accidentally introduced into the New England area in 1869 and remained a problem only in those states until a few years ago. For unknown reasons, this moth has extended its range southward into the Middle Atlantic States, where it has reached epidemic proportions. The gypsy moth initially attacks deciduous trees such as the white oak (Quercus bicolor) but then spreads to other tree types, both deciduous and non-deciduous. This defoliation, repeated over several years, will kill most trees.

As of mid-summer 1974, the gypsy moth infestation appears to have peaked in the counties of northern New Jersey. However, defoliation caused by this moth is still a serious problem in the counties of central and southern New Jersey. Spraying infested trees with insecticides is a method of control that has been applied with various stages of success.

TABLE #6

PRINCIPLE VEGETATION OF THE
FREEHOLD TOWNSHIP REGION

Scientific Name	Common Name
Acer rubrum	Red maple
A. saccharum	Sugar maple
Betula lenta	Black birch
Carpinus caroliniana*	Ironwood
Carya sp.*	Hickory
Fagus grandifolia	American beech
Fraximus sp.*	Ash
Lindera benzoin*	Spicebush
Liquidambar styraciflua	Sweet gum
Pinus rigida*	Pitch pine
Populus grandidentata	Bigtooth aspen
Quercus alba*	White oak
Quercus coccinea*	Scarlet oak
Quercus rubra*	Northern red oak
Quercus velutina*	Black oak
Quercus bicolor	Swamp white oak
Quercus michauxii	Swamp chestnut oak
Liriodendron tulipifera	Tulip tree
Quercus ilicifolia	Scrub oak
Nyssa sylvatica	Sour gum
Chamaecyparis thyoides	Atlantic white cedar
Betula populifolia	Gray birch
Populus tremuloides	Quaking aspen
Prunus pennsylvanica	Wild red cherry
Prunus serotina	Wild black cherry

* Dominants

SOURCE: Kuchler, 1964
Freehold Township Environmental Commission, 1974

TABLE #7

SOME COMMON BIRDS OF THE
FREEHOLD TOWNSHIP REGION

Scientific Name	Common Name
Aeglains phoenicus	Red-wing blackbird
Buteo jamaicensis	Red-tailed hawk
Chaetura pelagica	Chimney swift
Colaptes auratus	Common flicker
Corvus brachyrhynchas	Common crow
Cyanocitta cristata	Blue jay
Dendroica petechia	Yellow warbler
Dendrocopos pulsescens	Downy woodpecker
Hirundo rustica	Barn swallow
Hylocichla mustelina	Wood thrush
Mimus polyglottus	Mockingbird
Mniotilta varia	Black and White warbler
Passer domesticus	House sparrow
Parus atricapillus	Black-capped chickadee
Quiscalus quiscula	Common grackle
Richmondena cardinalis	Cardinal
Spinus tristis	American goldfinch
Sturnus vulgaris	Starling
Furdus migratorius	Robin
Zenaidura macroura	Mourning dove
Anas platyrhynchos	Mallard duck
Philohela minor	American woodcock
Otus asio	Screech owl
Megaceryle alcyon	Belted kingfisher
Branta canadensis	Canada goose
Bonasa umbellus	Ruffed grouse
Phasianus torquatus	Ring-necked pheasant
Icterus galbula	Baltimore oriole
Hesperiphona vespertina	Evening grosbeak
Parus bicolor	Tufted titmouse
Colinus virginianus	Bob-white
Spinus pinus	Pine siskin
Zonotricha albicollis	White-throated sparrow

Source: N.J. Dept. of Conservation and Economic Development 1969

TABLE #8

SOME COMMON MAMMALS OF THE FREEHOLD TOWNSHIP REGION

Scientific Name	Common Name
Didelphis marsupialis	Opossum
Mormota monax	Woodchuck
Mephitis mephitis	Striped skunk
Peromyscus maniculatus	Deer mouse
Procyon lotor	Raccoon
Scuirus carolinensis	Gray squirrel
Sylvailagus floridanus	Eastern cottontail
Tamias striatus	Eastern chipmunk
Mustela vision	Mink
Ondatra zibethicus	Muskrat
Odocoileus virginianus	White-tailed deer
Vulpes fulva	Red fox
Urocyon cinereoargenteus	Gray fox
Mustela frenata	Weasel
Tamiasciurus hudsonicus	Red squirrel
Condylura cristata	Starnose mole
Lasiurus borealis	Red bat

Source: N.J. Dept. of Conservation and Economic Development 1969
Monmouth County Park System, 1971
Freehold Township Environmental Commission, 1974

TABLE #9

COMMON AMPHIBIANS AND REPTILES
OF THE
FREEHOLD TOWNSHIP REGION

Scientific Name	Common Name
AMPHIBIANS	
Bufo americanus	Common Toad
Notopthalmus viridescens	Red-spotted newt
Rana catesbeiana	Bullfrog
Rana clamitans	Green frog
Rana pipiens	Leopard frog
Hyla crucifer	Northern spring peeper
REPTILES	
Chelydra serpentina	Common snapping turtle
Clemmys gutta	Spotted turtle
Kinosternum subrubrum	Mud turtle
Natrix sipedon	Northern water snake
Terrapene carolina	Eastern box turtle
Thamnophis sirtalis	Eastern garter snake
Chrysems picta	Eastern painted turtle
Coluber constrictor	Northern black racer

Source: Monmouth County Park System, 1971
Freehold Township Environmental Commission, 1974

TABLE #10

COMMON FISH OF THE
FREEHOLD TOWNSHIP REGION

Scientific Name	Common Name
Lepomis macrochirus	Bluegill
Ictalurus nebulosus	Brown bullhead
Micropterus salmoides	Largemouth bass
Esox niger	Eastern chain pickerel
E. americanus vermiculatus	Mud pickerel
Lepomis cyanellus	Green sunfish
Perca flavescens	Yellow perch
Salmo trutta	Brown trout

Source: McDermott, 1971
Freehold Township Environmental Commission, 1974
Monmouth County Park System, 1974

Fauna

Many faunal species utilize the terrestrial habitats. Those common land vertebrates (birds and mammals) that may be found in the region are mentioned in Table 7 and 8. Since no estimates of relative abundance are available, the status of the faunal species in the area is not well known.

Semi-Aquatic Habitats

The semi-aquatic habitats present within Freehold Township are swamps and bogs located along the rivers and their tributaries that flow through the area. The flora of these lowland areas consist of sphagnum logs and swamp-oak and tulip tree forests. The fauna (amphibious and reptiles) which may be found in these freshwater swamps and bogs are listed in Table 9.

Aquatic Habitats

The aquatic habitats within the Township are the rivers, tributaries,ponds and lakes associated with these waterways. These fresh water habitats support a variety of plant and animal life. Vegetation consists of rooted aquatic plants and phytoplankton. Fish species which occur in the rivers, streams or lakes are mentioned in Table #10.

Rare and Endangered Species

A rare plant species which occurs in the general vicinity of Turkey Swamp Park is Trailing Arbutus (Epigaea repens), (T. Kellers, Personal Communication).

A rare bird species which may be found in the Township is the Eastern Bluebird (Sialia Sialis).

HISTORIC AND AESTHETIC SITES

General

This section is an inventory of these places within Freehold Township that are listed by the state and federal government and by the Freehold Township Environmental Commission as having historic and aesthetic value. Homes and schools are identified and listed on Factor Maps 17 and 18 by the same numbers that describe them in the following paragraphs. Those areas having historic or aesthetic significance are shown on the Factor Maps 17 and 18 with a shading pattern to indicate their areal extent.

Historic Sites

The New Jersey Department of Environmental Protection, Historic Sites Section, has established criteria for processing areas, sites and structures for inclusion in the State Register of Historic Places. The Register is a permanent record of public and private properties that possess historical, archaeological, architectural, or cultural merit. Prior to inclusion within the State Register, historic areas, sites and structures are listed in the New Jersey Inventory of Historic Places.

Table #11 lists those historic sites situated within the Township, as recognized by the State and local historical societies by map name, identification number, approximate date of erection, and location.

The Battleground Historical Society, a local historical society, has prepared the following brief chronicles of some of the interesting sites within Freehold Township. The number preceeding each opening paragraph refers to the map identification number of that particular historic site as displayed on the Historic and Aesthetic Site Factor Maps 17 and 18.

TABLE #11

HISTORIC SITES

Number	Name	Date	Location
1.	Conover Farm**		Randolph Road
2.	Ralph Smith House	c. 1750	Route 79
3.	Wyckoff Hill Cemetery		Route 79
4.	Old East Freehold School Site		East Freehold Road
5.	Peter Saker Jr. House		East Freehold Road
6.	Yesteryear House	c. 1831	Route 537
7.	Old Toll House Site		Burlington Road
8.	Wyckoff Family Cemetery		Longview Avenue
9.	Old Wyckoff Place	c. 1840	Burlington Road
10.	Rosewell**	c. 1770	Burlington Road
11.	Buck Farm	c. 1750	East Freehold Road
12.	Monmouth Battelfield*	1778	Route 522
13.	Harry Taylor House	c. 1780	Route 33
14.	Calvin Reid House	c. 1820	Route 33
15.	Oakley House	c. 1750	Wemrock Road
16.	Old West Freehold School**	c. 1847	Wemrock Road
17.	Moore's Inn**	c. 1793	Route 537
18.	Smithburg Inn***		Route 537
19.	Statesir House		Route 537
20.	Frudden House	c. 1831	Stillwells Corner Road

TABLE #11 (continued)

HISTORIC SITES

Number	Name	Date	Location
21.	Dennis' Mill Site		Elton-Adelphia Road
22.	William Clayton Farm		Route 537
23.	Russell Clayton Farm	c. 1862	Route 537
24.	Elkins House	c. 1834	Siloam Burke Road
25.	Georgia School House	c. 1795	Georgia Road
26.	Naurez House	c. 1841	Jackson Mills Road

* National Historic Landmark, National Register, State Register
** State Inventory of Historic Places
*** Located in Millstone Township

(2) The Ralph Smith House located on Route 79, dates from circa 1750 and has been owned by the Smith family since 1871. Tree trunks, complete with bark, are used as floor joists and hand-hewn beams are present throughout the house. The house contains numerous lamps and other antiques.

(4) The Old East Freehold School, located off of East Freehold Road, was a one-room school for children living in the eastern portion of the Township. The school house was equipped with a pot-bellied stove fired by wood and coal and a communal drinking pail.

(6) The home of Mr. and Mrs. Ernest Frank Jr., Colts Neck - Freehold Road, appropriately named "Yesteryear Farm," is dated circa 1831 and was the home of Henry Wikoff. Mr. Wikoff was the descendant of Cornelius Wikoff who came from Holland in 1636, on the ship "King David."

(7) The Old Toll House, situated on the corner of Burlington Road and Route 537, was a one-room structure adjacent to the Old Burlington Road. The toll could be handled by the gate keeper without exiting from the house. The gate was a long pole, hinged to a start upright across the road from the toll house that could be swung across the road to halt a vehicle.

(9) The Old Wyckoff Place was constructed off of Burlington Road around 1840. This house is part of the former Henry Wyckoff farm and is noted for its interior decoration.

(10) Rosewell, located on Burlington Road, contains a portion built around 1770. The land, presently owned by Lafayette Page, dates from an original grant from George III. A middle section of the structure was built in 1830, the remainder in 1860.

(11) The Edgar Buck Farmhouse, circa 1750, is located on the East Freehold Road. This old farmhouse has been the home of the Buck family for generations. They bought it from the Freneau family. It was here that Philip Freneau lived with his sisters prior to his death. Philip Freneau was a pamphleteer and a great critic of George Washington. He was a famous writer and editor. The farmhouse and surrounding buildings typify a well-run farm.

(12) The Battle of Monmouth was fought on the plains of western Monmouth County (now the site of Monmouth Battle field) on June 28, 1778, an extremely hot day. This battle was the last major engagement in the north and proved to the British that the American colonists were now determined to fight for their beliefs. This battle, one of the largest of the entire Revolutionary War, is also remembered for the humanitarian efforts of Molly Ludwig Hays (Molly Pitcher) who carried water to the parched American troops and manned her husband's cannon when he fell wounded.

(13) The Harry Taylor home, Route 33, was built around 1780. The older, western section of the house features a hallway with a typical 18th century paneled stairway with a handrail similar to that in Clinton's headquarters, circa 1750. This suggests that the house is post-revolutionary.

The eastern section of the house was added in the first part of the 19th century, at which time the front doorway was changed. This addition gave the house a typical Georgian style plan which did not hit the Freehold area until after 1800.

The entire house retains most of its original glass and has been covered with shingles, with the original siding probably underneath. The foundation of both sections is fieldstone.

(14) The Calvin Reid House on Route 33 was built around 1820 and once was part of the Forman tract. This house was constructed by Tunis Forman to be a wedding gift for his son John Conover Forman. The home, a two-story colonial,that retains much of its original appearance, contains a large living room made from the double parlors.

(15) The Elizabeth Oakley House on Wemrock Road dates from 1750.

(16) The Old West Freehold School on Wemrock Road was constructed circa 1847 and is being restored and furnished by the Battleground Historical Society. The building is a one-room schoolhouse that is leased by the society for 99 years.

(18) The Smithburg Inn, located on the corner of Route 537 and Smithburg Road in Millstone Township, is of Revolutionary War fame and the birthplace of Joel Parker, Civil War Governor of New Jersey.

(20) The home of Miss Louise Frudden, Stillwells Corner Road, West Freehold, dates from 1831. The original owner of this farm was Job Clayton. A noteworthy feature in this house is a new fieldstone fireplace in the living room. The stones were all found in Millstone Township.

(23) The Russell Clayton farm, circa 1862, is located on Route 537. Russell Clayton was born in the old "stone house" across the road. This house was known throughout the countryside for its stone construction, unusual in this area. The stones were gathered from the

Zdancewic property, a nearby farm, which was part of the Cornelius Thompson estate which comprised 3,000 acres. The inside of this house burned and the stone building was demolished.

Archaeological Sites - The State of New Jersey has documented two Indian sites that are located within Freehold Township. These sites, located to the west of Georgia Road, have been excavated, published, and officially recorded. Map number 5 shows the approximate locations of these two archaeological sites.

Aesthetic Sites - Numerous areas of aesthetic value are found within the Township. These sites include the Baysholm and Durand Conservation Areas, and Turkey Swamp Park. An area of unique interest and natural value is the Turkey Swamp Public Hunting and Fishing Grounds which is administered by the State Fish and Game Dept. In addition to the native wildlife of rabbit, fox, raccoon, mink, muskrat, deer, grouse, woodchuck, squirrels, and ducks, this wildlife area is stocked with pheasant and quail. Public hunting and fishing is permitted during the appropriate seasons. The area is open to the public for hiking and horseback riding during non-hunting times of the year.

Turkey Swamp Park is an integral part of the Monmouth County Park System. During the year of 1972, a total of 250,667 visitors utilized the camping, boating and other recreational facilities of this park. The Durand and Baysholm Conservation Areas are undeveloped tracts that are of unique interest and natural value. Camp Nomoco, administered by the Monmouth Council Girl Scouts, is a resident camp from the Fourth of July to the second week in August. During the remainder of the year,Camp Nomoco is available for weekend camping by the Girl Scouts.

TABLE #12

AESTHETIC SITES

	Acres	
Durand Conservation Area	90	
Baysholm Conservation Area	71	
Turkey Swamp Public Hunting and Fishing Grounds	1,856	
Turkey Swamp Park	363	
Monmouth Battlefield	253	(within Freehold Twp.)
Stone Hill		
Lake Topanemus		

Source: Freehold Township Environmental Commission, 1974
NJDEP Inventory of Historic Places

Monmouth Battlefield, previously mentioned as a historic site, when fully developed,will comprise an area totalling 1,875 acres, of which 253 acres are to be situated within Freehold Township. Upon completion as a state park, this site will not only be an area of aesthetic value but also one of historic significance as the locale of one of the most memorable battles of the Revolutionary War.

The aesthetic sites located within Freehold Township are listed in Table #12 and shown on the Historic and Aesthetic Site Factor Maps 17 and 18.

CLIMATOLOGY

General

In this section we have summarized various climatological data such as frontal activity, precipitation, temperature, storms, winds, and air quality. To compile this information,we have reviewed data collected by U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington D.C., New Jersey Department of Environmental Protection Bureau of Air Standard, Trenton, N. J. and U.S. Air Force Technical Application Center Washington, D.C. The basic data are statistical summaries useful to evaluate potential air quality impacts and to perform engineering studies such as structural design and flood studies.

Introduction

The Freehold Township region is characterized by a continental climate, experiencing only minor influences from proximity to the Atlantic Ocean. Generally, four air mass types influence the area. These air masses are two dry continental types (Polar and Artic) and two moist

maritime types (Polar and Tropical). The continental air masses flow in from the north and west and are usually preceded by cold fronts. Maritime air masses sweep into the area from the Atlantic Coast or from the Gulf of Mexico. The interplay of these air masses produces extratropical cyclones (low pressure systems).

Frontal Activity

The frequency of passing cyclones and the associated fronts are the major factors in determining climate variability. These systems not only determine the types and duration of air mass dominance over a given region, but also produce characteristic wind and precipitation patterns. This is particularly noteworthy for the North Atlantic Coastal Region, which is a focal area for storm tracks from the west, southwest and occasionally from the south. The most extensive precipitation patterns occur with stationary fronts and with warm fronts moving from the south.

Table #13, Mean Monthly Occurrences of Frontal Passages, is a summary of occurrences of frontal passages over the State of New Jersey by month based on a four-year "normal" period as determined by the Palmer-Drought Index. These frontal passages can be considered as representative of an average year. The frequent occurrence of fronts shows that air masses are changed often. This indicates that stagnation conditions occur infrequently.

Temperature

Table #14, Climatological Summary, details temperature and precipitation data for the Freehold Township area, compiled over a 30-year period (1941-1970) at the Freehold weather station. The normal mean temperature of the region is 53.0°F. Summer temperatures seldom exceed

TABLE #13

MEAN MONTHLY OCCURRENCES OF FRONTAL PASSAGES

For New Jersey

Month	Average Number of Fronts			
	Cold Fronts	Warm Fronts	Occluded Fronts	Stationary Fronts
January	3.25	0.25	0.75	1.75
February	3.25	0.75	1.50	1.50
March	2.50	0.25	1.25	1.00
April	4.50	2.50	0.00	5.00
May	3.00	2.00	0.75	2.50
June	5.25	2.25	0.25	2.00
July	4.00	1.00	0.00	6.25
August	4.75	1.00	0.00	3.50
September	3.50	0.25	0.50	4.25
October	5.24	1.50	0.00	1.50
November	4.50	1.75	1.75	0.50
December	4.25	1.50	0.50	1.25
TOTALS	48.00	15.00	6.75	32.00

Source: E. T. Killam and Dames & Moore
Waste Water Management Study of the Manasquan Basin and the Metedeconk Basin in Monmouth County, 1974.

TABLE #14

CLIMATOLOGICAL SUMMARY
RECORDED AT FREEHOLD (N.J.) WEATHER STATION
1941 - 1970*

Month	Temperature (°F)							**	Precipitation Totals (Inches)								Mean number of days					Month
	Means			Extremes								Snow, Sleet						Temperatures				
																		Max.		Min.		
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 inch or more	90° and above	32° and below	32° and below	0° and below	
(a)																						
Jan.	39.7	23.0	31.4	73	1950	-14	1935	1060	3.17	2.38	1936	6.8	20.0	1965+	12.8	1964	5	0	8	27	1	Jan.
Feb.	41.5	23.8	32.7	76	1954	-20	1934	897	3.09	2.40	1966	7.2	25.3	1967	9.8	1969	6	0	5	23	*	Feb.
Mar.	50.0	30.3	40.2	87	1945	-2	1967	781	4.23	2.63	1953	5.0	17.5	1958	9.0	1958	7	0	1	19	*	Mar.
Apr.	62.3	39.7	51.0	92	1941	18	1944+	422	3.45	2.05	1961	0.5	4.0	1956	4.0	1956	7	*	0	6	0	Apr.
May	73.1	49.1	61.1	96	1941	29	1952+	174	3.93	4.54	1968	T	T	1963+	T	1963	6	1	0	*	0	May
June	81.6	58.4	70.0	100	1934	35	1938	23	3.40	4.30	1938	0	0	-	0	-	6	5	0	0	0	June
July	85.6	63.5	74.6	106	1936	46	1945	1	4.69	5.15	1961	0	0	-	0	-	6	7	0	0	0	July
Aug.	83.6	61.9	72.8	102	1955	42	1940	4	4.39	4.04	1955	0	0	-	0	-	6	4	0	0	0	Aug.
Sept.	77.5	55.4	66.5	99	1953	32	1963+	71	3.47	5.68	1938	0	0	-	0	-	5	2	0	*	0	Sept.
Oct.	67.3	45.3	56.3	94	1941	20	1969	283	3.14	2.95	1955	T	1.8	1962	1.8	1962	5	0	0	2	0	Oct.
Nov.	55.1	36.1	45.6	83	1950	7	1938	577	4.11	3.55	1963	0.6	9.0	1938	6.0	1953	7	0	*	12	0	Nov.
Dec.	42.5	25.9	34.2	72	1966+	-5	1942	944	3.65	2.68	1946	5.7	26.0	1957	10.3	1959	7	0	5	24	*	Dec.
Year	63.3	42.7	53.0	106	July 1936	-20	Feb. 1934	5235	44.72	5.68	Sept. 1938	25.8	26.0	Dec. 1957	12.8	Jan. 1964	73	19	19	113	1	Year

* Extremes for period 1931 - 1970
Means for period 1941 - 1970

SOURCE: Climatology of the United States, National Oceanic and Atmospheric Administration, U. S. Department of Commerce.

100°F., but frequent readings in the 90's occur from late May until early September. Winter readings below 0°F. are very infrequent. The hottest and coldest months of the year are July and January, respectively. Recorded temperature extremes range from 106°F. to -20°F.

The average growing season of the region is 178 days in duration, extending from the last freezing temperature (mean date April 23) to the first freezing temperature (mean data October 18).

Precipitation

Precipitation in Freehold averages about 45 inches a year (Table #14). Precipitation is generally evenly distributed throughout the year averaging 3.7 inches/month. Generally,precipitation is greatest during the summer months of July and August and least during the winter months of January and February. Forms of precipitation include drizzle, rainy sleet, and snow which are produced by frontal activity, thunderstorms, or tropical storms. Snowfall averages about 26" a season,although total amounts per year vary considerably. Recorded total monthly snowfall amounts range from zero to 26 inches.

Storms

Destructive storms are infrequent in the vicinity of Freehold. The major storms affecting the area are thunderstorms,which generally occur from May through August and are frequently accompanied by heavy rains and high winds. The frequency of thunderstorms (30 to 35 per year at most inland stations) is very high. Comparing the thunderstorm frequency in New Jersey with that of all other coastal regions in the same latitude (California, East Asia, Mediterranean) New Jersey experiences by far the greatest number. As far as damages are concerned, in middle latitudes,the

number of lightning flashes striking the ground per square mile and year ("cloud-to-earth flashes") equals about one-half of the annual number of thunderstorms. (Boman & Schulman 1968). Other storm threats are hurricanes and tornadoes, although the latter is infrequent. Hurricanes occur in late summer and early fall as they move northward along the mid-Atlantic coast accompanied by high winds and heavy rainfall.

Winds

The predominant wind direction over central New Jersey is westerly. That is, winds generally blow from the west to the east. The best available wind data for the Freehold Township area are those reported at Lakehurst Naval Air Station in Ocean County, New Jersey and McGuire Air Force Base in Burlington County, Table #15. These locations are not within Freehold Township, but are in similar terrain and represent a reasonable estimate of wind distribution for the region. The wind distribution at Atlantic City, Atlantic County is included to illustrate a coastal site and is not appropriate for Freehold Township. The mean windspeed is 7.2 knots at Lakehurst and 6.6 knots at McGuire AFB. A graphic illustration of wind direction occurrence is shown in Figure # 3, Annual Frequency of Occurrence Wind Direction.

Air Quality

The State of New Jersey has been conducting an air monitoring program for the past several years. State standards have been established for such pollutants as sulfur dioxide, carbon monoxide, and suspended particulates, and methods of sampling have been developed. A network of 21 stations, including a site at Freehold, is conducting continuous monitoring of sulfur dioxide, carbon monoxide, and smoke shade. In

TABLE #15

MEAN PERCENTAGE OF ANNUAL WIND SPEEDS, BY DIRECTION
MCGUIRE AIR FORCE BASE
SPEED

Direction	1-3 kts	4-6 kts	7-10 kts	11-16 kts	17-21 kts	22-27 kts	All Speeds
N	1.0	1.9	2.0	0.6	0.1	0.0	5.6
NNE	0.6	1.2	1.3	0.4	0.1	0.0	3.6
NE	0.6	1.1	1.2	0.5	0.1	0.0	3.5
ENE	0.5	0.9	1.2	0.6	0.1	0.0	3.3
E	0.7	1.2	1.3	0.5	0.1	0.0	3.8
ESE	0.5	0.8	0.9	0.3	0.0	0.0	2.5
SE	0.5	0.9	0.8	0.2	0.0	0.0	2.4
SSE	0.7	1.1	1.0	0.1	0.1	0.0	3.0
S	1.5	2.3	2.1	0.7	0.1	0.0	6.7
SSW	1.2	2.1	2.3	0.8	0.1	0.0	6.5
SW	1.1	2.6	2.9	0.9	0.1	0.0	7.6
WSW	0.8	2.0	2.3	1.0	0.1	0.0	6.2
W	1.0	2.6	3.2	2.0	0.5	0.1	9.4
WNW	0.7	2.0	3.2	2.3	0.6	0.1	8.9
NW	0.6	1.6	2.5	1.6	0.4	0.1	6.8
NNW	0.7	1.7	2.1	1.1	0.2	0.0	5.8
TOTAL	12.7	26.0	30.3	13.6	2.7	0.3	

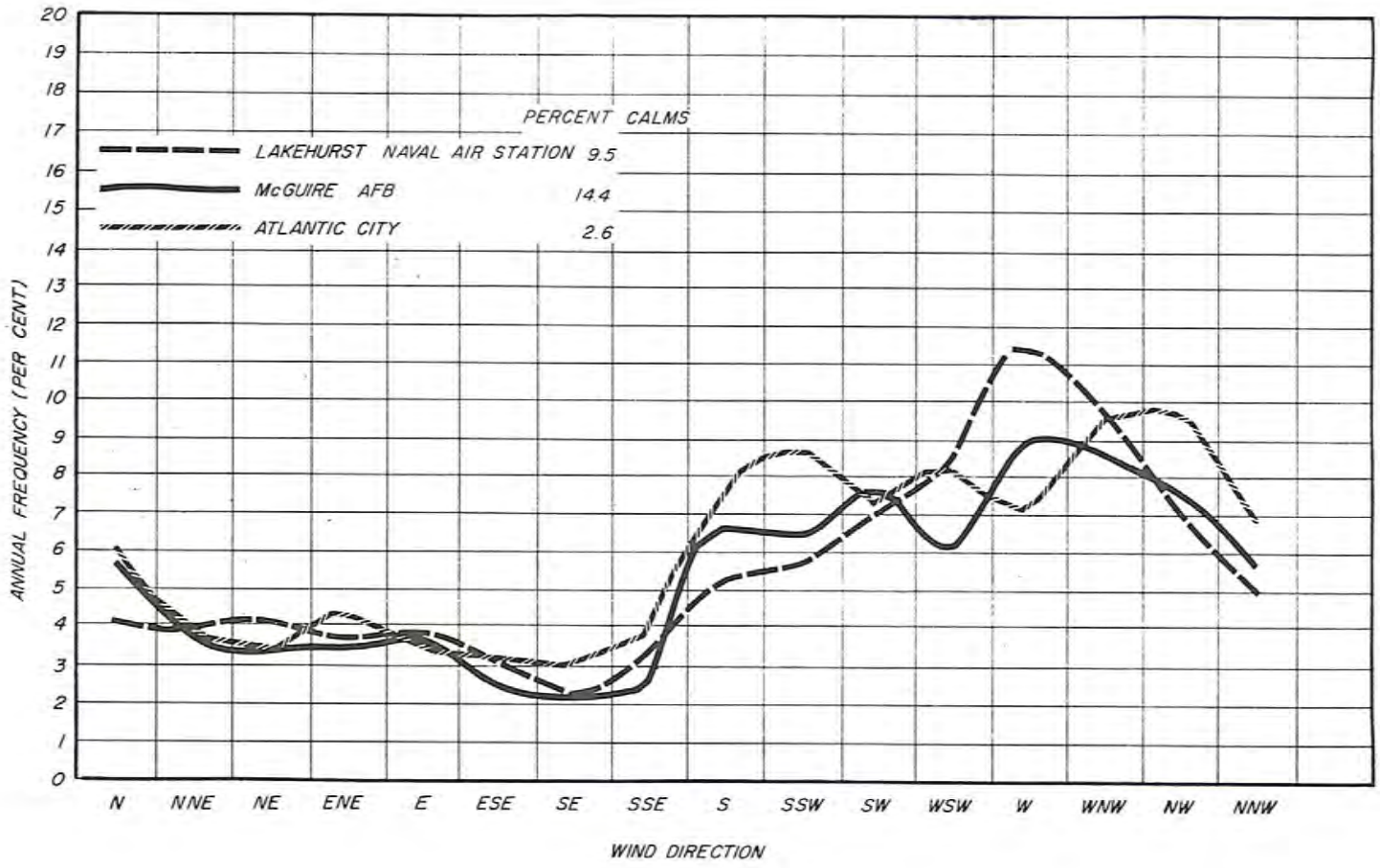
Speed in Knots
Mean Wind Speed 6.6 kts
Percent Calms 14.4

TABLE #15 (CONTINUED)

MEAN PERCENTAGE OF ANNUAL WIND SPEEDS, BY DIRECTION
LAKEHURST NAVAL AIR STATION
SPEED

Direction	1-3 kts	4-6 kts	7-10 kts	11-16 kts	17-21 kts	22-27 kts	All Speeds
N	1.3	1.7	1.1	0.2	0.0	0.0	4.3
NNE	0.8	1.4	1.3	0.4	0.1	0.0	4.0
NE	0.7	1.2	1.4	0.7	0.1	0.0	4.1
ENE	0.5	1.0	1.4	0.7	0.1	0.0	3.7
E	0.7	1.2	1.4	0.5	0.1	0.0	3.9
ESE	0.5	1.2	1.3	0.3	0.0	0.0	3.3
SE	0.6	1.2	1.3	0.3	0.0	0.0	3.4
SSE	0.6	1.0	1.2	0.4	0.1	0.0	3.3
S	1.1	1.6	1.7	0.8	0.2	0.0	5.4
SSW	0.8	1.6	2.0	1.0	0.2	0.1	5.7
SW	1.0	1.7	2.4	1.6	0.3	0.1	7.1
WSW	1.0	2.1	2.9	1.8	0.5	0.2	8.5
W	1.5	2.8	3.7	2.5	0.8	0.3	11.6
WNW	1.1	2.2	3.2	2.6	0.7	0.2	10.0
NW	1.1	2.0	2.3	1.4	0.3	0.1	7.2
NNW	1.0	1.7	1.6	0.6	0.1	0.0	5.0
TOTAL	14.3	25.6	30.2	15.8	3.6	1.0	

Speed in Knots
Mean Wind Speed 7.2 kts
Percent Calms 9.5



ANNUAL FREQUENCY OF OCCURRENCE
WIND DIRECTION

DAMES & MOORE
Figure #3

addition, a network of high volume samplers has been established to monitor particulates at strategic points. One of these, Red Bank, is representative of the Freehold Township area.

Air quality readings as available in the area of interest are indicated in Table #16. Sulphur dioxide samplings at Freehold have been well below the national secondary air quality standards. However, maximum 8-hour averages of carbon monoxide values have exceeded the air quality standards 10 percent of the time. Also, the suspended particulate levels observed at Red Bank are virtually at the secondary standard level.

SOILS

General

The Soil Factor Maps 7 and 8 are reproductions of the U.S. Department of Agriculture, Soil Conservation Service (SCS) maps of Monmouth County. Monmouth County Soil Map 7 to 9, 14 to 16, and 24 to 26 were photographically enlarged to form the Soil Factor Map 7 and 8. The symbols displayed on these maps are explained in Table #17 and #18 of the text.

From interpretation of the SCS data,additional Factor Maps illustrating regional slope, septic suitability, and foundation limitation were developed. These are Factor Maps 9 through 14. The information presented on these Factor Maps should not be considered a substitute for on-site investigations. This information may be utilized for generalizations of substantial areas but are in appropriate for detailed evaluations of small sites. These Factor Maps 9 through 14 illustrate regions.

Introduction

The soils of the study area are both of the transported and residual. The transported soils have been moved primarily by water and

TABLE #16

AIR QUALITY VALUES FOR FREEHOLD TOWNSHIP

Month	Sulphur Dioxide (ppm)	Carbon Monoxide (ppm)	Smoke (RUDS*)
1973			
January	0.016	6.1	0.90
February	0.009	7.3	0.75
March	0.008	2.5	0.59
April	0.008	2.4	0.51
May	0.006	2.1	0.44
June	0.004	2.3	0.27
July	0.004	2.4	0.59
August	0.012	3.0	0.71
September	0.016	3.2	0.76
October	0.020	4.0	0.81
November	0.020	4.0	0.74
December	0.018	4.3	0.74
Annual Avg.	0.12	3.6	0.65
1974			
January	.037	4.1	0.92
February	.027	2.6	0.88
March	.014	3.3	0.59
April	.016	3.3	0.55

Sulphur Dioxide (SO_2 ppm)

	Max. 1-Hr. Avg.	Max. 24-Hr. Avg.	12 Month Avg.
1973	0.182	0.067	0.012
1972	N.A.	0.057	0.007
1971	0.116	0.061	0.008
1970	0.151	0.053	N.A.

Carbon Monoxide (CO ppm)

Year	Max. 1-Hr. Avg.	Max. 8-Hr. Avg.	Times 1-Hr. STD. Exceeded	Times 8-Hr. STD. Exceeded
1973	53.0	23.6	2	468
1972	49.4	26.6	N.A.	1644
1971	34.44	20.5	0	659
1970	N.A.	N.A.	N.A.	N.A.

*Reflectance Units Density
ppm-parts per million

TABLE #16 (CONTINUED)

SUSPENDED PARTICULATES **

Year	# of Samples	Annual Geom. Mean ug/m^3*
1973	60	40.1
1972	26	44.6
1971	--	--
1970	34	60.1
1969	40	59.9

SMOKE (RUDS)

Year	Annual Avg. (RUDS)
1973	0.65
1972	0.86
1971	0.91
1970	0.82

** Sampled at Red Bank

* ug/m^3 - milligrams per cubic meter

SOURCE: NJDEP, Bureau of Air Standards, 1974.

TABLE 17

DESCRIPTION OF SOIL SERIES AND TYPES

MONMOUTH, NEW JERSEY

DESCRIPTION OF SOIL SERIES AND TYPES
MONMOUTH COUNTY, NEW JERSEY

Symbol	Series Name	Types Mapped	DISTINCTIVE CHARACTERISTICS							DRAINAGE		General Adaptability
			Parent Material Composition		COLOR		OUTSTANDING PROFILE CHARACTERISTICS					
					Surface Soil	Subsoil	Surface Soil	Subsoil	Substratum	General	Underdrainage	
801	MARLTON	0,1,3, 5,J	Clay	High in greensand	Brown-green	Green to brown-green	5 to 8 in.	Very heavy, plastic		Good	Slow	Hay, pasture, grain, corn.
802	KRESSON	0,C				Gray-green, mottled with yellow				Imperfect (gentle slopes)	Slow; moderately high water table	Hay, pasture. Improvement of subsurface drainage difficult.
811	MONMOUTH	1,3,5		Intermediate in greensand	Brown	Brown-green	8 to 12 in.	Very heavy, plastic	Heavy to very heavy, plastic	Good	Slow	Hay, pasture, grain, corn. Fair for some vegetables.
812	DONLONTON	1,2,3,5			Dark brown	Brown-green, lightly mottled	6 to 12 in.			Imperfect (gentle slopes)	Slow; moderately high water table	Hay, pasture. Improvement of subsurface drainage difficult.
813	COLEMANTOWN	0,3			Gray, dark gray, faintly mottled Black	Gray-green, strongly mottled	About 6 in. High org. cont.			Poor (flat areas)	Slow; seasonal high water table	Forest. If surface water is removed, pasture. Subsurface drainage difficult.
814	MATLOCK	0,3				Gray-green mottled rusty red	12 to 14 in.		Very heavy, tight	Very poor (flat areas)	Slow; constantly high water table	Forest. If surface water is removed, pasture. Subsurface drainage difficult.
821	COLLINGTON	1,2,3,5			Brown	Green brown	10 to 12 in.	Moderately heavy	Sandy, open structure	Good	Moderate	Good for wide variety of crops selected according to surface texture.
822	ADELPHIA	1,3	Sands and clayey sands		Dark brown to gray-brown	Yellow or gray-yellow, lightly mottled	6 to 8 in.	Heavy	Sandy, open structure	Imperfect (gentle slopes)	Moderate; seasonal mod. high water table	Hay, pasture, corn, veg. tolerant of seasonal excess moisture. Draining increases adaptability. Drainable.
823	SHREWSBURY	0,3,5			Gray	Yellow-brown to gray, strong mottling		May have iron hardpan		Poor (flat areas)	Moderately slow, high water table	Hay and pasture. With drainage, types 3 and 5 can be used for late veg. as corn, beans, etc. Drainable.
824	KEANSBURG	0,3			Black	Varied gray, rusty red, blue-green	8 to 12 in. High org. cont.	Heavy	Sandy, open structure	Very poor (flat areas)	Moderately slow, constantly high water table	Highest recommended uses hay or pasture. Draining needed. Drainable.
841	LINCROFT	3,5			Brown to red-brown	Brown to red-brown	Generally deep	May have crusts of iron Loose, sandy to mod. heavy	Sandy, open structure, red or olive	Good to exc. (Slopes gentle to steep)	Moderate	Open subsoil types droughty; light soil crops at sweet potatoes. Heavier subsoil types; most veg., fruit.
861	FREEHOLD	1,2,3,5		Low in greensand	Brown	Yellow-brown to green-brown	12 to 18 in.	Moderately heavy	Sandy, open structure	Good	Moderate	One of the best all purpose soils. Type 1, potatoes; types 2,3,5, veg. and fruit.
862	HOLMDEL	1,2,3,5			Dark brown to gray-brown	Yellow-brown, lightly mottled	About 10 in.			Imperfect (gentle slopes)	Moderate, moderately high water table	Some excess moisture. Drained, fit for most veg. except for very early market. Soil nature favors draining.

871	FREEHOLD with deep surface soil	3,5	Sands and clayey sands	Low in greensand	Light brown to gray-brown	Pale yellow-brown	Deep, 18 to 30 in.	Med. tex.; thin, 4 to 10 in.	Sandy, open structure	Moderately excessive	Moderately rapid	Sweet potatoes, melons, peaches other crops favored by deep light soil with moderate moisture supply.
890	COLTS NECK	1,3		Variable greensand content	Brown-red	Brick red	12 to 14 in.	Moderately heavy	Sandy, open structure red to red-brown	Good	Moderate	Moderately good all purpose soil Type 1, potatoes, types 1,3, veg. type 3, orchard fruits
801	FREEHOLD with light subsoil	5		Low in greensand	Light brown to gray-brown	Pale yellow or yellow-brown	Deep and indefinite	Light sandy	Sandy, open structure	Moderately excessive	Rapid	Peaches and vegetables favored by deep light soils and able to withstand low moisture conditions.
802	HOLMDEL with light subsoil	3,5			Gray-brown	Yellow-brown, faint mottling				Imperfect (low slopes)	Moderately rapid moderately high water table	Vegetables
811	HOWELL	1,3,5	Clay		Brown	Yellow-brown to light olive-gray or gray	8 to 12 in.	Heavy	Very heavy, moderately plastic	Good	Slow	Hay, pasture, grain, corn. Fair for some vegetables.
930	EVESBORO	6	Pale yellow sands	Little or no greensand	light gray brown	Pale yellow	Deep, vague, May have shallow leachings	Sand		Highly excessive	Very rapid	Too droughty for cropping, hay, or pasture. Best suited to forest or wildlife.
931	EVESBORO	3,5,E			Light yellow-brown			About same texture as topsoil		Excessive	Rapid	Peaches, vegetables adapted to deep light soils and able to withstand low moisture. Natural fertility low.
932	KLEJ	3,5,6			Gray-brown or brown	Pale yellow-brown, faintly mottled	Deep and indefinite	Sandy, very little or no heavier than surface soil	Sands, may include gravel	Imperfect (gentle slopes)	Rapid, seasonal moderately high water table	Veg., grain, type 3. Veg. adapted to light soil and seasonal excess moisture, type 5. Woods, type 6.
933	PLUMMER	3,5			Gray to dark gray	Gray, mottled				Poor (flat areas)	Rapid, seasonal high water table	Hay and pasture. Vegetables if drained. Soil nature favorable to draining.
934	RUTLEDGE	1,3,5			Black	Light gray or gray. May be mottled	8 to 12 in. High org. cont.			Very poor (flat areas)	Rapid, continually high water table	Hay and pasture if drained. Soil nature favorable to draining.
941	SASSAFRAS	1,2,3, 5,W	Silty or sandy material, without greensand		Gray-brown	Brown-yellow to red-yellow	12 to 14 in.	Moderately heavy	Sand or gravel, open structure	Good	Moderately rapid	One of the best all purpose soils. Types 1,2, potatoes, veg., apples. Types 3,5,W, veg., apples, peaches.
942	WOODSTOWN	0,2,3,5			Dark gray-brown	Brown-yellow, lightly mottled	About 10 in.			Imperfect (gentle slopes)	Moderate, seasonal moderately high water table	Hay, pasture, With draining veg., not suitable for fruit. Soil drainable.
943	FALLSINGTON	0,3,5			Gray to dark gray	Mottled gray and yellow	8 to 10 in.			Poor (flat areas)	Moderate, high water table	Hay, pasture. With draining adaptable to such late veg. as corn, beans. Soil drainable.
[illegible]4	POCOMOKE	0,3			Black	Gray, usually mottled	8 to 12 in. High org. cont.	Moderately heavy to heavy		Very poor (flat areas)	Moderate, continually high water table	Highest recommended use is hay, pasture. Draining necessary, soil favorable to draining.

Key to abbreviations: esp. - especially; exc. - excessive; ft. - feet; in. - inches; gen. - generally; med. - medium; mod. - moderate, moderately; org. cont. - organic content; org. mat. - organic matter; var. - variable; veg. - vegetables; ss - sandstone.

Source: U.S. Soil Conservation Service ; Open Space Plan, Mon. Co. Park System, 1971

TABLE 17 (Continued)

SYMBOL	SERIES NAME	TYPES MAPPED	DISTINCTIVE CHARACTERISTICS						DRAINAGE		GENERAL ADAPTABILITY
			PARENT MATERIAL COMPOSITION	COLOR							
				SURFACE SOIL	SUBSOIL	SURFACE SOIL	SUBSOIL	SUBSTRATUM	GENERAL	UNDERDRAINAGE	
970	LAKEWOOD	6,F	Pale yellow sand without greensand	White, light gray	Yellow or "coffee" brown over yellow	Var. depths leached sand	In 972 to 974 thin layers high in iron and org. mat. in sand. Most developed with poorest drainage. Often dry, hard. In 970 layer may be absent or cemented	Sand and coarse sand	Very excessive	Very rapid	Unsuited to cropping, infertile, very droughty. Best uses, forest, wildlife
972	LAKEHURST	6,F		Gray or dark gray over white	"Coffee" brown over mottled yellow, gray				Imperfect (gentle slopes)	Very rapid, seasonal mod. high water table	Gen. unsuited to cropping, infertile. Seasonal relief from drought by high water table. Best use forest
973	LEON	5,E		Dark gray, may be over white	"Coffee" brown over gray and rusty yellow	4 to 6 in Mod. org. cont. over leached sand			Poor (flat areas)	Very rapid except as retarded by hardpan and high water table; somewhat seasonal in 973, continuous in 974	In natural condition best suited to forest. With control of water table suited to cranberries, blueberries
974	ST. JOHNS	0,5		Black over white	"Coffee" brown over light gray	6 to 10in. High org.cont. over leached sand			Very poor (flat areas)		In natural condition suited only for forest. With controlled water, suited to special crops such as cranberries
982	KEYPORT	0,2,3,5	Clay without greensand	Gray brown to light gray	Gray, lightly mottled yellow	Generally shallow 6 to 8 in.	Heavy plastic clay to clay loam	Heavy clay, blocky structure	Imperfect (gentle slopes)	Slow, moderately high water table	Hay and pasture. Subsurface draining difficult
983	ELKTON	0,3,5,C		Dark gray	Mottled gray	Generally shallow about 6 in.	Heavy plastic clay	Heavy clay; plastic	Poor (flat areas)	Slow, seasonal high water table	Pasture if surface water is removed. Subsurface draining difficult
984	ALLOWAY	0		Black	Light gray or mottled	Shallow, about 6 in.		Very heavy clay, plastic	Very poor (flat areas)	Slow, high water table	Forest. With surface draining seasonal pasture is possible. Subsurface draining difficult
JB1	MATAWAN	1,E,F	Sandy clay without greensand	Gray brown, may be white first 2" to 4"	Yellow or yellow brown	8 to 10 in. May be leached 2 to 4 in.	Moderately heavy, plastic	Mod. heavy to heavy; blocky structure	Good	Slow	Fair for hay, pasture, grain, corn and veg. most tolerant of heavy subsoil and substratum
9K0	EATONTOWN	5,6	Pale yellow sand without greensand over greensand	Light gray to white	Brown; may be absent	Leached; depth varies	generally indefinite	Beds of greensand at 2 to 4 ft.	Excessive	Rapid	Best suited to forest
9N1	NAVESINK	3,5,W	Reddish sand with ledges of ironstone	Brown	Yellow brown to red brown	Var.; may have blocks iron-cemented ss.	Generally mod. light, var.	Sand, and iron ss. ledges within 3 ft.	Exc. to good (Slopes mod. to steep)	Very rapid to rapid	Peaches, veg., type 3. Some drought ness esp. 5,W. Type 5 gen. on steep slope. Ledges may be in plow depth
9T1	TUXEDO	5	Mixed sands and clay, non green sand	Brown or gray brown	Variable yellow brown, gray, red	Var. in texture and depth	Mod. heavy to heavy, var.	Varied, inter mixed clay and sand	Good to imperfect	Slow	Forest and pasture. Of some use for vegetables depending on conditions per field

C01	TINTON	3,5	Recent sand deposits having greensand	Brown	Light brown	Very little surface soil and subsoil development	Sands, open structure	Excessive (gentle slopes)	Rapid	Veg. adapted to deep, light soils. Type 5 especially subject to blowing
C02	DELANCO	3,5		Gray-brown	Light brown, lightly mottled			Imperfect (gentle slopes)	Rapid, seasonal mod. high water table	Late veg. adapted to deep light soils with moderately high water table
C23	FRENEAU	1							Moderate, high water table	Pasture is the highest recommended use. If drained, could produce crops, but subject to overflow
C24	MANALAPAN	0	Present-day silty stream deposits with greensand	Brown to dark brown	Brown to dark brown, strongly mottled	Materials vary at different depths and from place to place		Imperfect to poor (stream bottoms)	Moderate, continually very high water table	Forest. If drained, pasture. Subject to overflow
C54	JOHNSTON	0				High in org. mat	See description for C23	Very poor (stream bottoms)		Forest. Because of location draining usually too difficult to be practicable
C75	ALLUVIAL UNDIFFERENTIATED	Textures not distinguished	Mainly sand without greensand	Black	Dark brown mottled	Very high in org. mat	Generally sand; little profile development	Very poor (stream bottoms)	Rapid, continually very high water table	
C85	TIDAL MARSH		Recent accumulation of silt and org. mat	This is unclassified land except that it is very poorly drained. On flats along streams under standing water most of the year						Very wet land, subject to overflow
CM	MADE LAND									
FM	FRESH WATER MARSH		Recent accumulation silt, org. mat. on tidal flats	Dark gray to dark brown usually somewhat mottled		Without development into surface soil and subsoil		Very poor	Slow (standing water)	Wildlife and salt hay are only presently recognized uses
		This is not soil, but is only earth material thrown up or spread out during excavations, river dredging or similar artificial processes. Textures and drainage conditions are not distinguished								Widely variable, generally unsuited for crops
M64	MUCK	Marsh and swamp areas permanently wet or actually covered with water. Not classified as to texture, type of underlying material, composition, etc.						Very poorly drained. Under water most of the time		Suitable only for wildlife
M74	MUCK SHALLOW	M M	Organic accumulation		Black, sometimes very dark brown	The whole soil depth is accumulated organic matter to 30 in. or deeper		Poor to very poor	Variable	Naturally adapted only to forest. When ditched and dammed suitable for cranberries
						Similar to M64 except that the organic deposit is less than 30 in., although more than 12 in. in depth		Depressed areas of high water table		

Key to abbreviations: esp. - especially, exc. - excessive, ft. - feet, in. - inches, gen. - generally, mod. - medium, mod. - moderate, moderately, org. cont. - organic content, org. mat. - organic matter, var. - variable, veg. - vegetables, ss. - sandstone

Source: U.S. Soil Conservation Service; Open Space Plan, Mon. Co. Park System, 1971

TABLE #18

IDENTIFICATION OF SOIL TEXTURE, SLOPE AND EROSION

Texture

Most soil symbols consist of four numbers or letters. The first three identify the soil series; the fourth shows the texture of surface soil which completes the name of the soil type. The texture classes and symbols are:

0 - Silt loam	3 - Sandy loam	C - Clay loam	J - Sandy clay loam
1 - Loam	5 - Loamy sand	E - Loamy fine sand	W - Gravelly sandy loam
2 - Fine sandy loam	6 - Sand	F - Fine Sand	

Slope

Soils except those numbers beginning with 96, 97 or 9N	Soil numbers beginning with 96, 97 or 9N
A - 0 to 2 percent	0 to 3 percent
B - 2 to 5	3 to 8
C - 5 to 10	8 to 15
D - 10 to 15	15 to 25
E - 15 to 25	25 to 35
F - 25 percent or more	35 percent or more

P preceding the slope symbol indicates a depression that has no outlet. These occur in soils having clay subsoil.

Erosion

Sheet Erosion

1 - Less than 25 percent of topsoil removed
2 - 25 to 75 percent of topsoil removed
3 - More than 25 percent of topsoil and less than 25 percent subsoil removed
4 - All topsoil and 25 to 75 percent of subsoil removed
5 - All topsoil and more than 75 percent of subsoil removed

Gully Erosion

7 - Occasional gullies
8 - Frequent gullies
7, 8 - Deep gullies; Too deep to be crossed with tillage implements
7V, 8V - Deep gullies in friable substratum

TABLE #18 (CONTINUED)

Wind Erosion

H - Moderate or severe accumulations by wind
R - Moderate or severe removal by wind

Miscellaneous

0 - No apparent erosion
+ - Recent alluvial deposits
θ - Erosion not classified. Used chiefly on disturbed areas

SOURCE: U. S. Dept. of Agriculture, SCS, Monmouth County.

are found mostly in flood plains or stream terrace. The residual soils have been formed in place from the geologic parent materials outcropping at each location -- Pleistocene deposits, Cohansey Sand, Kirkwood Formation, Vincentown Formation, Hornerstown Formation, and the Red Bank Sand.

There are 49 series of soils represented by 114 types in Monmouth County as shown in Table #17. The physical characteristics of the soil series and types are described in Table #18. The Soil Conservation Service (SCS) in Monmouth County recognizes 22 groups of soils similar in agricultural capability and conservation treatment. For ease of inventory and study, these 22 groups are grouped into 6 major soil categories as shown on Figure #4.

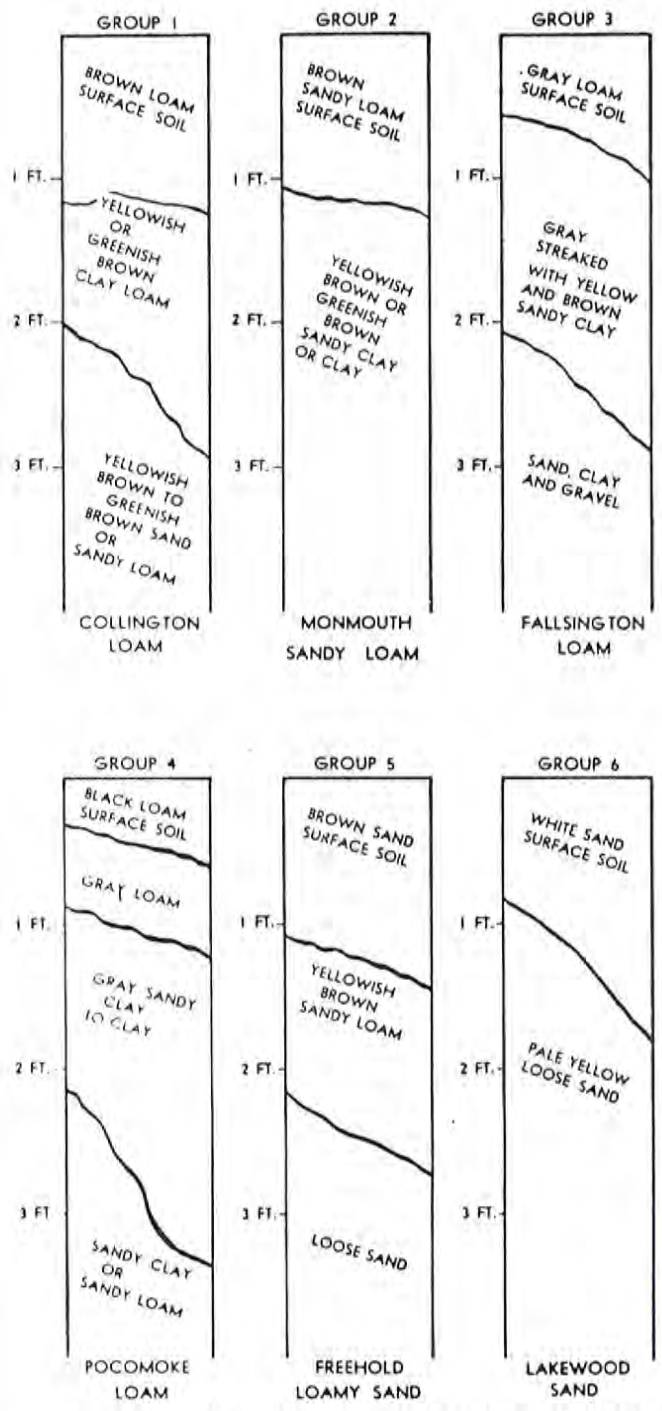
Soil Characteristics

Soil characteristics in the region are dependent primarily upon topographic position (hilltop, hill slope, or valley bottom), native vegetation, parent material, and the degree of development of the soil profile. Other factors affecting soil properties are the ground-water relative to the land surface, and the extent of soil erosion. Topographic position is, perhaps, the most important factor in judging the probable soil characteristics in the region.

The soils in the relatively flat valley bottoms, tend to be heavier (finer-grained) with a greater organic matter content than soils on more sloping land. Such lowland soils in many places in the region, are found under high water-table conditions and are represented by soil series such as Shrewsbury, Fallsington, Pocomoke and St. Johns. Soils that are well-drained and are located on slightly higher land than the wet soils, are represented by soil series such as Monmouth, Collington, Freehold and Sassafras. These well-drained soils have surface textures of loam or

Figure #4

SOILS GROUPS



Profile of a soil type for each of the six soil groups.

Source: U.S. Soil Conservation Service

GROUP 1

Well-drained soils, with moderately heavy subsoils becoming more open at a depth of 2½ to 3 feet. Collington, Freehold and Sassafras loams and sandy loams with brown surface soils and yellowish brown subsoils are the best examples. They cover 35% of the land area of the county. These soils are considered to be the best soils in terms of fertility and physical properties.

GROUP 2

Well-drained soils, with heavy subsoils, remaining heavy to a depth of at least 4 feet, Monmouth and Matawan sandy loams and Monmouth loam, with brown to grayish brown surface soils and subsoils are good examples. These soils are considered to be good and they cover 4% of the county's land area.

GROUP 3

Wet soils such as Adelphia, Shrewsbury, Fallsington and Elkton loams and sandy loams with gray to brown surface soils and subsoils, are included. These soils cover 6% of the land area.

GROUP 4

Very wet soils - Keansburg, Pocomoke and St. Johns loams and sandy loams with block surface soils and gray subsoils are in this group. These soils cover 14% of the land area.

GROUP 5

Dry soils - Freehold, Sassafras and Evesboro loam sands, with yellowish brown surface soils and yellowish to grayish brown subsoils, are the most prominent members. These soils cover 16% of the land area of the county.

GROUP 6

Very Dry Soil - Lakewood and Evesboro sands, with white to gray surface soils and pale yellow to gray subsoils, belong to this group. These soils are considered to be quite infertile. They cover 19% of the county's land area.

sandy loam and subsoils that are heavy or moderately heavy and are useful for production of most field and truck crops. Upland soils that are very dry and not fertile, are represented by the Lakewood and Evesboro soil series. These soils are coarse textured and generally encountered well above the water table.

According to COX (COX 1948) nearly half of the soils of Monmouth County exhibit moderate to severe sheet erosion. At that time, about 16 percent of the land surface showed no signs of sheet erosion and about 37 percent had slight erosion (1 to 25 percent of the topsoil removed). On the remaining land area more than 25 percent topsoil had been removed. Since this soil survey report, there has been little additional soil removal by accelerated erosion in the region (N. Munch, Personal Communication).

An additional data source which describes the engineering characteristics of soils found within Freehold Township is the Engineering Soil Survey of New Jersey, Report #19, which was conducted in 1955 as a joint project by Rutgers University and the New Jersey State Highway Department. As part of this study, a report was prepared detailing information concerning the various soils within Monmouth County. Test borings were drilled at various locations throughout the Township. Soil samples from these borings were evaluated in laboratory test programs. Various soil identification tests were performed.

Soil Identification

Soils listed on the Factor Maps 7 and 8 are identified with numerical entries. An explanation of an entry shown in the area of the

municipal complex is as follows:

Entry	-	$\frac{8233}{A-1}$
823	-	identifies the soil series (Table #17)
3	-	identifies the soil texture (Table #18)
A	-	identifies the slope (Table #18)
1	-	identifies the degree of erosion (Table #18)

Tables 17 & 18 present further explanations for each portion of the entry. In the above example, 823 refer to Shrewsbury series, 3 indicates sandy loam, A is a slope 0 to 2%, and 1 indicates the extent of topsoil erosion as less than 25%

Slope

Slope information was obtained from the SCS Soils Maps. This data is presented in five categories on Factor Maps 9 and 10; 0-5%, 5%-10%, 10%-15%, 15%-25% and greater than 25%. A comparison of Factor Maps 9 and 10 shows the northern portion of the Township with a more varied topography than the southern portion. The southern portion of the Township has extensive areas of relatively flat terrain.

Septic Suitability Factor Maps 11 & 12

Information for septic suitability, Factor Maps 12 and 13, was obtained from the SCS Legends for Soil Interpretation 1969. The three classifications of slight, moderate, severe septic suitability is

based on various factors including: permeability percolation; slope and the height of the local water table.

Foundation Limitation Factor Maps 13 & 14

Information for Foundation Limitation, Factor Maps 13 and 14 was also obtained from the SCS Legends for Soil Interpretations 1969. The three classifications of slight, moderate and severe foundation limitations are based on various factors including: shear strength; shrink swell potential; compressibility; consolidation characteristics; depth of the water table and flood hazards.

Average Depth to Water Table Factor Maps 19 & 20

Information for the Average Depth to Water Table, Factor Maps 19 and 20, was obtained from Engineering Soil Survey of New Jersey, Rutgers University, Report #1, Soil Environment and Methods of Research, 1955 and Report #19, Monmouth County, 1955. The four categories of ground water classification are based primarily on the interpretation of aerial photo patterns supplemented by some field observations.

NATURAL RESOURCES INVENTORY
OF
FREEHOLD TOWNSHIP, MONMOUTH COUNTY, N.J.
FACTOR MAPS

TOPOGRAPHY (N) ..... FACTOR MAP 1
TOPOGRAPHY (S) ..... FACTOR MAP 2
FLOOD PLAINS (N) ..... FACTOR MAP 3
FLOOD PLAINS (S) ..... FACTOR MAP 4
GEOLOGY (N) ..... FACTOR MAP 5
GEOLOGY (S) ..... FACTOR MAP 6
SOILS (N) ..... FACTOR MAP 7
SOILS (S) ..... FACTOR MAP 8
SLOPE (N) ..... FACTOR MAP 9
SLOPE (S) ..... FACTOR MAP 10
SEPTIC SUITABILITY (N) ..... FACTOR MAP 11
SEPTIC SUITABILITY (S) ..... FACTOR MAP 12
FOUNDATION LIMITATION (N) ..... FACTOR MAP 13
FOUNDATION LIMITATION (S) ..... FACTOR MAP 14
VEGETATION (N) ..... FACTOR MAP 15
VEGETATION (S) ..... FACTOR MAP 16
HISTORIC AND AESTHETIC SITES (N) ..... FACTOR MAP 17
HISTORIC AND AESTHETIC SITES (S) ..... FACTOR MAP 18
AVERAGE DEPTH TO WATER TABLE (N) ..... FACTOR MAP 19
AVERAGE DEPTH TO WATER TABLE (S) ..... FACTOR MAP 20

PREPARED FOR

FREEHOLD TOWNSHIP ENVIRONMENTAL COMMISSION

BY

DAMES & MOORE, JULY 1974

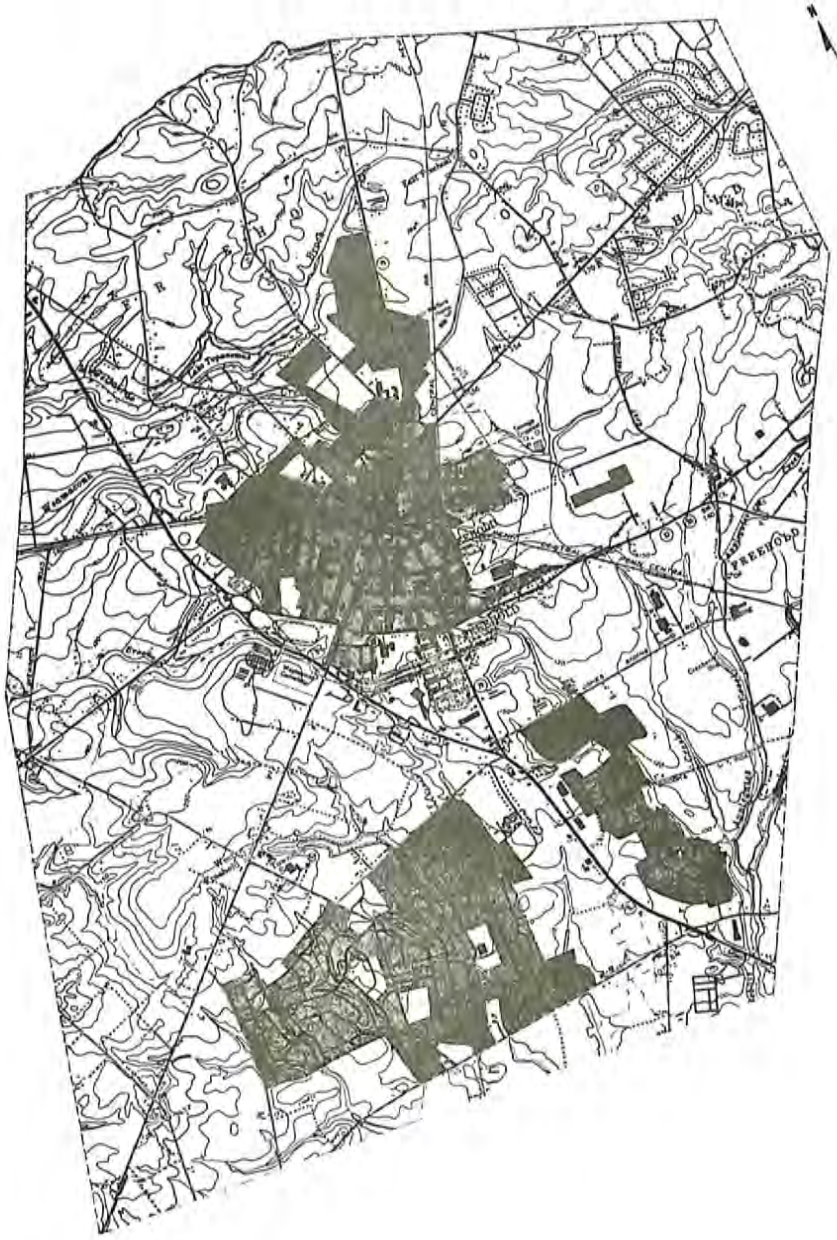
FREEHOLD TOWNSHIP

TOPOGRAPHY

NORTH

CONTOUR INTERVAL IS 20 FEET

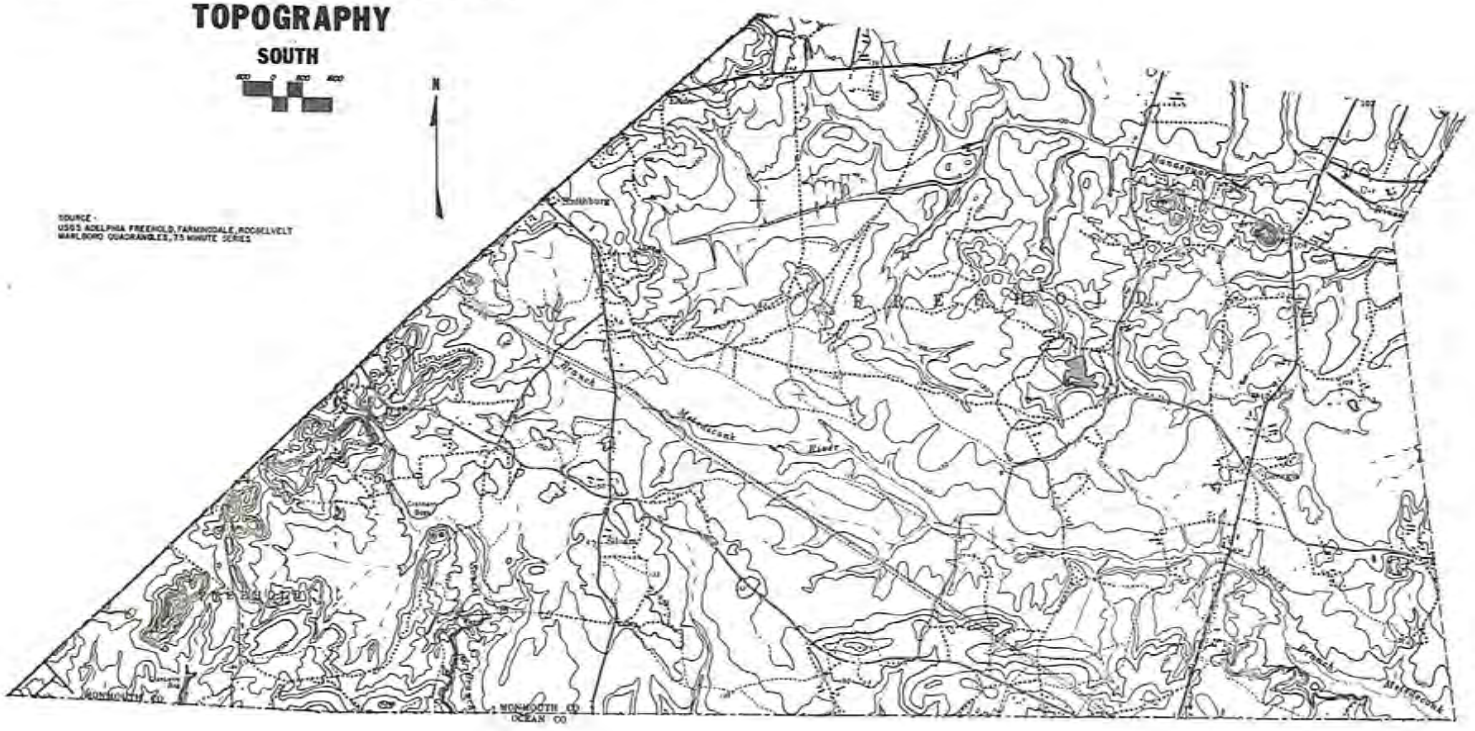
SOURCE:
USGS ADELPHIA FREEHOLD, FARMINGDALE, ROOSEVELT, MARLBORO QUADRANGLES, 7½ MINUTE SERIES



FREEHOLD TOWNSHIP

TOPOGRAPHY

SOUTH



FREEHOLD TOWNSHIP

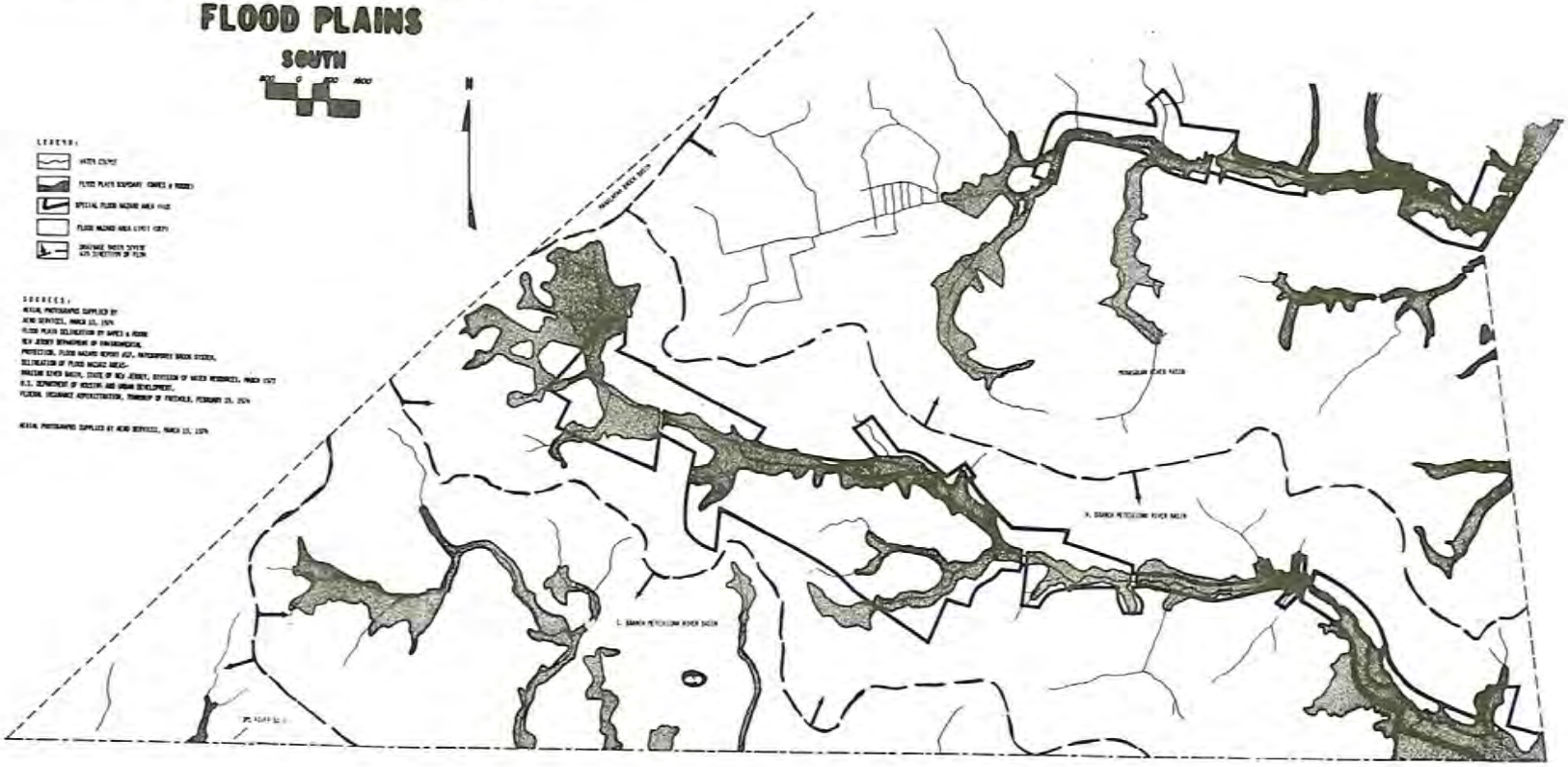
FLOOD PLAINS

NORTH

FREEHOLD TOWNSHIP

FLOOD PLAINS

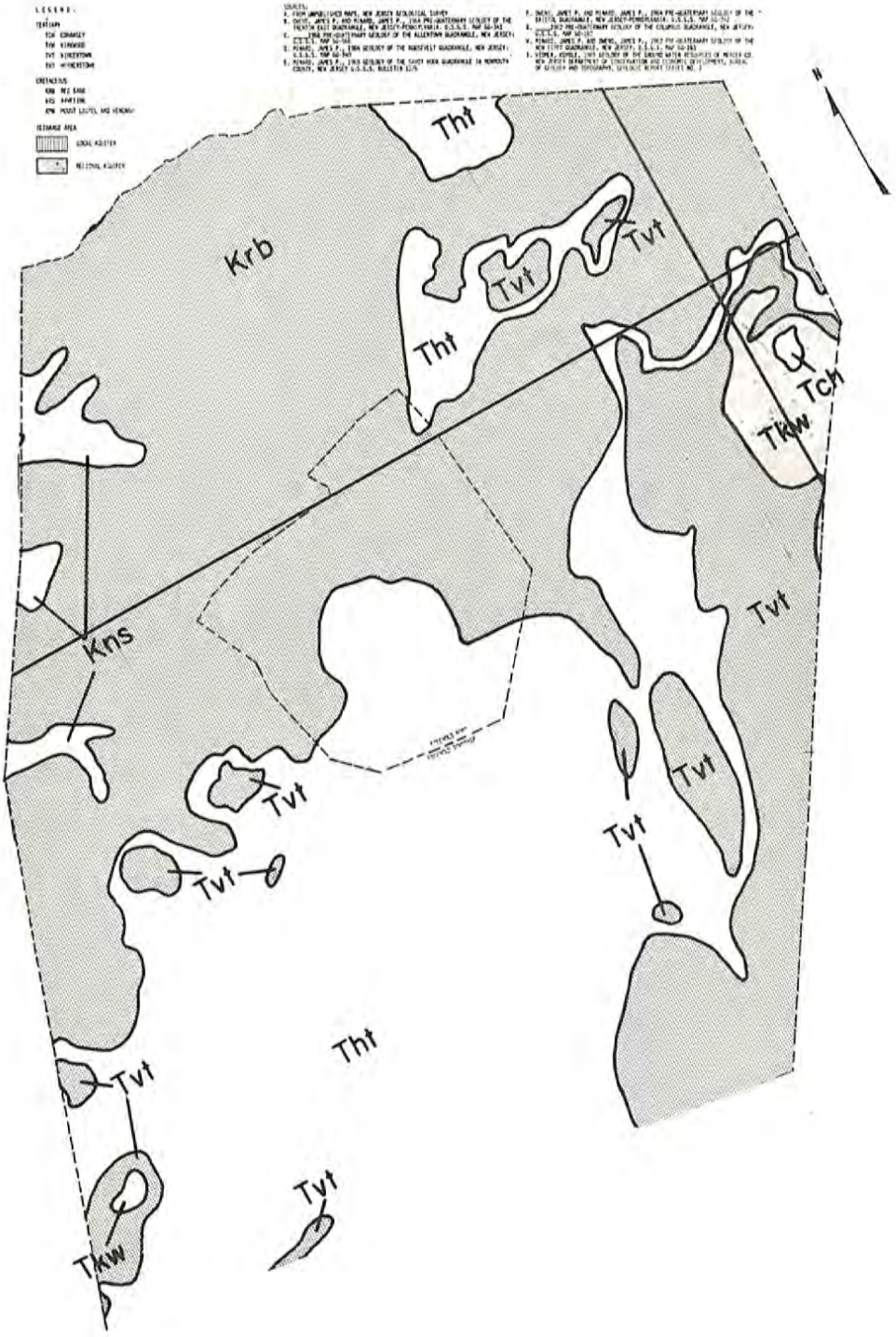
SOUTH



FREEHOLD TOWNSHIP

GEOLOGY

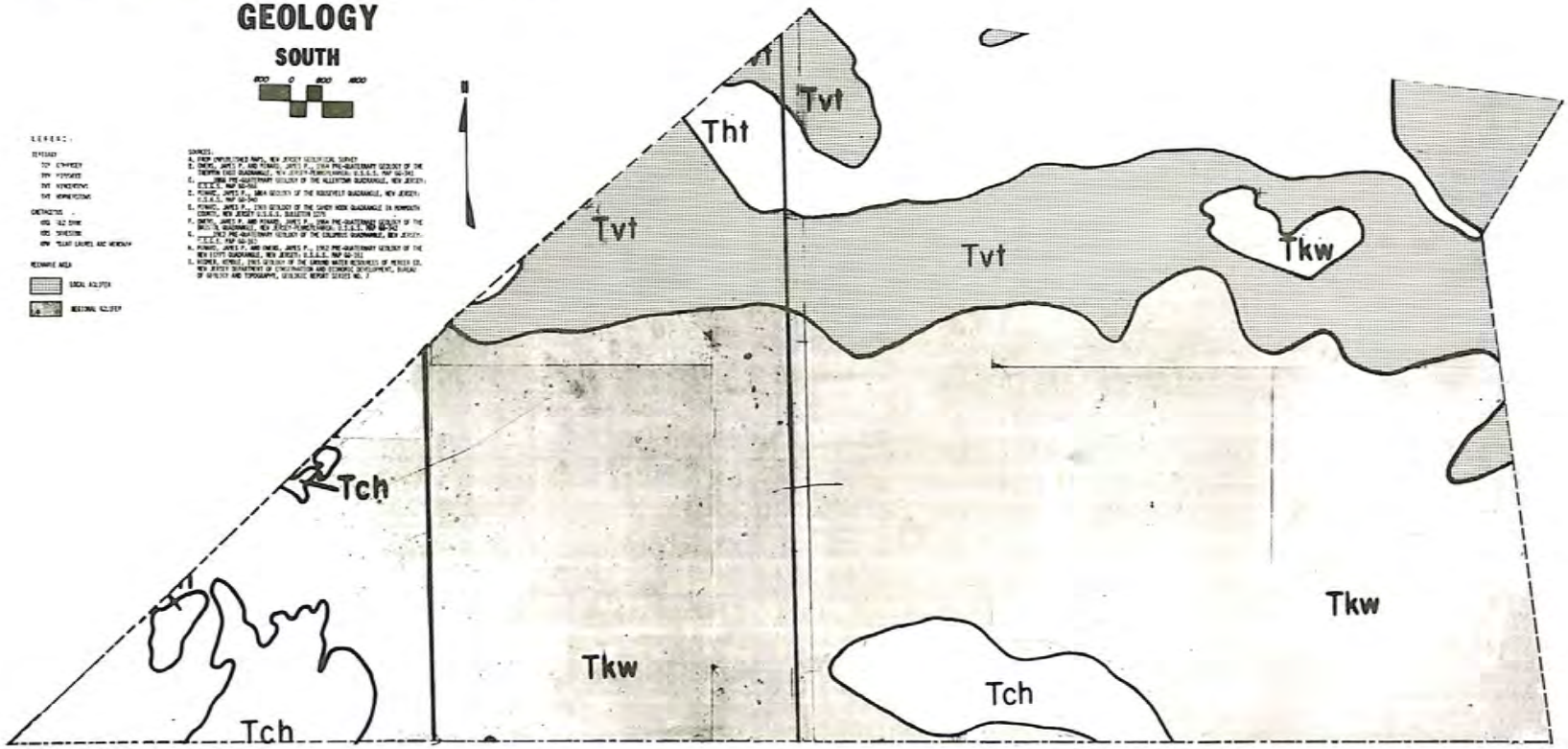
NORTH



FREEHOLD TOWNSHIP

GEOLOGY

SOUTH



FREEHOLD TOWNSHIP

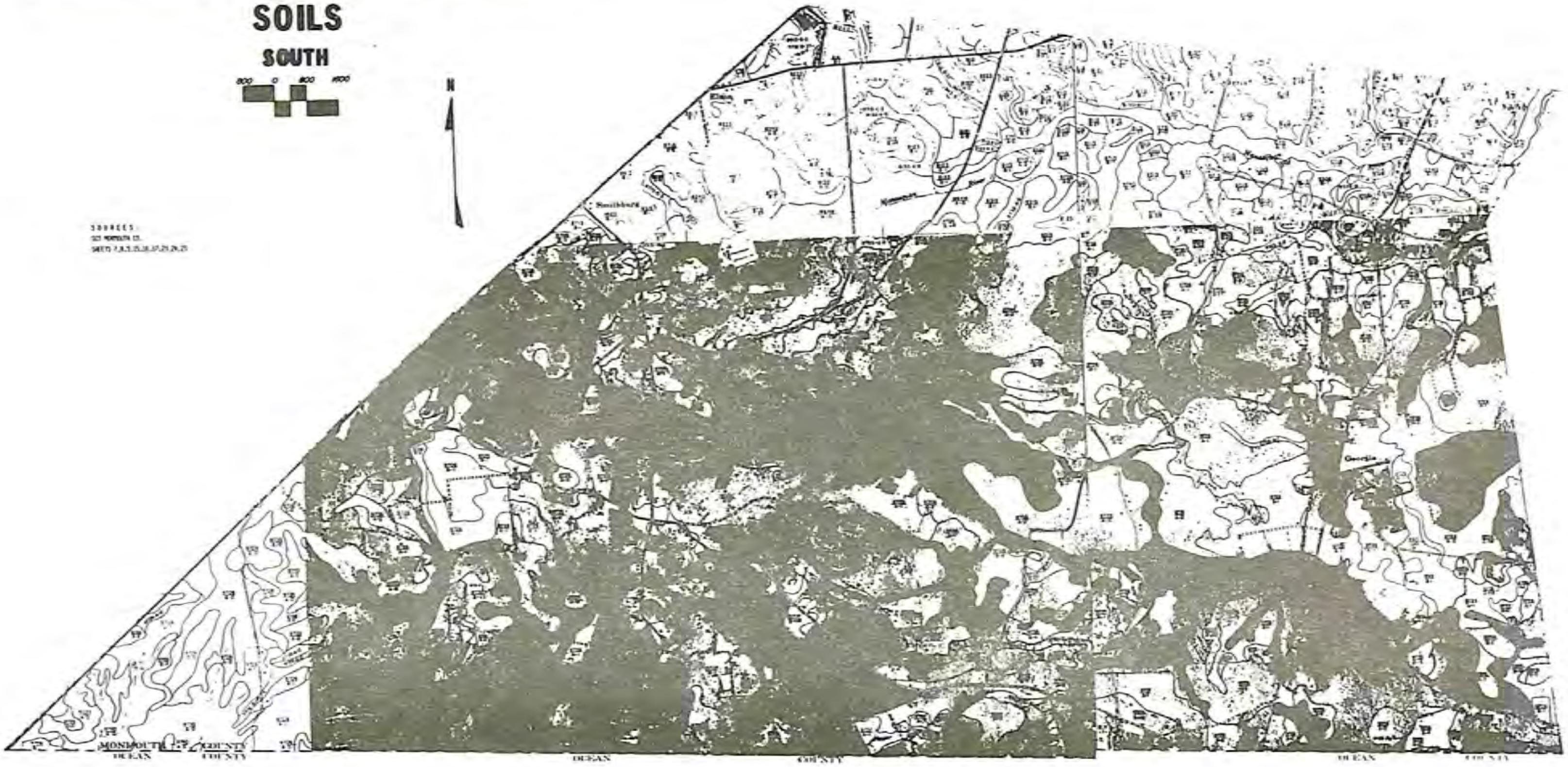
SOILS

NORTH

FREEHOLD TOWNSHIP

SOILS

SOUTH



SOURCES:
SCS MONMOUTH CO.
SHEETS 7,8,9,15,16,17,23,24,25

FREEHOLD TOWNSHIP

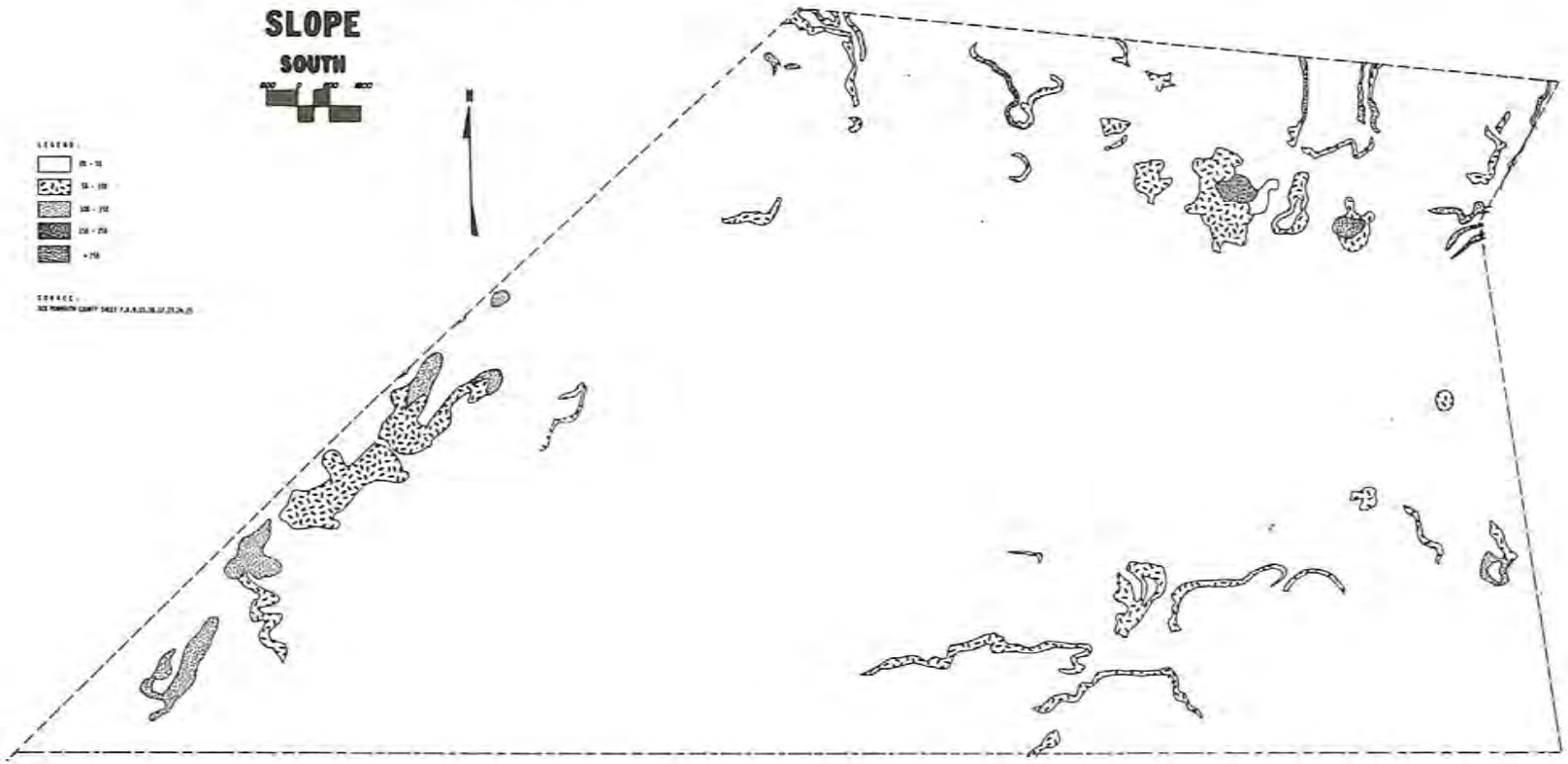
SLOPE

NORTH

FREEHOLD TOWNSHIP

SLOPE

SOUTH



FREEHOLD TOWNSHIP

SEPTIC SUITABILITY

NORTH

800 0 800 1600

SOURCES:
SCS MONMOUTH CO.
SHEETS 7,8,9,15,16,17,23,24,25

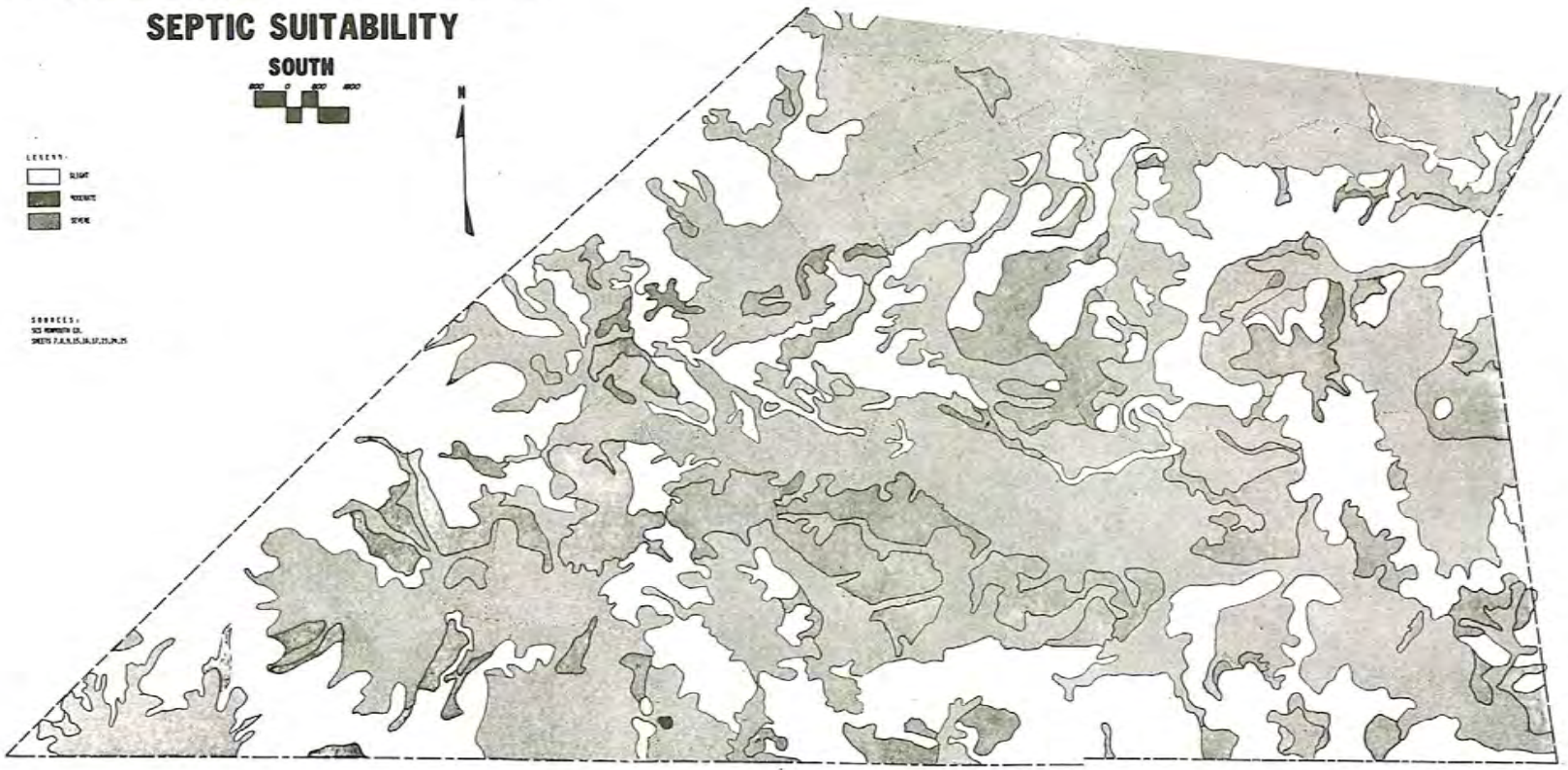
LEGEND:

- SLIGHT
- MODERATE
- SEVERE

FREEHOLD TOWNSHIP

SEPTIC SUITABILITY

SOUTH



FREEHOLD TOWNSHIP

FOUNDATION LIMITATION

NORTH

SOURCE:
SCS MONMOUTH COUNTY SHEETS 7,8,9,15,16,17,23,24,25

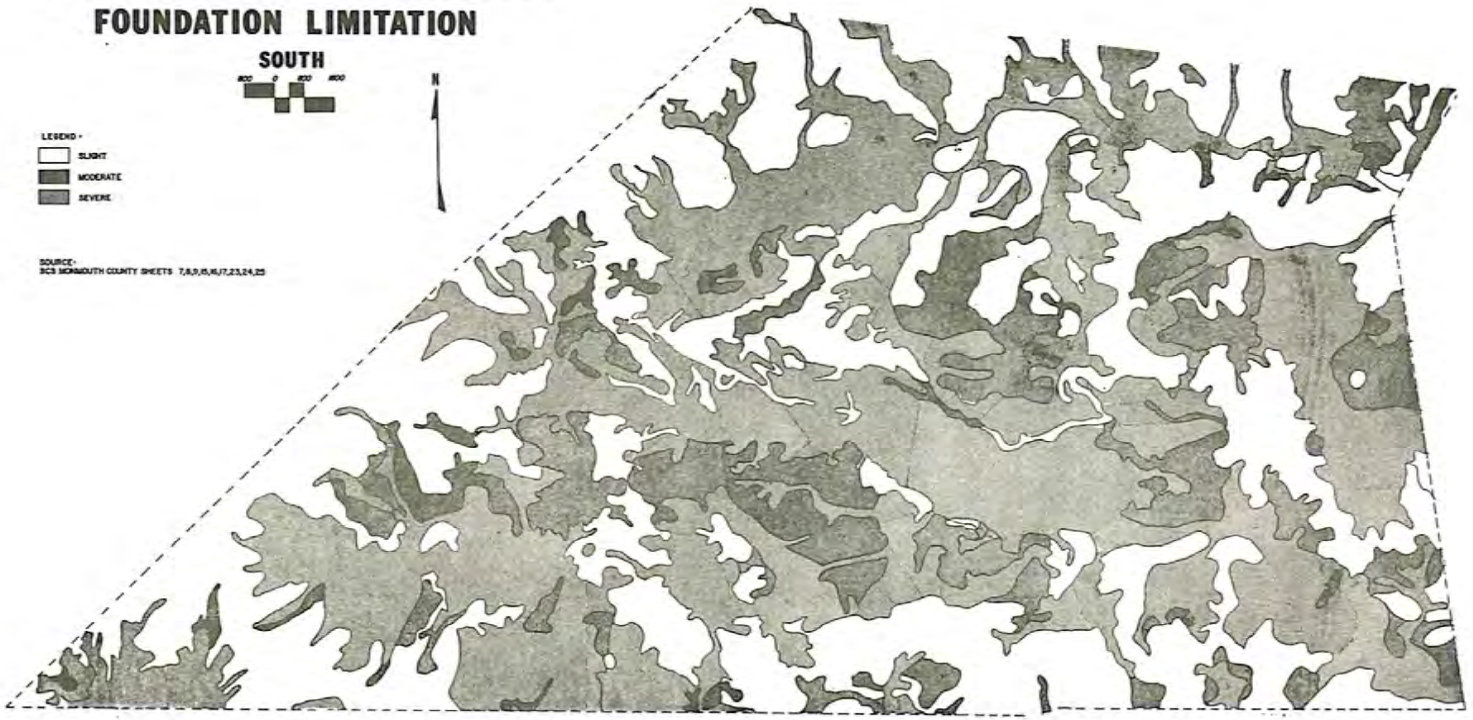
LEGEND:

- SLIGHT
- MODERATE
- SEVERE

FREEHOLD TOWNSHIP

FOUNDATION LIMITATION

SOUTH



FREEHOLD TOWNSHIP

VEGETATION

NORTH

FREEHOLD TOWNSHIP

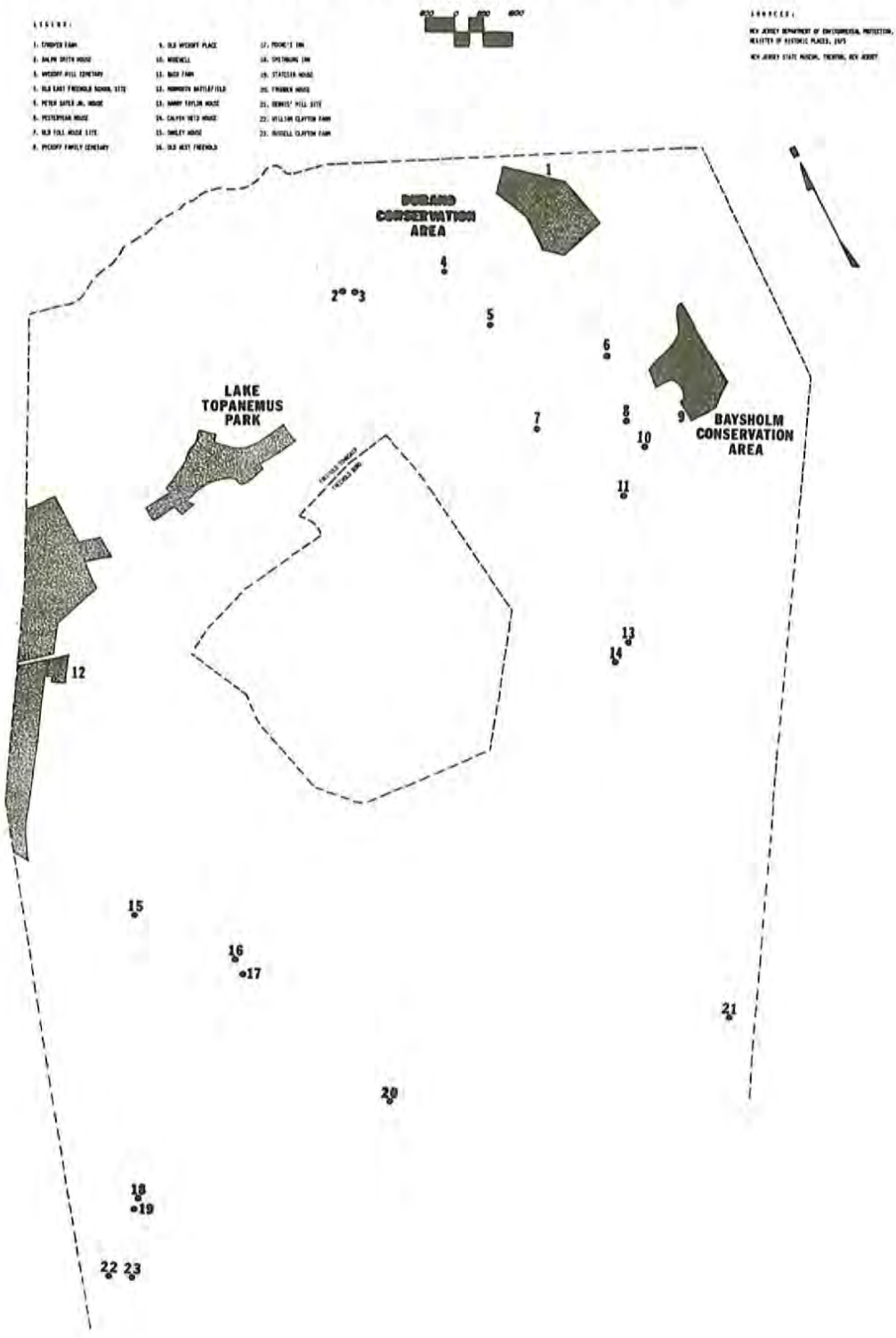
VEGETATION

SOUTH

FREEHOLD TOWNSHIP

HISTORIC AND AESTHETIC SITES

NORTH



FREEHOLD TOWNSHIP

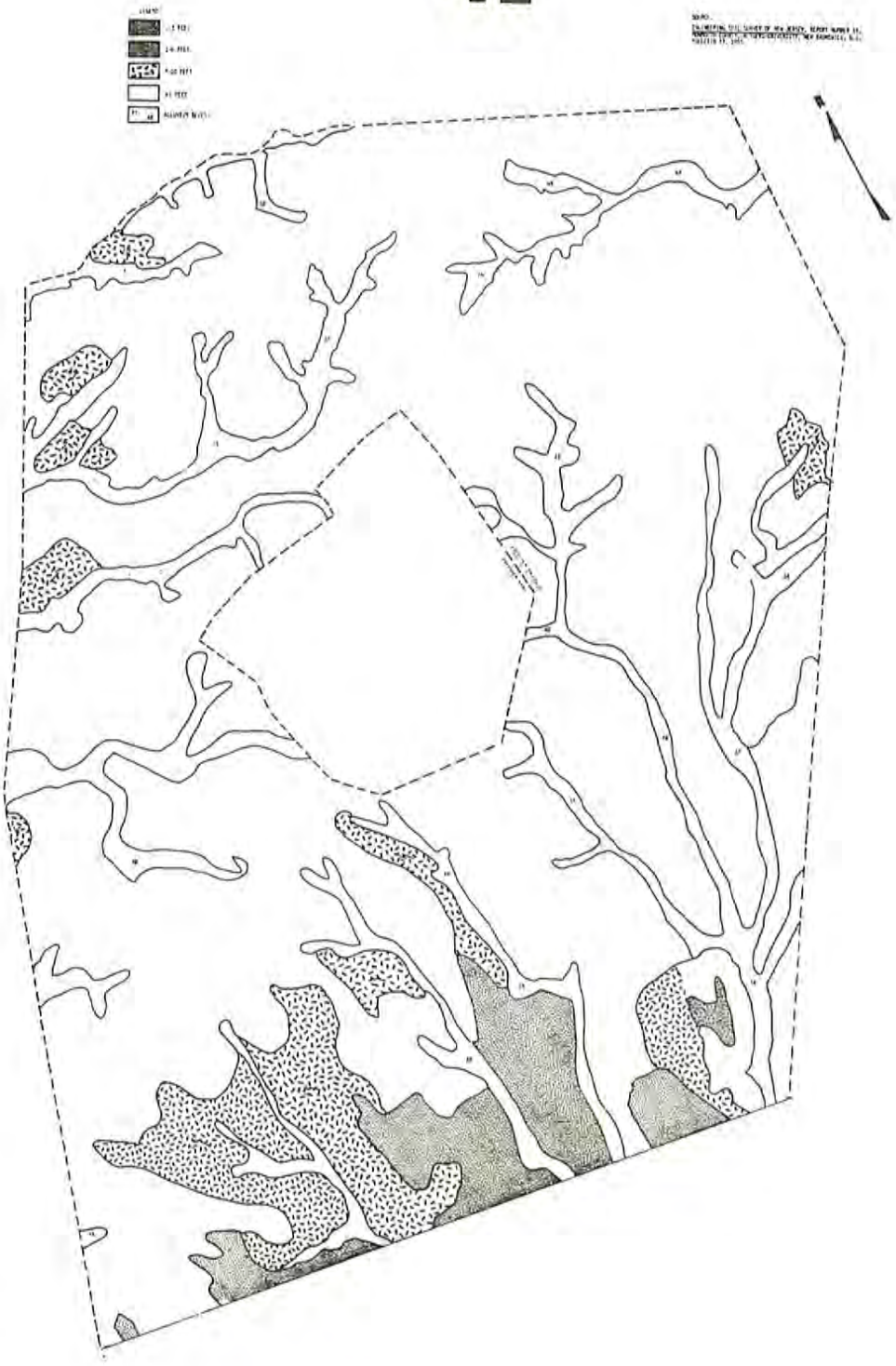
HISTORIC AND AESTHETIC SITES

SOUTH

FREEHOLD TOWNSHIP

AVERAGE DEPTH TO WATER TABLE

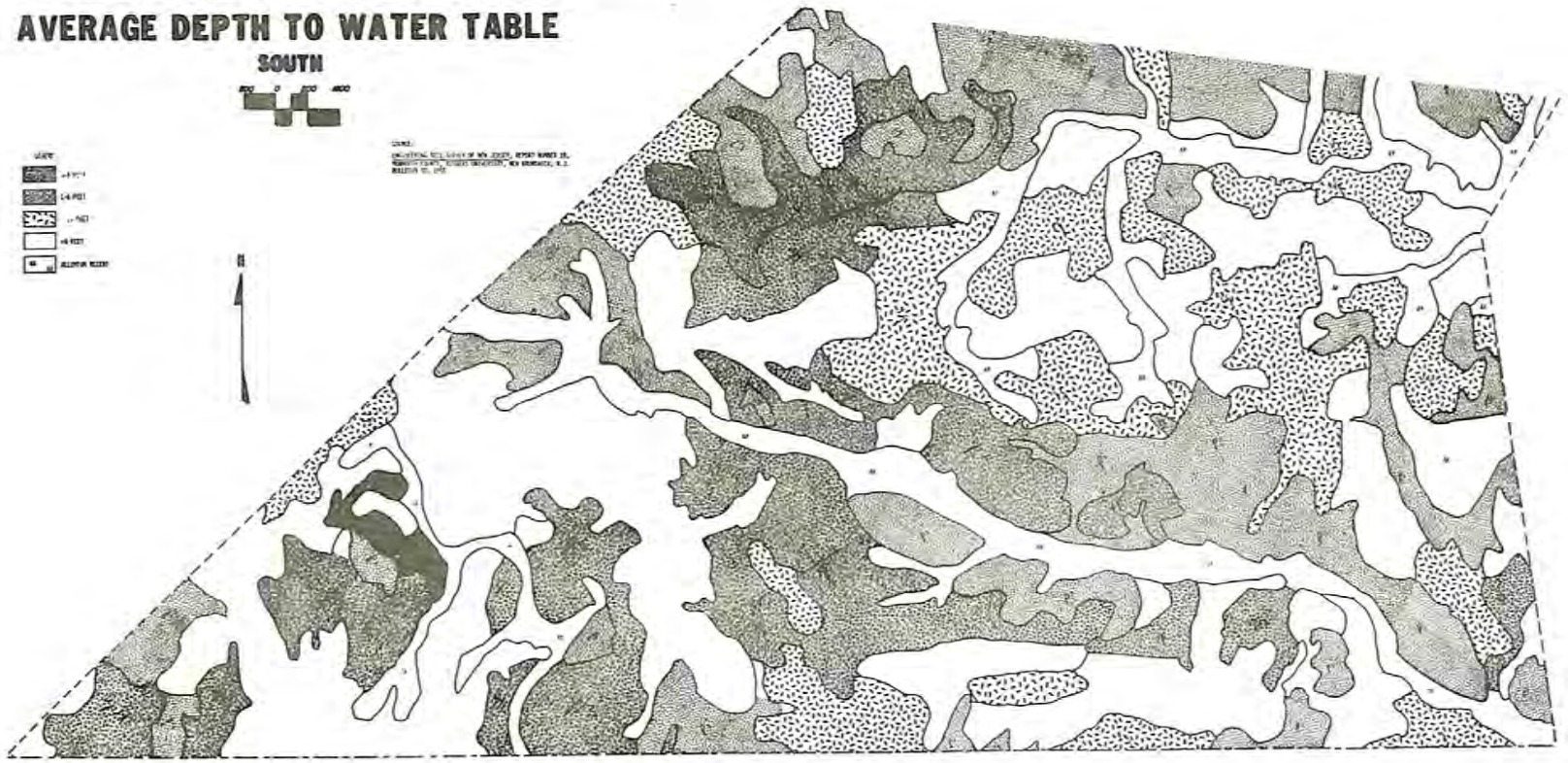
NORTH



FREEHOLD TOWNSHIP

AVERAGE DEPTH TO WATER TABLE

SOUTH



REFERENCES

Biel, E., The Economy of New Jersey, the Climate of New Jersey, Department of Conservation and Economic Development of the State of New Jersey, 1958.

Bowman, H. D., Shulman, M. D., Analysis of Air Mass Thunderstorm Precipitation in New Jersey, New Jersey Academy of Science, Volume 13, No. 2, 1968.

Brotak, Edward A. and Shulman, Mark, "Tropical Cyclone Precipitation in New Jersey." N.J. Academy of Sciences, Volume 16, No. 12, 1971.

Climatology Data, U.S. Dept. of Commerce, No. AA 1943-1972.

Cox, H. R., Monmouth County, Soils, Their Nature, Conservation, and Use; New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey, Bulletin 738, 1948.

Dames & Moore, Phase 1 - Environmental Assessments of Concepts for a Proposed Regional Wastewater Management System for the Manasquan Basin and Metedeconk Basin in Monmouth County, Cranford, N.J. 1973.

Elson T. Killam & Dames & Moore - Wastewater Management Study of the Manasquan Basin and the Metedeconk Basin in Monmouth County, 1974.

Elson T. Killam Associates Inc., A Master Sewerage Plan for Monmouth County, New Jersey - for the Board of Chosen Freeholders, Monmouth County, N.J., March, 1966.

Galantowicz, Richard E. The Process of Environmental Assessment - Options and Limits, Part I - Things You Never Wanted to Know about Zoning and Now are Being Forced to Ask, Part II - Natural Resource Inventory for Municipal Fun and Profit, Part III - It All Begins with Sunlight and Green Plants, Part IV - A House is More Than a Home, North Jersey Conservation Foundation, Morristown, New Jersey.

Horowitz, J. L. and Mark D. Shulman, "A Study of the Surface Synoptic Patterns in Association with the Drought of the 1960's in the Northeastern United States", Water Resources Bulletin, Volume 3, No. 2, June 1967.

Jablonski, Leo, A., Groundwater Resources of Monmouth County, New Jersey: State of New Jersey, Department of Conservation and Economic Development, Division of Water Policy and Supply, Special Report #23, 1968.

Kellers, Thomas, Chief of Visitor Services, Monmouth County Park System, Personal Communication, August, 1974.

Kuchler, A. W., "Potential Natural Vegetation of the Conterminous United States." American Geographic Society. Special pub., No. 36, 1964.

McCormack, R., Holman, W., and Jumikis, A., Engineering Soil Survey of New Jersey, Report Number 19, Monmouth County, Rutgers University, New Brunswick, N.J., Bulletin 33, 1955.

McDermott, V., Study of the Ichthyoplankton Associated with Two of New Jersey's Coastal Inlets, N.J. Dept. Environmental Protection, Div. Fish, Game and Shellfish, Bureau of Fisheries, Misc. Rep. No. 7M, 11pp. 1971.

McHarg, Ian, Design With Nature, Natural History Press, New York, 1970.

Minard, James P. and Owens, James P., 1960, The Geology of the North-Central part of the New Jersey Coastal Plain: John Hopkins University Studies in Geology, No. 18, 31 p. 4 fig.

Minard, James, P., Geology of the Roosevelt Quadrangle, New Jersey; U. S. Geological Survey, Geologic Quadrangle Map, GQ 340, 1964.

Monmouth County Park System, Outdoor Education in Monmouth County Parks, Holmdel; Shark River, Howell, Turkey Swamp.

Monmouth County Planning Board, Study of Land Use and Physical Characteristics: Monmouth County, Freehold, Monmouth County Planning Board, 1967.

Monmouth County Planning Board, Open Space Plan, January, 1971.

Monmouth County Park System Outdoor Education in Monmouth County Parks, Holmdel; Shark River, Howell, Turkey Swamp, 1971.

Munch, Neal, District Conservationist, Soil Conservation Service, Freehold, N. J., Personal Communication.

N. J. Department of Conservation and Economic Development, Division of Resource Development, Bureau of Parks and Recreation, Natural Areas Section, Nature at Allaire.

N.J. Department of Environmental Protection, State Register of Historic Places, December 31, 1973.

N.J. Department of Environmental Protection, Bureau of Air Pollution Control, Annual Report, 1971.

N.J. Department of Environmental Protection, Water Supply Division, Open well record file, 1973.

N.J. Department of Environmental Protection, Bureau of Air Standards Annual Report, 1971.

Rutgers University Engineering Soil Survey of New Jersey, Report #1, Soil Environment and Methods of Research Engineering, Research Bulletin #15, January, 1955.

Subitzky, Seymour, Geology of Selected Areas in New Jersey and Eastern Pennsylvania and Guidebook of Excursions, Rutgers University Press, New Brunswick, 1969.

Thom, H. C. S., "Tornado Probabilities" Monthly Weather Review, October-December, 1963.

U. S. Air Force Environmental Technical Applications Center, Wind Summaries for McGuire AFB, N.J., and Lakehurst, N.J., Washington, D.C.

U. S. Department of Agriculture, Soil Conservation Service, Freehold Soil Conservation District, Monmouth County Sheets 7, 8, 9, 15, 16, 17, 23, 24, & 25.

U. S. Department of Commerce, Climatic Summary, Freehold, New Jersey, Department of Commerce, National Oceanic and Atmospheric Administration, 1973.

U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study Guidelines, April, 1974.

U. S. Department of Housing and Urban Development, Federal Insurance Administration, Township of Freehold, N. J. (Monmouth County) Map Index No. H34-025-1094-01-06, February, 1974.

U. S. Department of Interior, Geological Survey, Adelphia, Freehold, Farmingdale, Roosevelt, Marlboro, Quadrangles, 7.5 minute series.

U. S. Department of Interior, Geological Survey, unpublished records, Trenton, New Jersey.

Zimmerman, Freehold Township Water Department, Personal Communication.