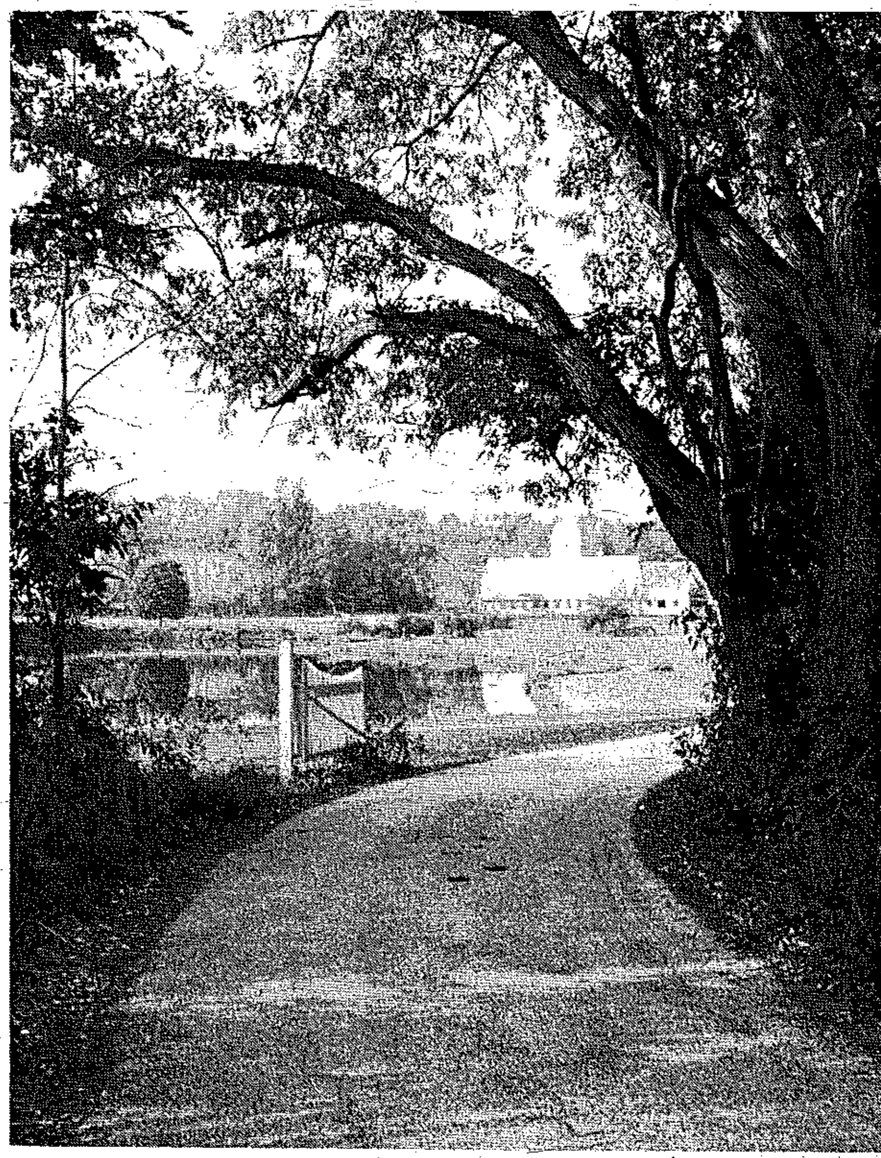
ENVIRONMENTAL RESOURCES



TOWNSHIP OF FRELINGHUYSEN

Warren County, New Jersey

FRELINGHUYSEN TOWNSHIP ENVIRONMENTAL COMMISSION

#102

ENVIRONMENTAL RESOURCES

A STUDY AND INVENTORY FOR FRELINGHUYSEN TOWNSHIP

> All good planning must begin with a survey of actual resources: the landscape, the people, the work-a-day activities in a community. Good planning does not begin with an abstract and arbitrary scheme that it seeks to impose on the community: it begins with a knowledge of existing conditions and opportunities.
>
> Lewis Mumford, from
> *The City in History*

Prepared by the Frelinghuysen Township Environmental Commission, begun 1984, completed 1989.

TOWNSHIP OF FRELINGHUYSEN

Charles Rydell, Mayor

Committee
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John Lotz
Fred Gebhardt

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*former members

ACKNOWLEDGEMENTS

The environmental Commission wishes to thank the following persons and organizations for their help in the preparation of this report:

Paul Armstrong, former ranger at Wildlife Preserves, Inc.; Sam Moore, writer; Mildred Read, local birder for the bird inventory; Sr. Miriam MacGillis of Genesis Farm; Margaret Dillon, Ecologist, for the Soils chapter; Olga Guiler, former resident and historian for valuable information on local history; Glen Wershing for Indian history of the area; Wendy Wolff, artist, for all wildlife drawings; Debra Natyzak-Osadca for all photographs; Leonard Lee Rue III for reviewing the wildlife chapter; Bros. Luke of St. Paul's Abby, Newton, for weather information; Abigail Fair of the N.J. Wetlands Coalition;

and

The Association of New Jersey Environmental Commissions; The New Jersey Conservation Foundation; Dan Jones, Soil Conservation Service and Duane Copley, Soil Conservation District, both from the Hackettstown Office; Russell Miles and his staff at the Warren County Planning Board; the many different offices of the New Jersey Department of Environmental Protection that supplied documents for our use; The U.S. Department of the Interior, Fish and Wildlife Service;

and

last, but not least, the citizens of Frelinghuysen Township who took the time to answer our questionnaires.

Our special thanks to Cathy Bao Bean for proofreading and correcting our many errors in grammar; and to Robert Canace, Geologist for the New Jersey Geological Survey, N.J. D.E.P., for the geology and hydrology chapters and maps and for his assistance and undaunted support on the whole Inventory.

Special thanks also to our Township Committee who made it possible to begin the inventory through their faith and financial assistance over the past eight years.

The members of the Environmental Commission wish to dedicate this report to Sieglinde Anderson, whose extraordinary efforts and skills made it possible for us to undertake this project.

September 1991

The publication of this Inventory was made possible in part by a grant from the N.J.D.E.P Office of Environmental Services.

Additional copies of this report and full size maps (24"x36") may be obtained at the town hall in Johnsonburg.

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GENERAL PREFACE

As citizens of Frelinghuysen Township, we approach the last years of the twentieth century with a sense that we bridge a critical stage of human history. Our region, our State and Nation, indeed, the whole industrialized world, are beginning to assess the benefits and losses of the last 300 years of rapid material development. The escalation of technological growth in the last several decades is of special concern. For while we justifiably boast of extraordinary technical achievements, we are only beginning to grasp the price of these achievements in the diminishment of the basic functioning of our Earth's living systems.

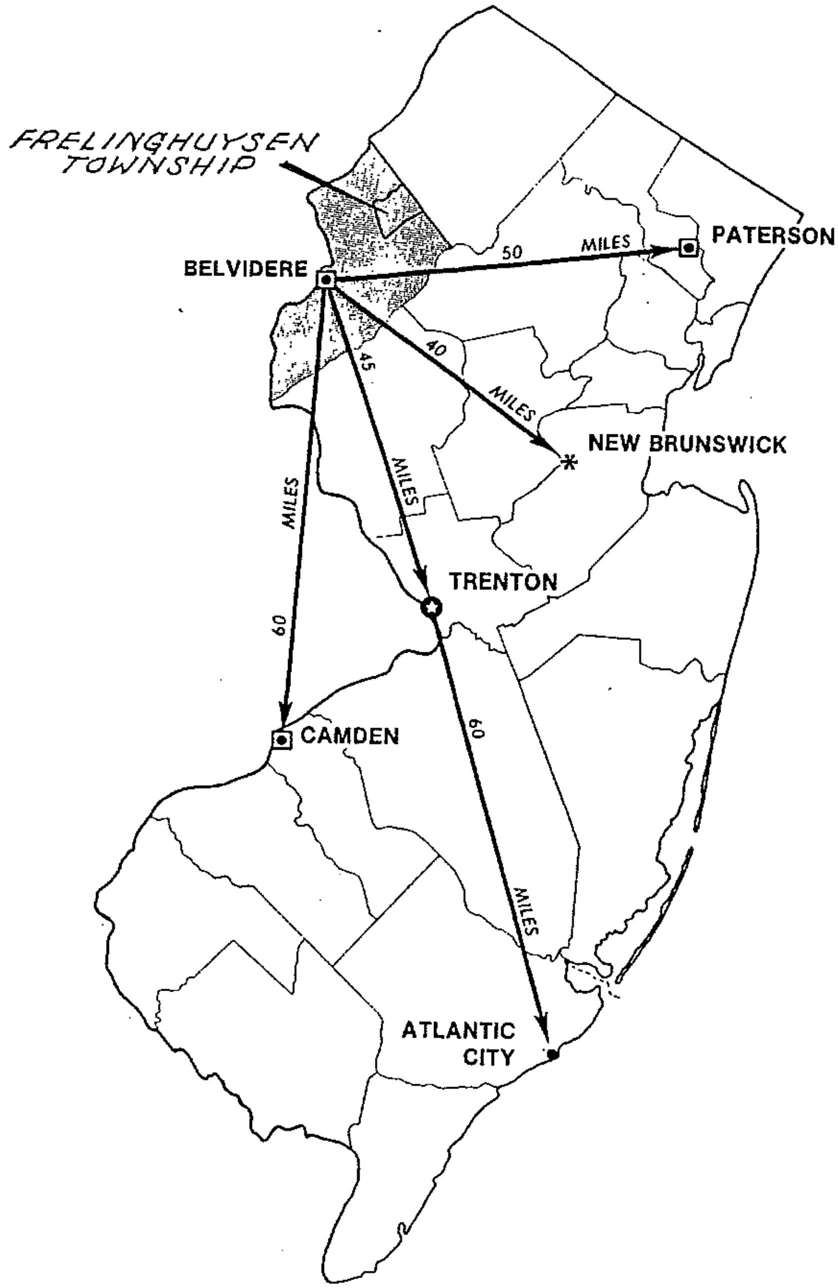
This document occurs in the wake of the last few decades which were marked by a growing sensitivity to our total human dependence on the well-being of the natural world. Our previous plundering of the air, soil, water and forests was given a startling jolt with the momentous work of Rachel Carson in 1962. Her landmark publication, *Silent Spring,* brought to American awareness the already advanced state of our environmental crisis.

During the late 1960's, the State of New Jersey legislated the formation of environmental commissions at the municipal level. Regional and local communities were urged to expand their criteria for planning to include the essential natural systems without which human development could not be sustained. In many areas, this awareness came too late.

As one of the few remaining regions of New Jersey which still preserves a measure of ecological health and diversity, we are in a privileged position to learn from the tragic consequences of unregulated growth. We have the opportunity to evolve as a region which guides its social, economic and political patterns by enlightened principles in harmony with our natural resources.

Let it be told by future generations that the people of this region approached the 21st Century with a maturity of vision and an advanced ecological ethic. May this inventory of our rich and diverse natural world be a context through which we define the quality of life we esteeme. Once lost, this quality cannot be restored. Once understood and valued, it ought not be squandered.

by Sr. Miriam MacGillis,
Genesis Farms



Location of Frelinghuysen Township, Warren County in New Jersey.

FOREWORD

"...Every individual on the planet must be made aware of its vulnerability and of the urgent need to preserve it. No attempt to protect the environment will be successful in the long run unless ordinary people.... are willing to adjust their life styles...We owe this not only to ourselves and our children but also to the unborn generations who will one day inherit the earth." (quotation from TIME MAGAZINE, January 2, 1989, by Thomas A. Sancton, *Planet of the Year*, page 26-30,"Endangered Earth - What on EARTH are we doing?")

It is perhaps timely that our Inventory, begun in 1984, should be completed the same year TIME chose EARTH as the Planet of The Year instead of a Man/Women of the Year. As ordinary people, we volunteered our time over the past five years with the hope that this manual would become an aid in the planning and decision-making process at the local level, by layperson and professional alike.

In New Jersey, decisions affecting the use of land and the quality of the physical environment are the responsibility of local governments. Planning and Zoning Boards, as well as the Environmental Commission, are appointed by the Mayor in order to fulfill requirements outlined by the New Jersey Municipal Land Use Law passed in 1975.

In this law the township government is charged with the duty to encourage the appropriate use or development of all lands in this State in a manner which will promote the public health, safety, morals and general welfare. Further, the township government is to prepare a Master Plan and adopt a Land Use Element designed to effectuate such a plan via a Zoning Ordinance which "shall be drawn with reasonable consideration to the character of (each) district and its peculiar suitability for particular uses."

The Land Use Element, as described in Section 19 of the Law, is a resource inventory which provides the baseline information of *how things are now*. The Environmental Resource Inventory seeks to provide information on the total environment (defined in its broadest terms to include all factors which contribute to the quality of life - social, cultural, economic and natural systems). Though inventories may differ from locality to locality within the State, they must all supply basic information which will ensure that planning for land use, roads, sewage and water supplies, public services, etc. reflects the capacity of the land and the needs of the people.

The inventory makes possible accurate assessment of the impact of proposed action on local and regional resources. Down-stream flooding, lowering of the water tables, ground water pollution, traffic hazards, lack of open space are only a few of the costs that must be weighed against possible benefits such as lowered taxes, higher employment, meeting local budgetary needs and industrial financial gain. The resource inventory is the environmental information bank for the municipality. It provides information, not decisions.

We prepared the following inventory by assigning chapters to commission members according to each individual's interests and expertise. Using their firsthand experience, research sources and personal contacts with professionals to obtain the latest available information, the members wrote drafts which were circulated for review within the commission and then reviewed and edited by outside experts.

Only time will tell if a Master Plan is successful or not. The ultimate success or failure of the plan depends on the competence with which it was completed and on the commitment and involvement of those responsible for implementation. Through continuous reevaluation and additional information, new alternatives may be implemented by the governing body to improve the Plan. It is our hope that this Inventory will become the basis for any Master Plan revisions at the local level.

Sieglinde Anderson, CLA, ASLA
Chair Person
Frelinghuysen Township
Environmental Commission
April 1990

PART I.

PHYSICAL RESOURCES

View from Mudpond towards Jenny Jump

INTRODUCTION

The Township of Frelinghuysen lies in the northwestern section of the State of New Jersey, in the eastern part of Warren County, approximately 65 miles west of New York City. It is located at approximately 41° 01' north latitude and 74° 56' west longitude.

Frelinghuysen is bounded on the north by Hardwick Township, on the east by Fredon and Green Townships (both in Sussex County), on the south by Allamuchy and Independence Townships, on the west by Hope and Blairstown Townships. The area of the township is 15,104 acres or 23.60 square miles.

Frelinghuysen is located in the "Valley and Ridge", one of the four major physiographic provinces of the State and is in the Pequest and Paulins Kill watersheds. The topography is characterized by a series of parallel hills and valleys, with ridges aligned approximately northeast-southwest. The terminal moraine of the last Ice Age, called the Wisconsin Glaciation, covered all of the township, depositing a terminal moraine just south of the township near Belvidere. The highest point (elevation 1134 ft.) is on Jenny Jump Mountain which forms the southern boundary. Elsewhere, elevations vary from 340 ft. above sea level in the Paulins Kill River valley to 900 ft. north of Route 519, and from 520 ft. to 1100 ft. south of Route 519. County Road 519 roughly bisects the township - south of 519 the rock is predominantly Kittatinny limestone, while to the north of 519, it is mainly Martinsburg shale.

Interstate Route 80 cuts across the southwestern corner and is accessible via either Allamuchy or Hope. State Route 94 traverses the entire northern portion of the township from the Sussex County line (coming from Newton) to Blairstown Township.

Frelinghuysen Township is predominantly a rural single-family and agricultural community without a central business district and virtually no industry. The two villages of Marksboro and Johnsonburg provide minimal convenience shopping and the township center in Johnsonburg also provides municipal services. Other than the road maintenance crew, there are no full-time municipal employees. The present Master Plan allows for minimal increases for both business and industry, mostly concentrated along the Route 94 corridor and in village centers. There is a great deal of vacant open land - some of it presently being farmed - which is available for further development.

The population of Frelinghuysen Township has increased from 1436 to 1800 since 1980, according to Mayor Rydell. This is well below the projected increase outlined in the 1966 Master Plan Report (fig. 1). There were no major subdivisions until 1988. However, since that time, the Planning Board has approved - or is in the approval process - of several major subdivisions which will drastically alter the population base.

PROJECTIONS OF FUTURE POPULATION GROWTH

YEAR	U.S.CENSUS	LOW/MODERATE DEVELOPMENT RATE	RAPID DEVELOPMENT RATE
1960	845 Actual		
1970		940	1100
1980		2000	4500
1990	1800 Actual	3000	7200

Fig. 1

Source: Master Plan Report for Frelinghuysen Township, 1966

CLIMATE AND LAND USE

Frelinghuysen Township lies within the temperate zone of the North American continent between the 40° north latitude and 41° north latitude. Over eons of time, climate has had a direct effect on not only natural processes, such as geologic and soil formations, but also the ways humans have used the landscape for food and shelter. Early Indian inhabitants were able to live in wigwams as compared to igloos or adobe shelters.

The temperate zone offers a naturally favorable climate. It is neither too cold nor too hot, and provides sufficient rain for man's many water needs not the least of which is the growing of food crops. Water and solar radiation are key influences on vegetation which, in turn, influences wildlife. Reproduction, migration, hibernation and feeding are all influenced by variations in climate.

Though our area has been covered by ice and ocean in the past, the climate of Frelinghuysen Township, as well as the rest of New Jersey, is influenced by its median position between the equator and the North Pole. It is greatly affected by tropical systems which bring warm humid weather and polar air masses from the North which are usually cold and dry. Climate is also affected by land use and land cover. Frelinghuysen Township's latitudinal and longitudinal position determine the length of day, temperature levels and the length of the growing season. Our weather is most influenced by air masses coming from the southwest, west and northwest, rarely from the southeast and east. Winters are cold with frequent ice rains and snow but intermittent thaws preclude a long lasting snow cover in valleys and on south-facing slopes. Temperature extremes are frequent,though the average annual temperature is 55° F, (approximately the same temperature as ground water). Extreme highs of 101° F with humidity of 99 percent (July 1988), and lows of -24° F (Jan. 1981) have been recorded. Although there has been no real change in our climate in the last fifty years, the last three years have seen higher than usual summer temperatures and unusual weather-related disasters such as droughts and floods.

The recent discovery of the large hole in the ozone layer above the North pole has caused scientists to warn of global warming which will have far reaching climatic changes over the entire planet. Build-up of CO_2 levels as well as other gases produced in an industrialized world are trapped in the earth atmosphere creating a "greenhouse effect" which may raise average temperatures by 3 to 8° F by the middle of the next century. Although scientists at this time cannot agree on how much global warming has occurred or what the climatic consequences will be, no one disputes the increased presence of CO_2 and the possible drastic alteration of climate-influenced ecosystems. Because plants use large quantities of CO_2 during photosynthesis and produce only 1/5 to 1/3 during the reverse process, it has been suggested that trees be planted to counteract the effect of carbon dioxide build-up.

As can be seen from the **Land Cover Map**, large portions of Frelinghuysen Township are covered by woodland. Trees, because of their large leaf surface, play a significant role in climate control. They control temperature linked directly to solar radiation, windflow and precipitation in that they absorb and transpire water. These functions are explored in greater detail in the chapter on "Vegetation."

Precipitation is evenly distributed throughout the year. The average rain fall is 43.8 inches. In nearly every year, however, there are periods when rainfall is not consistent or sufficient for high-value food crops or landscape plantings thus making artificial irrigation necessary. The highest precipitation recorded is 60 inches and the lowest is 34 inches.

Table I gives data on temperature and precipitation for Warren County as recorded at Belvidere, New Jersey. Table II shows probable dates of the first freeze in Fall and the last freeze in Spring as well as temperature extremes. Table III provides data on the growing season.

Of the total precipitation, 24 inches, or 53% usually falls from April through September. In two years out of ten, the rainfall during the same period is less than 19 inches. The heaviest rainfalls recorded were during July 1984 - 10.37 inches, January 1979 - 10.51 inches, July 1975 - 11.96 inches; and the highest snowfall in February 1978 - 26.5 inches. Depth to which soil freezes ranges from 1-2 1/2 feet except during extreme Winters such as 1978 when it reached 3-4 feet. There are about 32 thunderstorms each year, 19 of which occur during the Summer.

(Table I)

Month	Precipitation 30-year average (inches)	Precipitation(in.)/temperature(°F) 1986	1987	1988
January	3.0 (7.5 snow)	4.47/28.7	4.27/28.1	2.73/21.5
February	2.8 (8.4 snow)	4.38/27.7	0.57/28.5	3.84/28.3
March	3.2 (7.3 snow)	2.85/39.9	2.06/41.1	2.07/38.5
April	4.1 (.09 snow)	5.87/50.3	6.61/51.1	1.55/47.2
May	3.5	2.79/62.7	2.03/59.9	4.98/39.3
June	3.7	5.45/67.2	2.88/70.1	1.02/67.1
July	4.2	5.70/72.8	5.33/74.5	7.83/74.8
August		6.17/68.9	4.97/69.1	3.66/74.5
September	3.6	3.26/62.3	7.69/63.1	3.06/61.2
October	3.2 (.09 snow)	1.91/54.0	4.19/48.0	2.30/47.8
November	4.0 (1.15 snow)	6.40/39.4	2.16/42.1	5.49/42.9
December	3.7 (7.9 snow)	4.25/33.9	1.32/35.1	0.71/30.5
Total annual precipitation (inches)		53.50	44.08	39.24
Average annual temperature (°F)		50.7	50.9	49.5

Table I. AVERAGE TEMPERATURE AND PRECIPITATION FOR FRELINGHUYSEN TOWNSHIP, WARREN COUNTY.

(Table II)

Extremes	Year (date) 1986	1987	1988
Highest (°F)	96 (7/8/86)	94 (7/22/87)	101 (7/11/88)
Lowest (°F)	2 (1/15/86)	-5 (1/29/87)	-6 (1/12/88)
Last Spring Freeze (32° or below)*	31 (4/23/86)	30 (4/3/87)	31 (4/27/88)
First Fall Freeze (32° or below)**	30 (10/11/86)	31 (10/13/87)	32 (10/9/88)

* 1 year in 10 later than May 17
5 years in 10 later than April 30

** 1 year in 10 earlier than September 29
5 years in 10 earlier than October 13

Table II. TEMPERATURE EXTREMES AND FREEZE DATA (°F) FOR FRELINGHUYSEN TOWNSHIP, WARREN COUNTY

(Table III)

Frequency	Temperature	Duration
9 years in 10	higher than 32° F	142 days
8 years in 10	higher than 32° F	150 days
5 years in 10	higher than 32° F	166 days
2 years in 10	higher than 32° F	181 days
1 year in 10	higher than 32° F	189 days

Table III. LENGTH OF GROWING SEASON, FRELINGHUYSEN TOWNSHIP

(Sources for Tables I, II, II: Climatological Data Annual Summary, N.J., 1986, 1987, 1988, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, N.C.; and Soil Survey for Warren County, N.J., USDA, 1979)

Major Sources of Information

Robinette, Gary, *Plants/People/and Environmental Quality, Climatological Uses of Plants*, U.S. Dept. of Interior & the American Society of Landscape Architects. 1972.

Olgyay, Victor, *Design with Climate*, Princeton University Press. 1963.

Lemonick, Michael D., *Feeling the Heat*, Time, Inc., New York, January 2, 1989.

U.S. Dept. of Agricluture, Soil Conservation Service, Soil Survey of Warren County, N.J. 1979.

FRELINGHUYSEN TOWNSHIP
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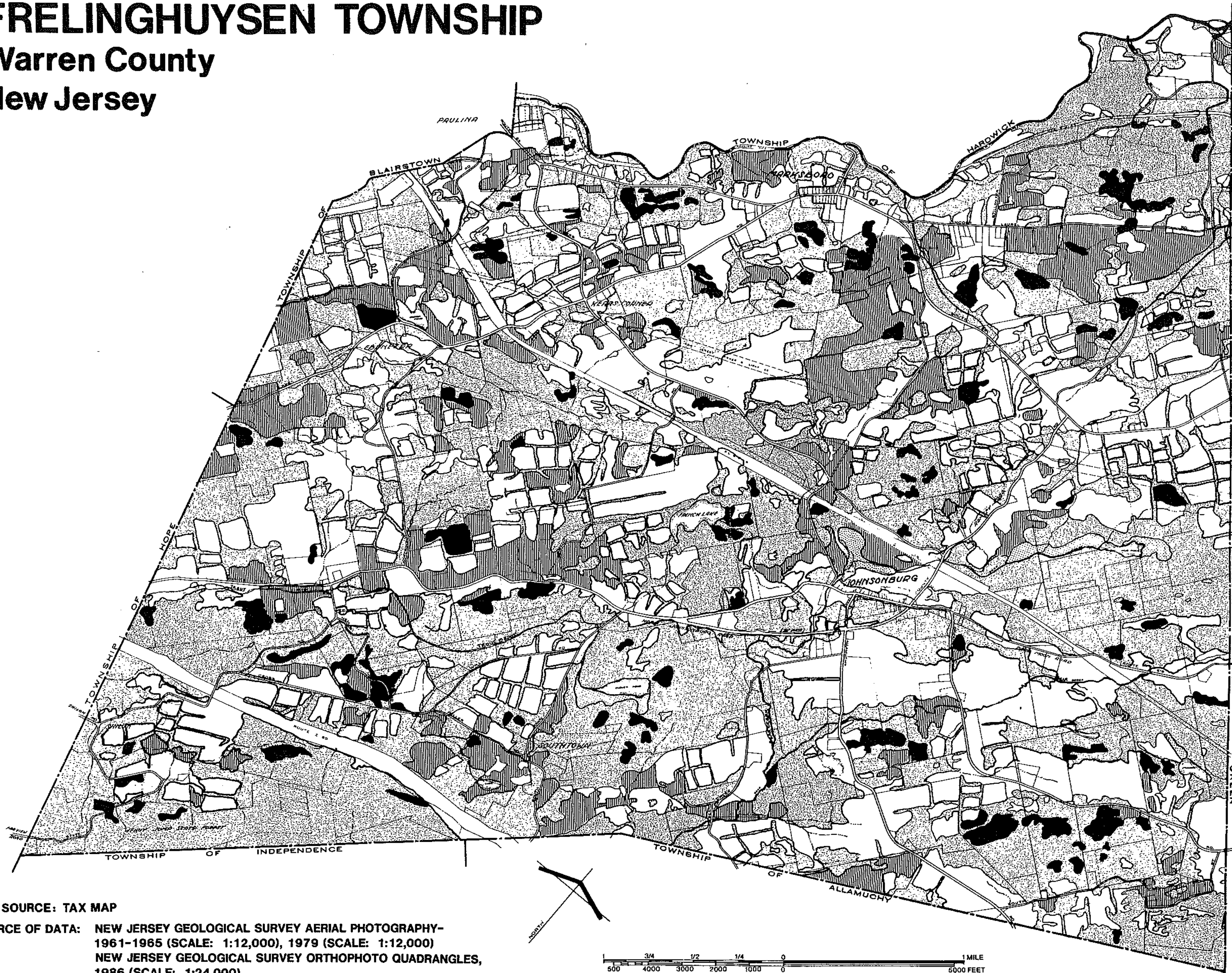

LAND COVER

- FIELDS
- OVERGROWN OLD FIELDS
- CONIFEROUS WOODS
- DECIDUOUS HARDWOODS
- MARSH

MAP SOURCE: TAX MAP

SOURCE OF DATA: NEW JERSEY GEOLOGICAL SURVEY AERIAL PHOTOGRAPHY-
1961-1965 (SCALE: 1:12,000), 1979 (SCALE: 1:12,000)
NEW JERSEY GEOLOGICAL SURVEY ORTHOPHOTO QUADRANGLES,
1986 (SCALE: 1:24,000)

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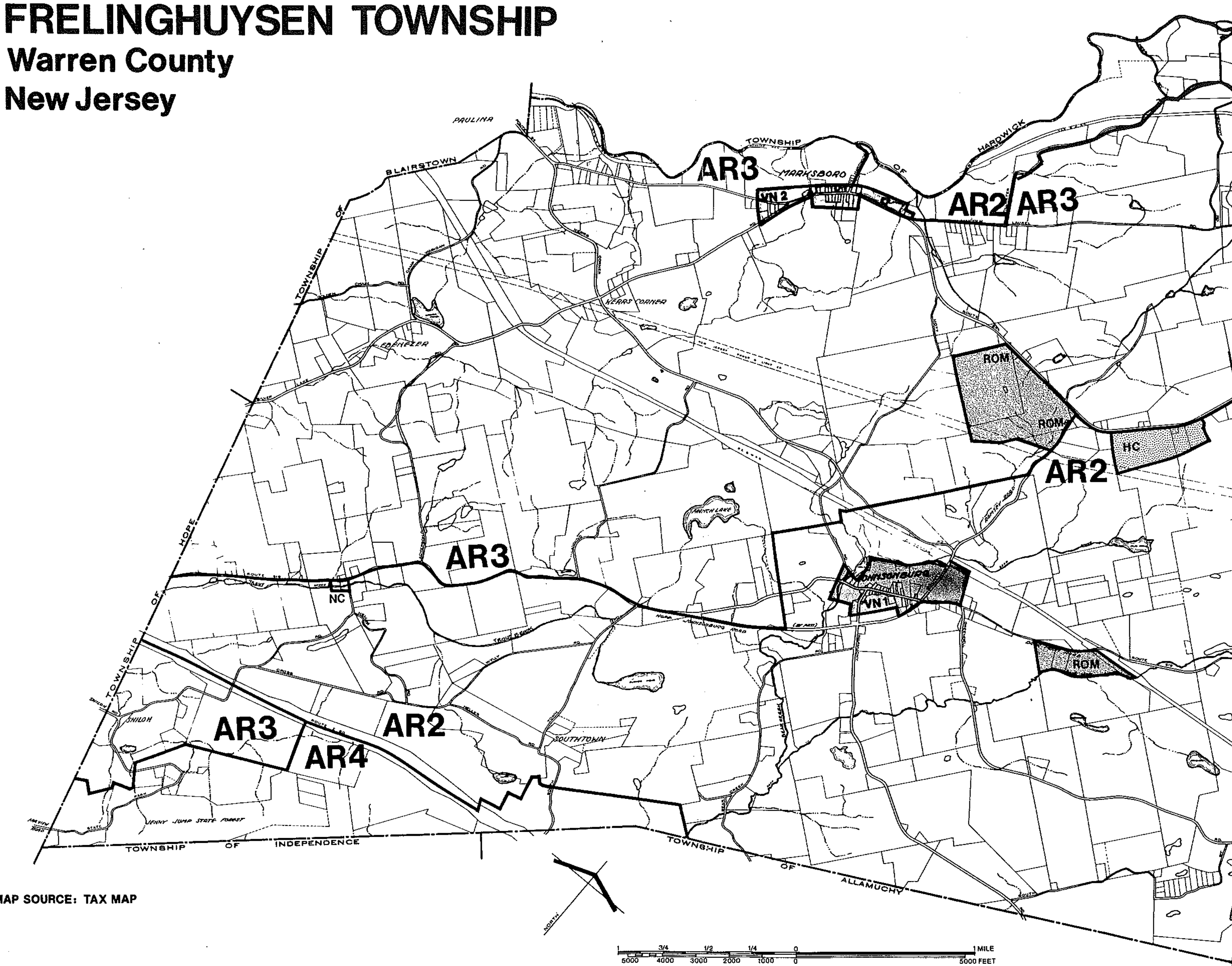
FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



MAP SOURCE: TAX MAP

EXISTING ZONING

AGRICULTURAL-RESIDENTIAL

AR2 2 ACRES **AR3** 3 ACRES **AR4** 4 ACRES

VILLAGE NEIGHBORHOOD

VN1 1 ACRE **VN2** 2 ACRES

NEIGHBORHOOD COMMERCIAL

NC 1 ACRE

HIGHWAY COMMERCIAL

HC 2 ACRES

RESEARCH-OFFICE-MANUFACTG.

ROM 3 ACRES

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PHYSIOGRAPHY

For purposes of land planning, the important aspects of physiography are elevation and slope (topography). Topography gives a fast overview of the lay of the land. It identifies crests, ridges and hilltops, valleys, swales, depressions, wetlands, floodplains and streams. A glance at the map helps us to pinpoint vista and view points.

All points of equal elevation are connected by a contour line which express surface modulation. From the map we can see where the land forms are sloping steeply (contour lines are closer together), or where they are flat (contour lines are far apart) (fig. 2). The contour interval shown on the U.S.G.S. map is twenty feet, that is, it shows a rise or drop in vertical elevation every twenty feet. For land-use decisions this is often too infrequent. Most major developments (housing subdivisions and commercial-industrial) require a smaller interval of five - or even two - feet to give a better understanding of a large site.

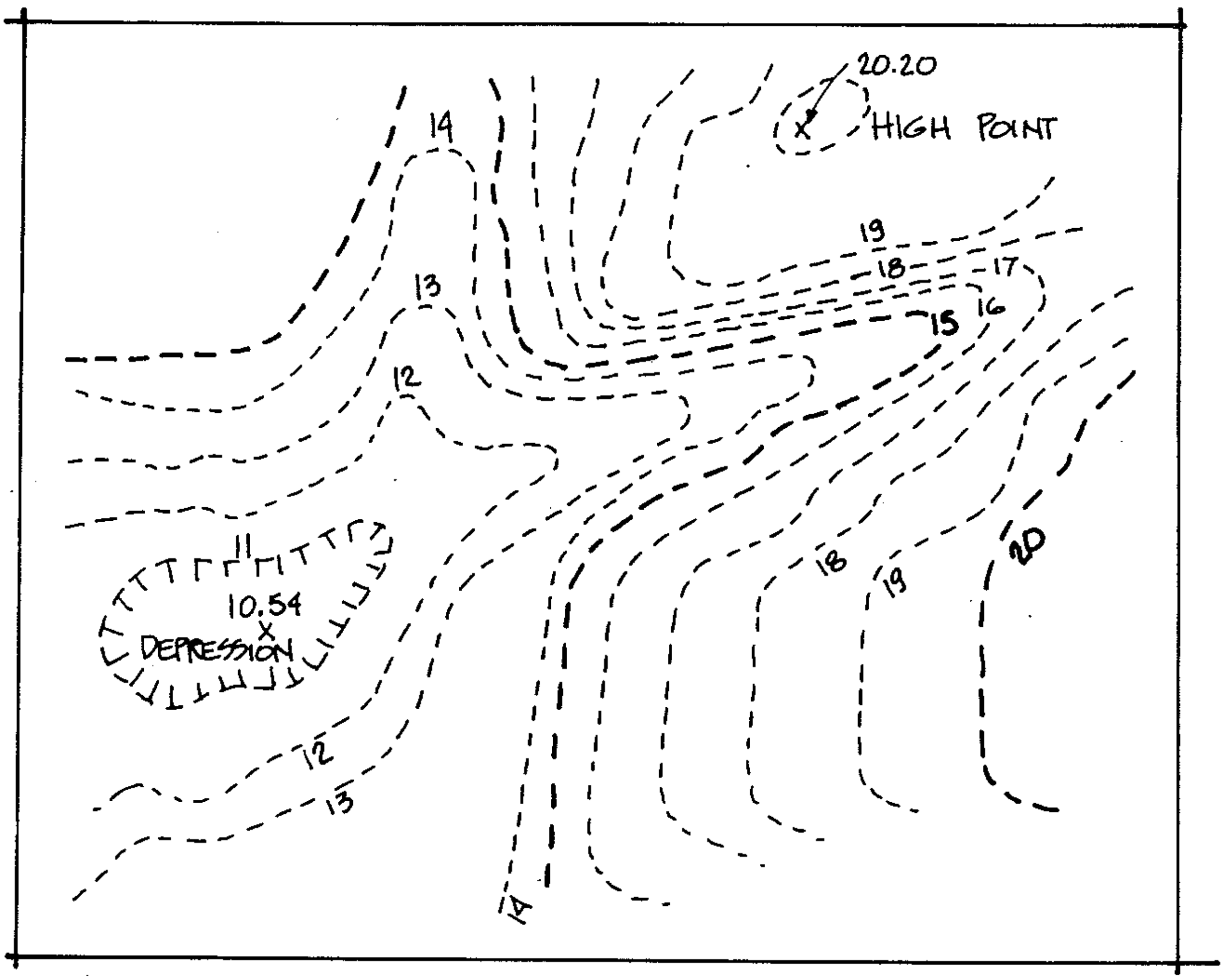


Fig. 2 – Examples of contour map.

Physiography affects microclimate. Where the terrain is aligned with prevailing winds, ventilation is stronger. Since our ridges are aligned roughly southwest - northeast, and prevailing winter winds are from the northwest, the southeastern slopes and valleys will receive less winter wind but more summer breezes when prevailing winds shift to the southwest (fig. 3).

From a map we can easily ascertain southern and northern exposures. This is useful information for land planning since southern slopes receive more direct sunlight and, in our hilly terrain, are often protected from cold winter winds. Northern slopes are colder and wetter since they receive less direct sunlight. They are exposed to cold winter winds and snow melts slower on roads and roofs. Southern exposures warm up quicker in the Spring and allow for a slightly longer growing season. Since space-heating consumes 53% of all energy used by households in northern climates, exposure may be an important factor in determining house locations.

Topography affects the placement of roads. Roads that follow the lay of the land are more attractive because they "fit" better. Avoiding steep slopes during development reduces construction costs and lessens the chance of erosion (fig. 4).

A conventional grid-type development, which may look good on paper, can wreck a site by ignoring the natural lay of the land. Access roads will be steeper and arbitrary rectangular lot locations may mean excessive construction costs and problems with erosion, septic systems, soil slippage and the destruction of the natural character of a site.

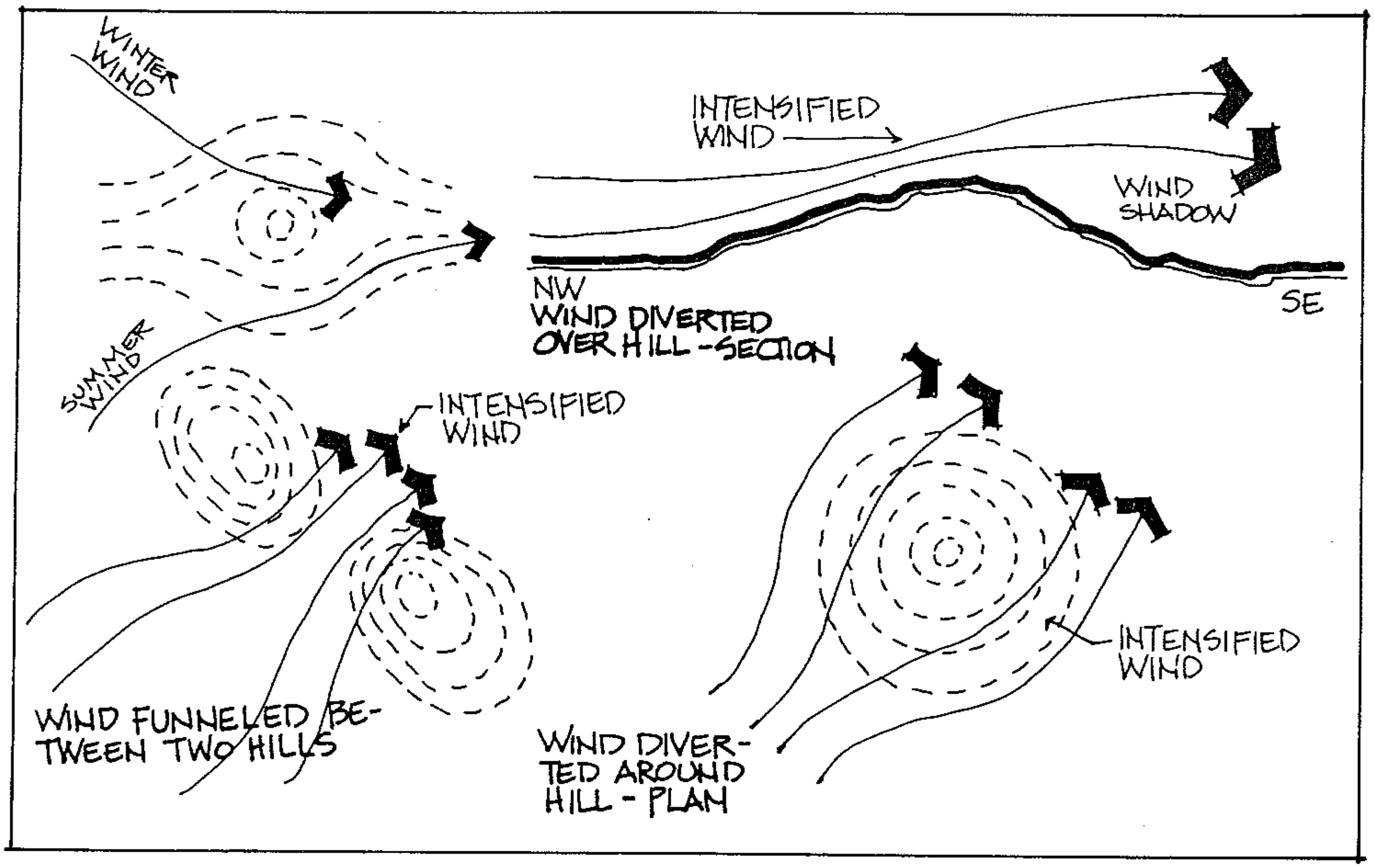


Fig. 3 - The effect of wind on topography. (adapted from *Site Design* by Norman Booth, Ohio State University)

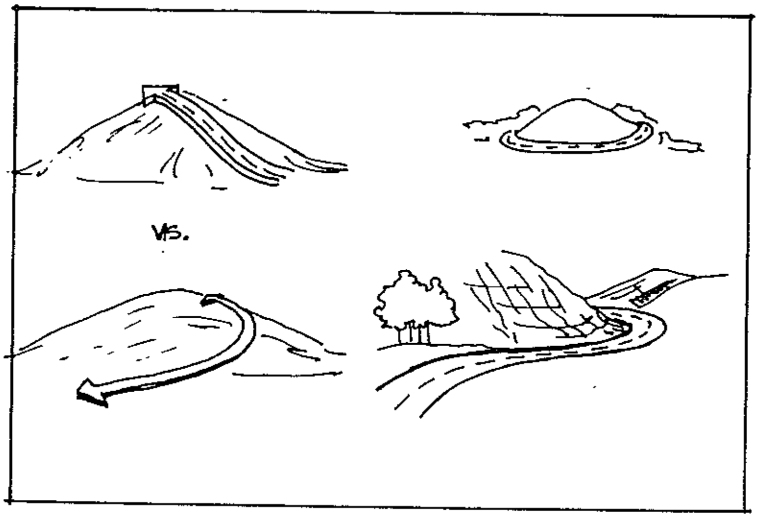


Fig. 4 - Alternative Road Placement (adapted from *Grade Easy*, by Richard Untermann)

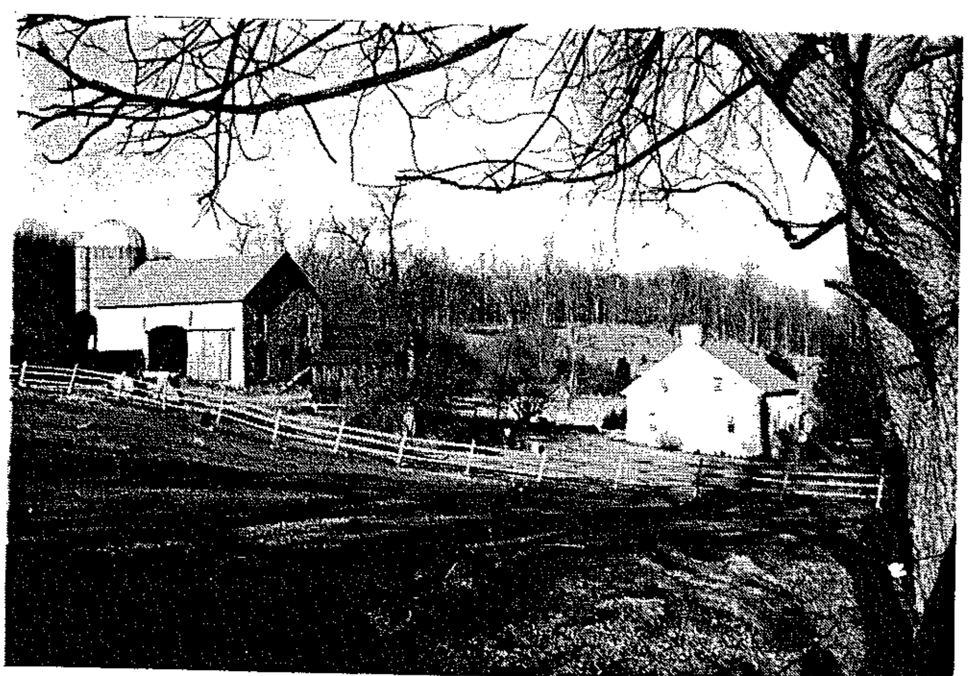
Major Sources of Information

Untermann, Richard K., *Principles and Practices of Grading, Drainage and Road Alignment: An Ecological Approach*, Reston Publishing Co., Inc., Reston, Va. 1978

Olgyay, Victor, *Design with Climate*, Princeton University Press, Princeton, N.J. 1963

Hendler, Bruce, *Caring for the Land*, American Society of Planning Officials, Report No. 328, Chicago, Illinois, June 1977.

McPherson, Gregory, *Energy Conserving Site Design*, Landscape Architecture Foundation, American Society of Landscape Architects, Washington D.C. 1984



Farmstead, ca. 1798, on the Hope-Johnsonburg Rd.

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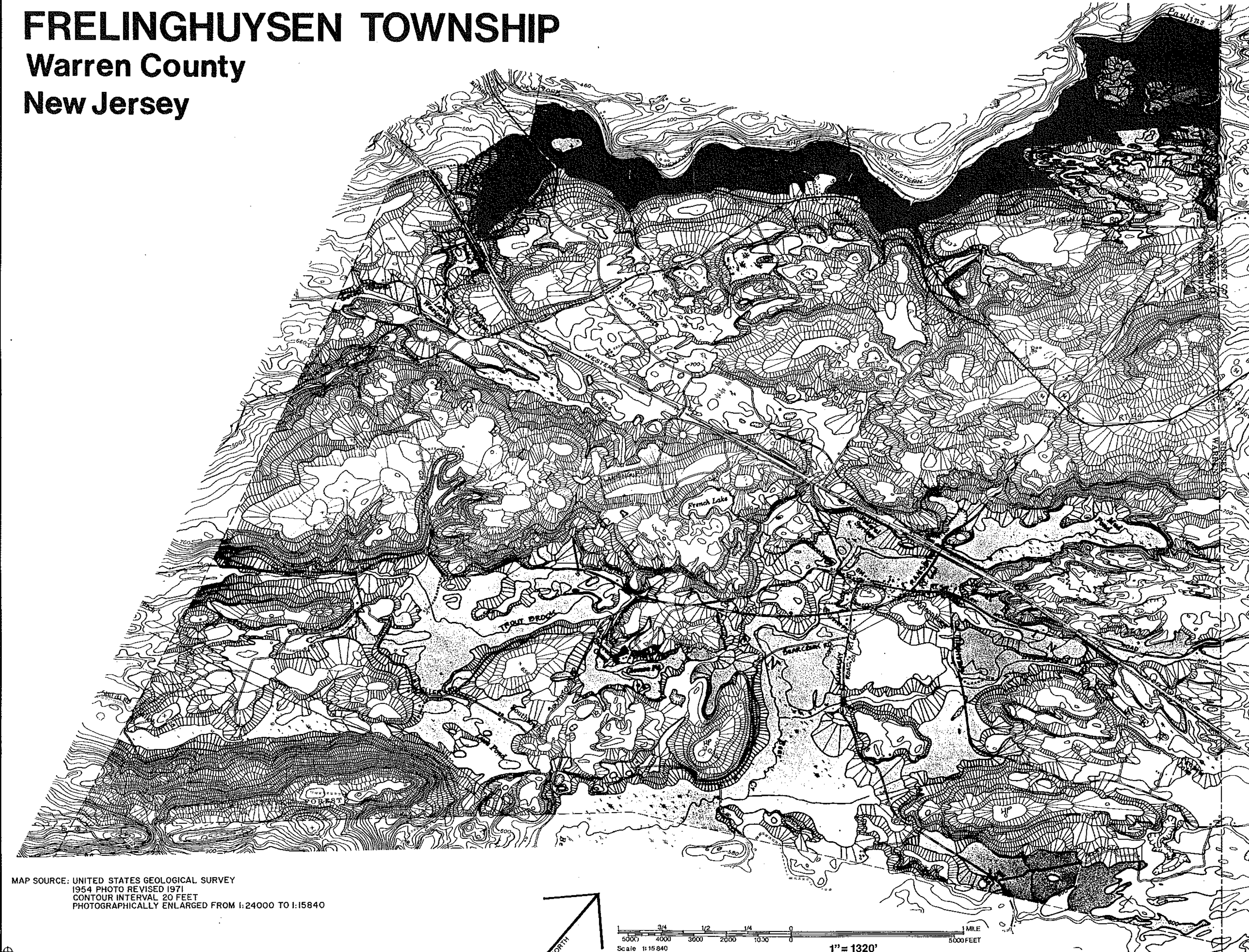

ELEVATION MAP

- 340-500 FEET
- 500-600 FEET
- 600-700 FEET
- 700-800 FEET
- 800-1100 FEET

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

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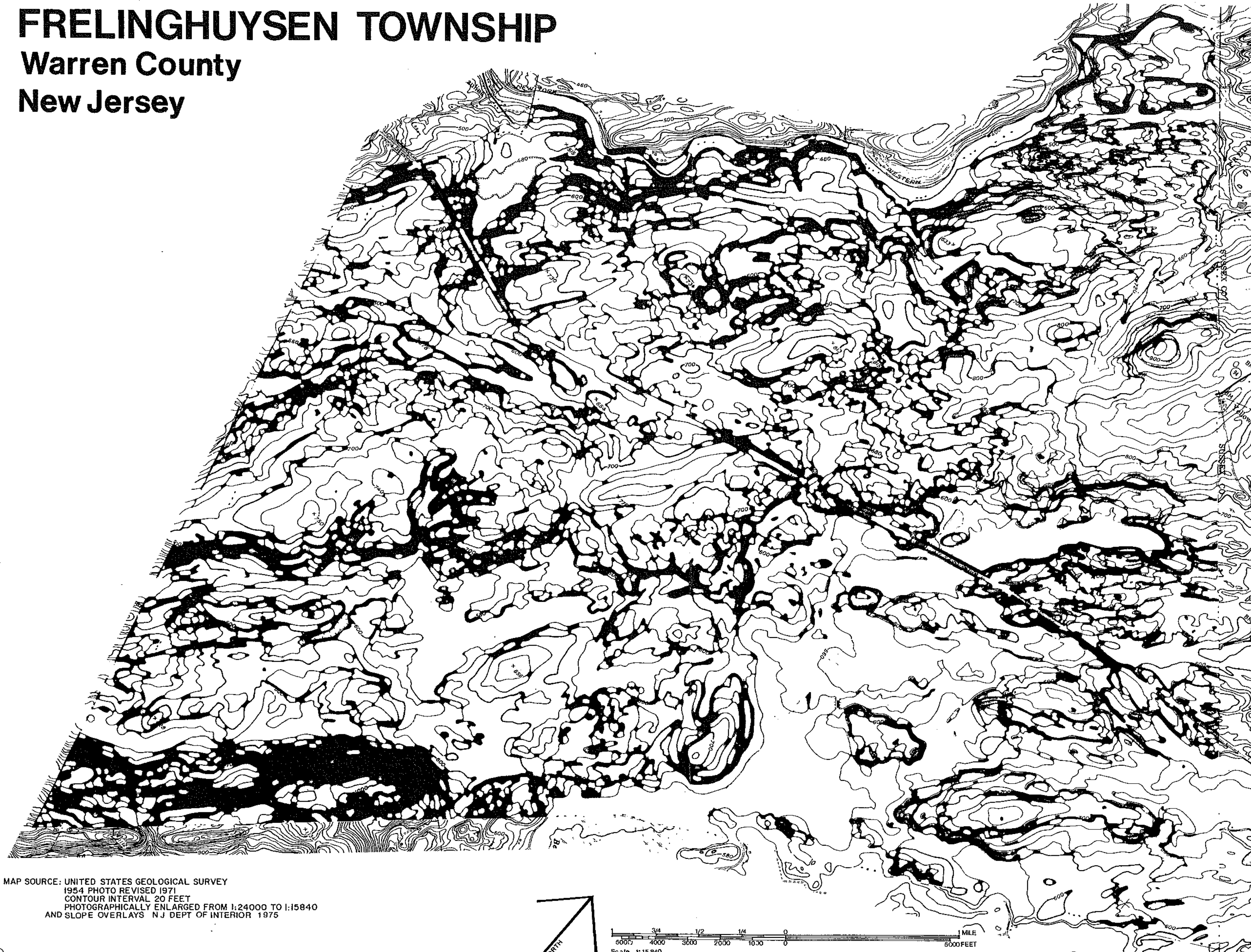
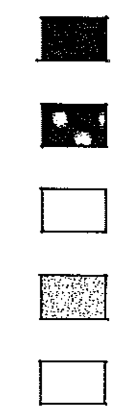
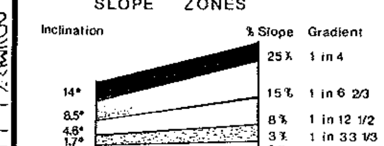


TOPOGRAPHY & SLOPES





MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840
AND SLOPE OVERLAYS N J DEPT OF INTERIOR 1975

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GEOLOGY, HYDROLOGY, AND SOILS

INTRODUCTION

An understanding of geology and soils and their interrelationship is crucial in determining the capability of land to support development. Both soils and geology affect the presence and movement of water, be it above or below ground. Available groundwater is the most important environmental consideration for development in an area such as ours where each person depends on well water supply.

Natural processes which continually change and adjust the surface of the earth and which have occurred since the beginning of time and will continue to do so, - with our without man - are described in the individual chapters on SOILS and GEOLOGY. Development without regard to these natural processes can speed up and interrupt these processes, often to the detriment of the environment and man. Engineering hazards to safe and economic development may result from preexisting natural conditions which occurred long before man's construction and urbanization, or they may occur as a direct result of such activities by the failure of geologic materials.

Listing just a few of these factors will readily show how geology, hydrology and soils will impact land-use decisions in many ways.

The **Soil** survey map identifies the location of soils within the township. The presence or absence of certain soil types gives information on the natural drainage class, stoniness, soil erodibility, engineering properties (such as the ability to support the weight of buildings and roads), available water capacity, runoff potential, and natural fertility (which determines the type of vegetation the soil can support and, therefore, agricultural productivity, shrink-swell potential, frost action potential, the presence or absence of organic matter, mineral resources and obvious wet areas).

The Geology maps (**Surficial** and **Bedrock**) identify rock formed long ago and underlying soils or exposed on the surface. The depth to bedrock affects building and sewage disposal location, the presence or absence of gravels and sands affects groundwater recharge and available water. The **Bedrock Geology** map also identifies areas of major faults in bedrock which have been, and may be again, earthquake zones. Geologic processes, which include soil formation, affect our physiography. For planning purposes, the most important aspects of physiography are elevation and slope, both strongly affected by climate and vegetation. These, in turn, affect erosion and sedimentation, natural processes which can be increased rapidly by man's activities.

Soils, rocks, climate, vegetation, elevation and slope all affect the *hydrology*, the movement and presence of water above and below the surface in the township. The **Surface Drainage** map reveals drainage patterns. Streams, brooks, ponds and lakes are indicators of our water table. Groundwater stored in rock formations below the surface continually moves towards surface water (the water table), unless trapped by impervious material. Changes in drainage patterns brought about by improper development can create downstream flooding and ponding in areas previously dry. Detention or retention basins located improperly can create new and unusual pressure on underlying geologic and soil formations and result in sinkholes where underground caves or caverns exist. Recharge areas of glacially deposited sands and gravels are easily polluted, making groundwater unusable to man.

This brief description of the interconnectedness of rocks, soils, water, and their effect on land use is explored in greater detail in the following chapters. All of them affect where and how much development can and should occur.

Major sources of information

Keller, Edward A., 1976. *Environmental Geology*, Charles E. Merrill Publishing Co., Columbus, Ohio.

(See additional references in Chapter 4: "Hydrology")

HYDROLOGY

Hydrology deals with the movement of water through the landscape both on the surface and in the ground. Groundwater is that water which fills all unblocked pores of material lying beneath the surface. Surface water is that which flows above ground. The why and how of the water cycle, or hydrology, can best be illustrated by the accompanying drawing (fig. 5). Depth to water table, water quality, aquifer yields, direction and rate of movement, and the location of wells are important ground water factors. Aquifers are located from the geology maps and are further explored in the chapter "Geology and Hydrogeology." The water from precipitation which is not used by plants or infiltrated to add to the groundwater, runs over the surface of the earth.

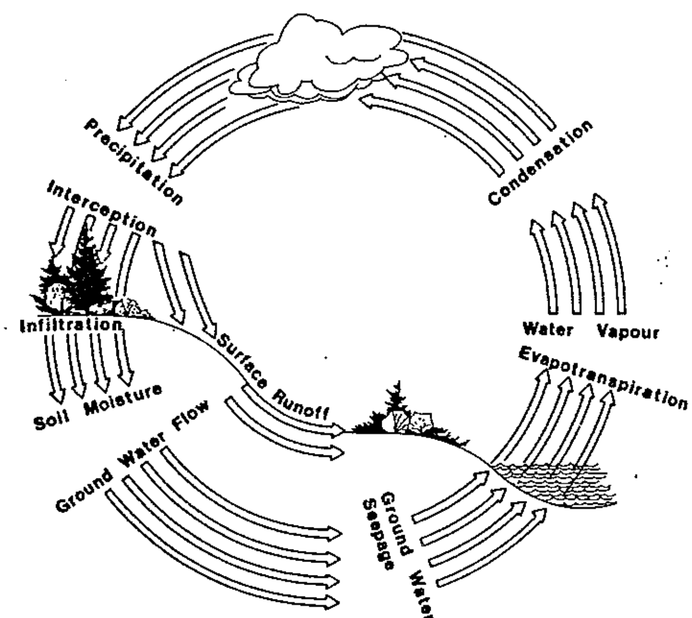


Fig. 5 - THE HYDROLOGIC CYCLE

The sun's energy transfers water from the sea and earth to the atmosphere in the form of water vapor, some of which is visible to us as fog. Evaporation from soil and inland waters adds large amounts of vapor but by far the largest amount comes from the oceans of the world. Man, animals, and machines add small amounts by means of respiration and combustion.

Air masses carry the water vapor across the earth and it condenses into precipitation. Depending on climate, season, and topography, the vapor falls back onto the earth as rain, snow, sleet and hail. Some of this water is intercepted by plants, buildings, roads, and other structures until it evaporates back into the atmosphere. Most of the water soaks back into the soil and is used by plants as it percolates past their root systems, deeper to the water table, to underground reservoirs and to springs and artesian wells. The part that does not soak into the soil, runs off the ground and to the sea by way of streams and rivers. Grass, trees and other plants hold soil in place and slow the run-off, allowing more water to soak into the ground. Run-off, on its way to the oceans, can be intercepted and stored in reservoirs for industrial and household use as well as irrigation. The motion of the water under and over the ground surface is dependent on the characteristics of the individual watershed. The water cycle prevails in all places and at all times with neither beginning nor end - little water has been added or lost through the ages, only the distribution has changed.

A watershed is a unique physical entity. It is bounded by the terrain, and, therefore, influenced by topography. Soil conditions, the type of rock both above and below the ground, as well as vegetation, stream patterns, and the amount and kind of development affect how water flows through a watershed - whether above or below ground, whether fast or slow.

The depth of the water table below the surface changes in relation to the amount of recent precipitation. Below the water table, the soil is saturated. Once water reaches the zone of saturation it tends to flow laterally, usually following the general contours of the landscape above, until it reaches a lake, pond, stream or river. This groundwater generally flows very slowly through the soil in comparison with surface run-off, thereby equalizing water availability during dry periods. When water from a rainstorm finally reaches a stream, it flows down the channel until it joins a larger stream or river and then the sea.

A stream that drains an undeveloped watershed, or one which has been carefully developed, will be in balance with normal amounts of rainfall and flood only occasionally. If the retentive capacity of the watershed is lowered by increases in impervious landcover (e.g. roads, roofs, parking lots), and no provision is made to detain and slowly release both normal and flood waters, low and high flow levels will be changed. The frequency and height of floods may increase. Streams may be lower or run dry during periods of drought and overflow their channels quicker during heavy rainfall. As has already been stated, the water running in streams can be intercepted in reservoirs but a less costly method is to let as much as possible soak into the ground where it will be stored in fractures and fissures in bedrock.

As a result of all of the above factors, a particular raindrop that falls on the ground may remain in the watershed a second or so if it evaporates from a hot roof or paved surface, a month as it flows down-channel to the sea, or many tens of years from the time it infiltrates into the soil until it is released from or pumped out of a storage area in bedrock far below the earth's surface. Regardless of how water is detained, eventually it enters the cycle above the surface again.

Research hydrologists have estimated that the world's water supply - liquid, frozen and vapor - totals about 330 million cubic miles. If this amount were poured upon the 50 states, the land surface would be submerged to a depth of 90 miles. The fact is that 97.2% of all water in the world is in salty oceans, and 2.15% is frozen in Antarctica and Greenland. Thus man must get along with less than 1% that is directly available to him for fresh water use. Of that amount .62% is below the earth's surface and only .02% is surface water.

Water levels rise in wet periods and decline in dry periods. In areas not heavily pumped water levels average about the same as in the past. Scientists have told us that the total supply of water in the hydrologic cycle has remained the same for billions of years. So why worry? Since 1960 groundwater withdrawals have doubled, creating severe problems of supply in many areas. Contamination from residential, agricultural, industrial and commercial activities has rendered many existing supplies unusable. Diverting streams, draining wetlands, and paving for roads and parking lots change the location and amount of water absorption and, eventually, the recharging of the aquifer. Development is creating unprecedented demands on ground water. This can lead to depletion or lowering of the water table to a depth where its extraction becomes economically unfeasible. Another serious side effect of groundwater overdraft is land subsidence which may occur in areas of limestone. When large volumes of water are extracted from an aquifer without sufficient recharge, the decline in pressure allows particles of rock to settle together, eventually resulting in the development of sinkholes. Sinkholes are of concern because their collapse usually happens suddenly, often causing property damage and, sometimes, injuries or even death to humans and animals.

In New Jersey, water is managed through a statewide Water Supply Master Plan (adopted in 1982). The use of water is regulated by a series of both federal and state laws. None of these laws provide for adequate monitoring. Warren County does not have a 208 Water Quality Management Program, Frelinghuysen Township does not have a Waste Water Management Plan or a Ground Water Management Plan.

Several streams and brooks in the township have been classified by the New Jersey Dept. of Environmental Protection, Division of Water Resources, as having significant value as trout production (FW2-TP) or trout maintenance (FW2-TM) waters:

Pequest River Drainage

Bear Brook - FW2-TP (Category One Waters)	entire length
Bear Creek - FW2-TM	entire length

Paulins Kill Drainage

Paulina Creek - FW2-TM	entire length
Paulins Kill - FW2-TM	specified lengths

Municipalities are encouraged to recognize trout waters and their watersheds as a valuable natural resource worthy of protection. Recommendations include:

- Protection of trees and other vegetation within fifty feet of either bank of trout waters;
- Stringent Soil Conservation Service review of erosion control measures for projects which may adversely affect trout waters.

It is obvious that, for land-use purposes, Frelinghuysen Township will need to address itself to the management of both surface and groundwater through its Master Plan and Zoning Ordinance while there is still time to implement the best management practices to protect this finite and most valuable resource.

Major sources of information

Heath, Ralph C., *Basic Ground-Water Hydrology,* U.S. Geological Survey Water-Supply Paper 2220.

U.S. Environmental Protection Agency, *Ground Water Handbook.* EPA/625/6-87/016. Washington D.C. 1987.

Waller, *Ground Water and the Rural Homeowner,* U.S. Department of the Interior, Geological Survey, U.S. Government Printing Office: Wash. D.C. 1989.

Getting It All Together (see General References).

American Forestry Association, *Groundwater-Buried Treasure;* American Forests, August 1984. Washington D.C.

Concern, Inc., *Groundwater-A Community Action Guide,* Washington D.C. 1984.

Sussex County Planning Office, *Groundwater Management and Protection Manual,* Newton, N.J. 1983.

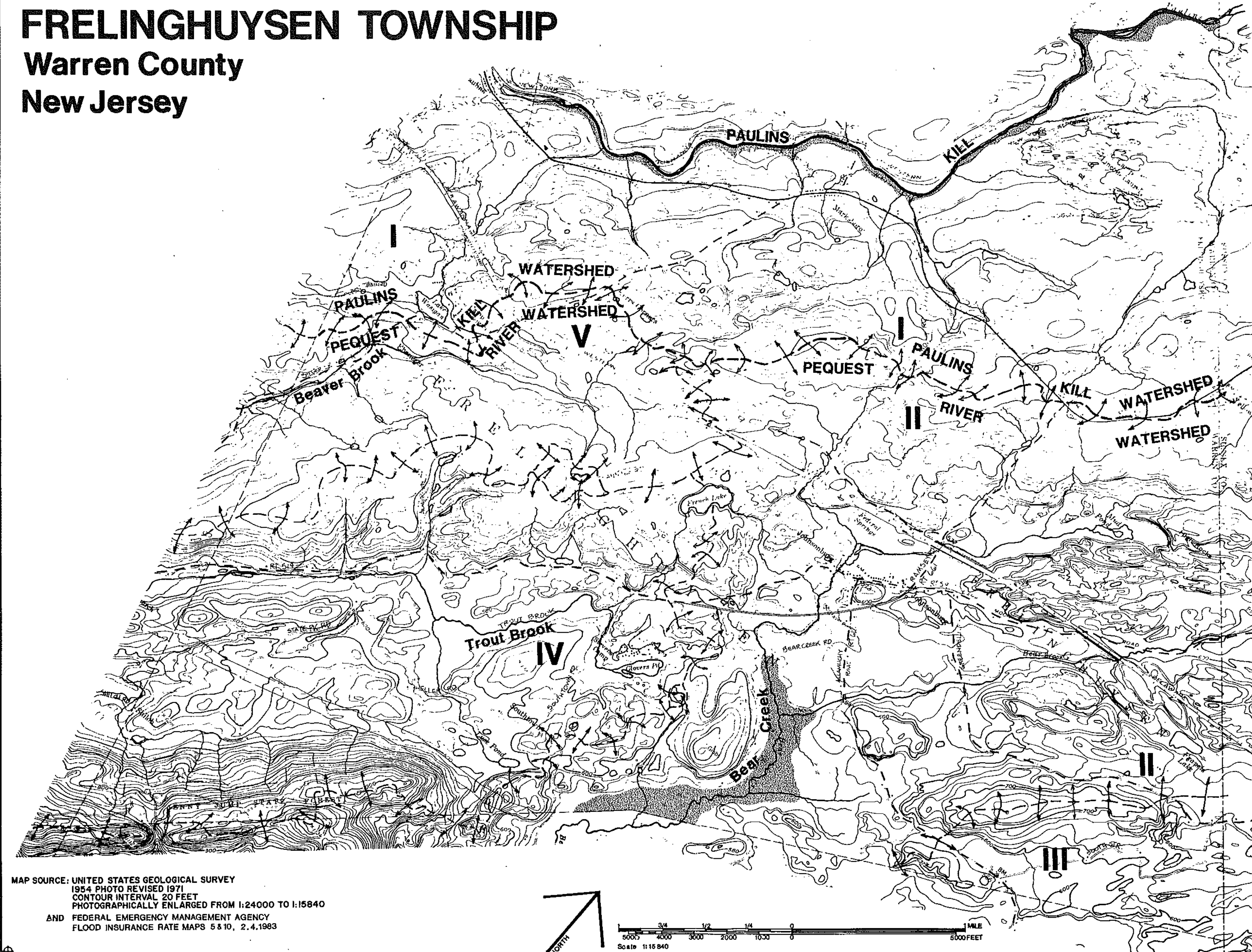
N.J.D.E.P. *Classification of New Jersey Waters as related to their suitability for trout.* Division of Fish, Game and Wildlife, Jan. 1988

N.J.D.E.P. *Statewide Water Quality Management Program.* Division of Water Resources, Dec. 1985

FRELINGHUYSEN TOWNSHIP

Warren County

New Jersey



SURFACE WATER

Sub Watershed Boundaries

I Paulins Kill Drainage
II Bear Creek "
III Pequest "
IV Trout Brook "
V Beaver Brook "

DRAINAGE DIVIDE
PERENNIAL STREAM / FREEFLOWING
PERENNIAL STREAM
INTERMITTENT STREAM / DRAINAGE CHANNEL
OPEN WATER
100 YR. FLOOD BOUNDARY

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

AND FEDERAL EMERGENCY MANAGEMENT AGENCY
FLOOD INSURANCE RATE MAPS 5 & 10, 2.4.1983

NORTH

Scale 1:15 840

ENVIRONMENTAL RESOURCES INVENTORY prepared December 1986 by the ENVIRONMENTAL COMMISSION

GEOLOGY AND HYDROGEOLOGY

GEOLOGIC HISTORY

Geology is the scientific study of the earth, including the materials of which it is made and the processes that have changed and continue to change it. The geologic history of the earth spans more than 5 billion years. Because of this great age, we tend to think of geology as something of the past. The earth's geological processes are at work constantly. These processes, and the rocks, soil and water they have formed, affect our ability to rely on the earth as a means of life support. Therefore, by understanding the geology of Frelinghuysen Township, we can better appreciate the ability of the geologic resources of the township to support a human population. (fig. 6)

Frelinghuysen Township's geologic history is long and complex. Its rocks record evidence of at least three major episodes of mountain-building. Warm, shallow, tropical oceans, deep oceanic trenches, and frigid arctic environments are all recorded in the rock formations shown on the geologic maps of the township. The geologic processes that formed the rock formations which occur in the area have produced an environment with great variety, and one that shaped human habitation of the region. Deep, rich limestone soils; steep, rocky, cavernous limestone outcrops; cool springs and perennial swamps; and rolling, thinly veneered hills of shale are all the product of the township's unique geologic history. Each one of these environments presents "built-in" limitations to human exploitation.

The geologic history of the township has its beginnings more than 1.5 billion years age, during the Proterozoic Epoch of the Precambrian Era. The resistant bedrock that forms Jenny Jump Mountain consists of igneous and metamorphic rocks with a long and complex geologic history. These Precambrian rocks were once sandstones, shales, limestones and volcanic rocks, that subsequently became buried deep within the earth, and formed the roots of mountains as high as many of the present great mountain ranges. As they were buried, these ancestors of our present granitic rocks were subjected to immense heat and pressure. These extreme forces altered, or even melted, the Proterozoic rocks, resulting in the present-day granites and granite gneisses that make up Jenny Jump Mountain. The crystalline rocks were later exhumed during other mountain-building events, which also affected the Paleozoic limestones and shales.

The next period of geologic activity in the region consisted of the formation of a major ocean basin. The history of the ocean basin started with the formation of shallow, warm seas in which limestone reefs and lagoon-like mudflats predominated. In another part of the same ocean basin, deep trenches formed in which large amounts of sediment accumulated rapidly.

The warm tropical sea was the origin of the rocks we now know as the Kittatinny Limestone. A period of sea level decline or emergence of the sea floor marked the end of the formation of the Kittatinny, recorded geologically by an interval of significant erosion of the limestone. The emergence and erosion of the Kittatinny Limestone was followed by the deposition of the Jacksonburg Limestone, which marked the reestablishment of the ocean basin. Deposition of the Martinsburg Formation shales tells of the subsequent rapid deepening of the ocean basin, when shallow conditions favorable to the formation of the limestones no longer prevailed in what is now New Jersey.

The immense thickness of the Martinsburg Formation (more than 20,000 feet), records a period of rapid deposition in a deepening ocean. Near the end of this deposition, more than 400 million years ago, the ocean basin occupied a place where great plates that make up segments of the earth's crust were beginning to converge. These crustal plates, like great ice flows that collide in an arctic thaw, collided, creating what is known as the Taconic orogeny or mountain-building episode. The wide ancient ocean basin, piled thick with the limestone of the Kittatinny and the shale of the Martinsburg, was caught up in the collision between the plates. The sediments formed in the ocean were in this way raised up above sea level.

The Taconic Orogeny squeezed the thick accumulation of shale and limestone and folded and uplifted them. Some of the folds created in this process are recorded in the rocks today. The folding process created weakened areas in the semi-brittle sediment, some of which were probably later reflected in the joints and fractures we see today.

As geologic processes are often cyclical, the region went through another period of ocean basin formation, deepening, and closing, which culminated about 225 million years ago in what is known as the Appalachian Orogeny. This last mountain-building episode imposed further stresses on the bedrock in the area, resulting in more folds, and many faults. Some of these faults of suspected Alleghenian age (such as the Jenny Jump Thrust, Reprinted with permission Crane, Russak and Company, Inc. publishers.

Geologic Time Scale

MILLIONS OF YEARS AGO

TIME SCALE	ERA	PERIOD	THE FOSSIL RECORD	ASSOCIATED DEVELOPMENTS
PRESENT	CENOZOIC	Quaternary	Rise of man	The great ice sheets
50		Tertiary	Rapid rise of mammals First primates	Advance and retreat of the Tertiary seas on the New Jersey Coastal Plain
100	MESOZOIC	Cretaceous	First flowering plants Extensive flooding, some continents subdivided into islands	Sea floor spreading advance and retreat of the Cretaceous seas modern geosynclinal deposition
150		Jurassic	Age of Dinosaurs	North America and Africa drifting apart Palisades disturbance Watchung lava flows Palisades intrusions Opening of the modern Atlantic Ocean basin, sea floor spreading Newark rift valley formed in the Piedmont Lowlands
200		Triassic	First mammals	
250	PALEOZOIC	Permian		Final closure of the Proto-Atlantic Ocean basin, collision of North America with Africa and Europe Valley and ridge Appalachian Mountain orogeny
300		Late Carboniferous (Pennsylvanian)	Great fern forests, formation of wide-spread coal deposits	Continental environment with extensive erosion—deposition
		Early Carboniferous (Mississippian)	Earliest reptiles	
350		Devonian	Amphibians venture onto land Age of fishes	Marine environment Deposition in Appalachian geosyncline Acadian continental collision
400		Silurian	First vertebrates	Marine deposition Appalachian geosyncline Taconic-Mt. collision
450		Ordovician		Opening of the Proto-Atlantic Beginning of sea floor spreading Marine deposition in Appalachian geosyncline continents drifting apart Grenville Collision New Jersey Highlands
		CAMBRIAN 570 million years ago	SHELL FISH TRILOBITES	
PRECAMBRIAN 570 million to over a billion years ago			PRIMITIVE LIFE	

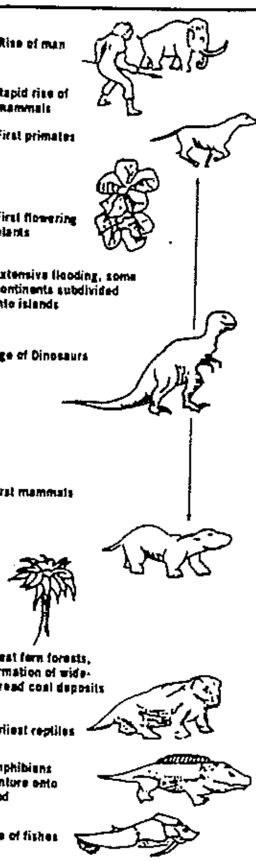


Fig. 6 - GEOLOGIC TIME TABLE from *The Geology and Landscapes of New Jersey,* Peter E. Wolfe (see references)

the Shades of Death Thrust, and the Tranquility Thrust) and shown on the **Bedrock Geology map**, are significant. These major faults may have important implications with regard to the occurrence of ground-water, radon gas, and earthquakes. In addition, many smaller faults formed at the same time, some of them off-shoots of major faults. These faults often serve as significant zones of ground-water circulation, and may enhance the water-bearing capabilities of nearby rocks.

The final geologic episode of note that shaped the township was a period of glaciation known as the Pleistocene Epoch. During the past two million years, New Jersey has undergone at least two, and probably three, advances of glacial ice sheets. The last glacier to occupy New Jersey, the "Wisconsin" glaciation, reached its maximum extent approximately 20,000 years ago (fig. 7).

The advance and subsequent retreat of the Wisconsin glacier, left a variety of unconsolidated sediments over the landscape. These glacially formed or surficial deposits are shown on the map entitled Surficial Geology. The type of sediments left behind the advance of the ice (glaciation) and its retreat (deglaciation), influence the present environment. The physical properties of these glacial deposits are a function of how the sediments were released from the ice during advancement and retreat.

At the end of the Wisconsin glaciation, large glacial lakes were formed by glacial meltwater that became trapped in closed basins caused by ice dams or dams in combination with mountains. The remains of these glacial lakes consist of silt, clay and fine sand, and are often found under the great swamps in the area, such as Great Meadows or Bear Swamp.

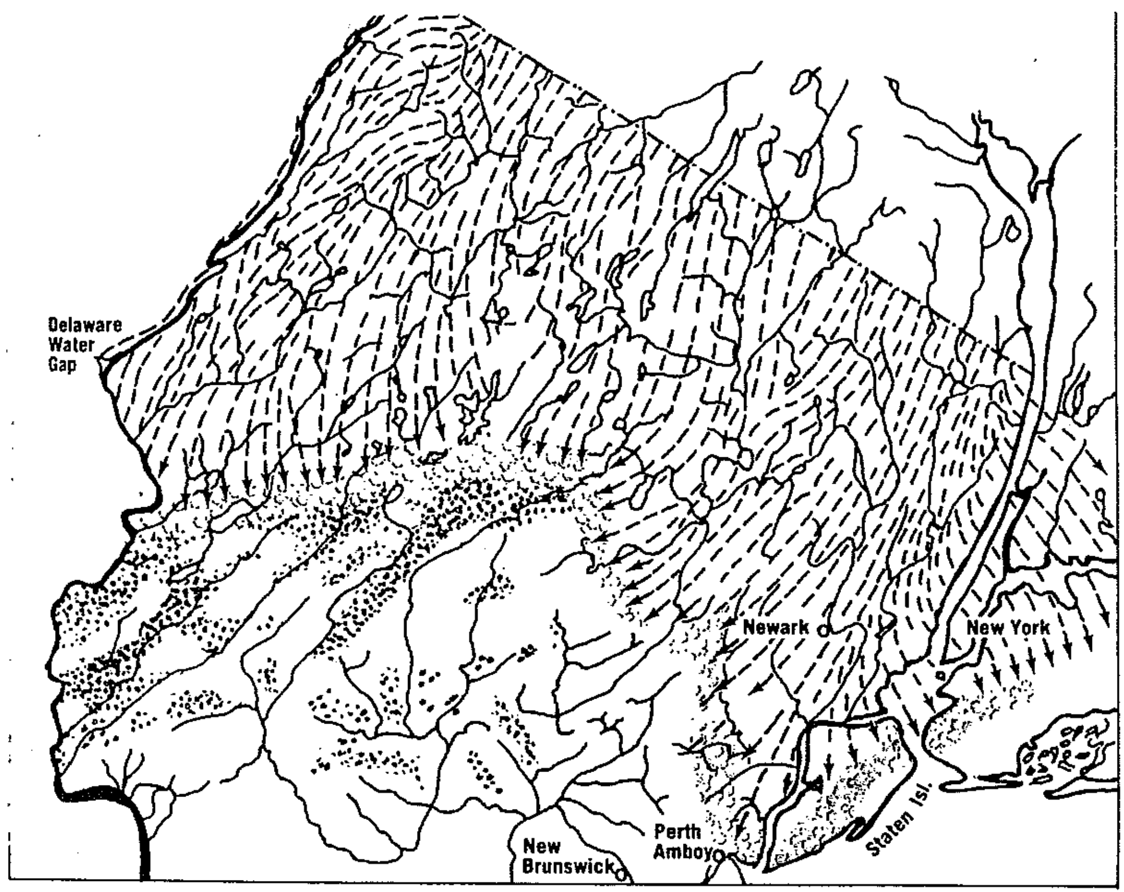


Fig. 7 - Map showing areas covered by the Wisconsin ice sheet (from *The Geology and Landscapes of N.J.*, Peter Wolfe)

Upland areas are draped with glacial till, an unsorted mixture of sand, clay and boulders deposited directly from glacial ice. Valleys are filled in places with thick accumulations of sand and gravel released and sorted by meltwater streams emanating from the melting glacier. These sand and gravel glacial outwash deposits are important sources of construction material and, where they are thick, form productive aquifers or serve as important recharge areas for underlying bedrock aquifers.

The various geologic processes described above left their mark on the landscape of Frelinghuysen Township. Mountain-building and differences in the resistance of the bedrock to weathering and erosion processes have controlled the location of valleys, hills and mountains. Glacial advances have modified the contours on the bedrock surface, stripping it of soil in places and piling up thick accumulations of sediment in other places.

The various forces that have broken and subsequently weathered the bedrock, have controlled the movement of water through the rock formations and, therefore, the availability of water to wells. The glacial processes have determined whether the unconsolidated overburden atop the bedrock permits rapid infiltration of precipitation or retards infiltration. The resultant topography has shaped the network of streams that drain the landscape.

HYDROGEOLOGY

Frelinghuysen Township is host to a variety of geologic settings. Two Physiographic Provinces are represented: (1) the Reading Prong of the New England Province, which in New Jersey is called the New Jersey Highlands, and; (2) the Kittatinny Valley, which is contained within the Appalachian Valley and Ridge Province. Each of the two provinces is characterized by particular geologic formations and geographic features (fig. 8).

Only a small part of the southern portion of the township lies within the Reading Prong, and most of this is contained within Jenny Jump State Park. This region is underlain by granitic rocks and is characterized by a rocky terrain, steep slopes, marshy depressions, bouldery,and generally poorly drained soils. Since soil formation is a function of the underlying parent rock and climatic conditions, soil types associated with the granitic formations are not found elsewhere in the township.

The crystalline upland is a source of runoff for the Trout Brook valley, and, therefore, the quality of the water draining from Jenny Jump mountain affects water quality within lower lying parts of the township. Surface and groundwater that originate in this granitic terrain are generally moderately soft, with a moderate ph (6-7), low dissolved solids and often moderate to high concentrations of iron and/or manganese.

The largest part of the township lies within the Appalachian Valley and Ridge Province. This Province is underlain by sedimentary rocks of Paleozoic age and includes limestone, siltstone, sandstone, and shale. Geologic structures and the resistance of the various sedimentary rocks to weathering and erosion have formed a landscape in this Province consisting of alternating linear valleys and ridges. Naturally, those rocks that are more resistant to erosion, such as sandstone and shale,form the ridges, while rocks more susceptible to erosion, such as dolomite and limestone, occupy the valleys. Soil cover is usually a function of the topography with thin soils found on ridges and deeper soils in valleys.

Within Frelinghuysen Township two bedrock units represent the Valley and Ridge Province; these are the Kittatinny Limestone and the Martinsburg Shale. Therefore, in keeping with the concept that terrain is related to resistance to weathering and erosion, limestone usually underlies the lower elevations while shale, siltstone and sandstone, form the higher elevations.

Kittatinny Limestone Supergroup

The Kittatinny Limestone can be subdivided into five separate formations, all of which are found in the township. The individual formations within the Kittatinny Group include the Leithsville, Allentown, Rickenbach, Epler, and Ontelaunee Formations.These formations are described in Table I. Underlying the Kittatinny is the resistant Hardyston Sandstone, while at the top of the Kittatinny is another limestone, the Jacksonburg Limestone.

The Kittatinny Limestone formations consist mostly of dolomite, a more resistant form of limestone which contains magnesium as well as calcium carbonate. This Dolomitic limestone is harder than pure limestone, but exhibits hydrogeologic traits. Caverns, sinkholes, undrained depressions, disappearing streams and springs are common in the Kittatinny terrain.

Within the Kittatinny, group formations that contain the coarsest dolomite grains have undergone the most severe weathering. The formations most susceptible to weathering include the Leithsville, the lower part of the Allentown, and the Rickenbach Formations. These formations constitute the most prolific carbonate aquifers and have the greatest number of caverns, sinkholes, springs, bedrock pinnacles, and other "karst" features, thereby making limestone valleys a very sensitive environment (fig. 9).

The carbonate formations that are less susceptible to weathering include the upper Allentown, Epler, and

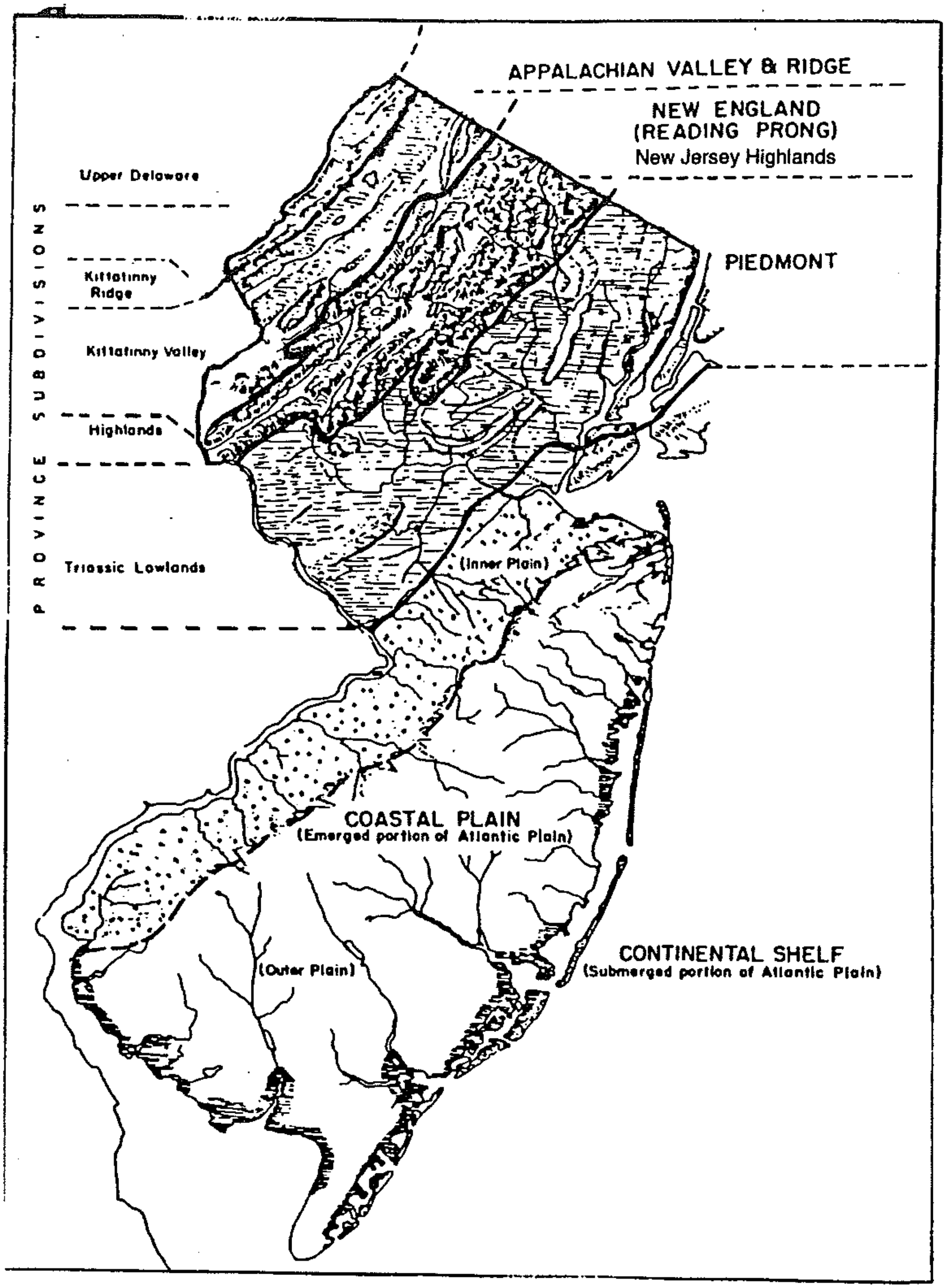


Fig. 8 - Map of the geomorphic provinces of New Jersey. (from *The Geology and Landscapes of New Jersey,* Peter E. Wolfe. see references)

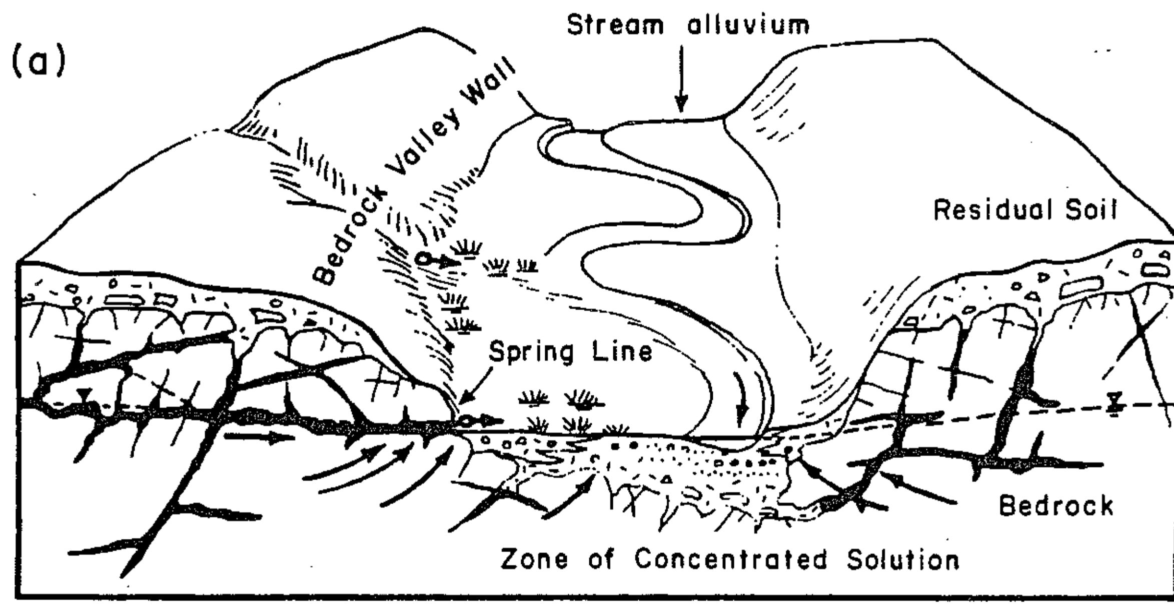


Fig. 9 - Hydrologic features of limestone valleys. (Parizek, 1971.)

Ontelaunee Formations. While sinkholes, caves and other karst features are found within these formations, environmental limitations associated with more resistant carbonate formations include steep slopes, small sinkholes, thin rocky soil, and poor ground-water yields. Within the Kittatinny Valley, the Leithsville, lower Allentown and Rickenbach Formations tend to underlie stream valleys, marshes, and floodplains; while the upper Allentown, Epler, Onteluanee and Jacksonburg Formations make up the more elevated terrain.

The topography, ground-water yield characteristics, and environmental limitations associated with the various carbonate formations within the township are outlined in Table II. These are general traits that help one to understand the potential for development atop these formations with its associated risks to the environment.

Martinsburg Shale

The Martinsburg Shale is found predominantly in the northern and western parts of the township. It forms the rolling, hilly terrain that divides the Paulins Kill and Pequest Valleys. The Martinsburg terrain is characterized by moderate to steep slopes, frequent bedrock outcrops, thin soils, and shallow - sometimes marshy - valleys.

The Martinsburg Shale in New Jersey can be divided into two distinct units, or members, known as the Bushkill and the Ramseyburg Members. Both are found within Frelinghuysen Township, although they are not represented separately on the accompanying geologic map. The Bushkill Member of the Martinsburg Shale consists mainly of claystone slate, a shale-like rock, and is found in the central to north-central part of the township. The Ramseyburg Member contains mostly siltstone and sandstone, and occupies the northernmost section of the township within the Paulinskill Valley. The Ramseyburg is the more resistant of the two members and, therefore, occupies the highest elevations.

The shale does not normally provide high ground-water yields to wells, although there have been prolific wells completed in the Martinsburg where geologic structure has caused extensive fracturing of the rock, such as near faults and folds. Because of recent requirements for longer well casings to protect against well contamination by septic effluent, and because of the well-drilling methods that are now commonly employed, well yields for recently drilled wells may be lower than yields reported from some of the wells drilled several years ago. Deeper well casings prohibit water within the upper, weathered portions of the bedrock from entering the well. This practice requires that water be obtained from fractures deeper within the rock aquifer; fractures generally decrease with depth (fig. 10).

The Topography and ground-water yields associated with the Martinsburg Shale are described in Table IV.

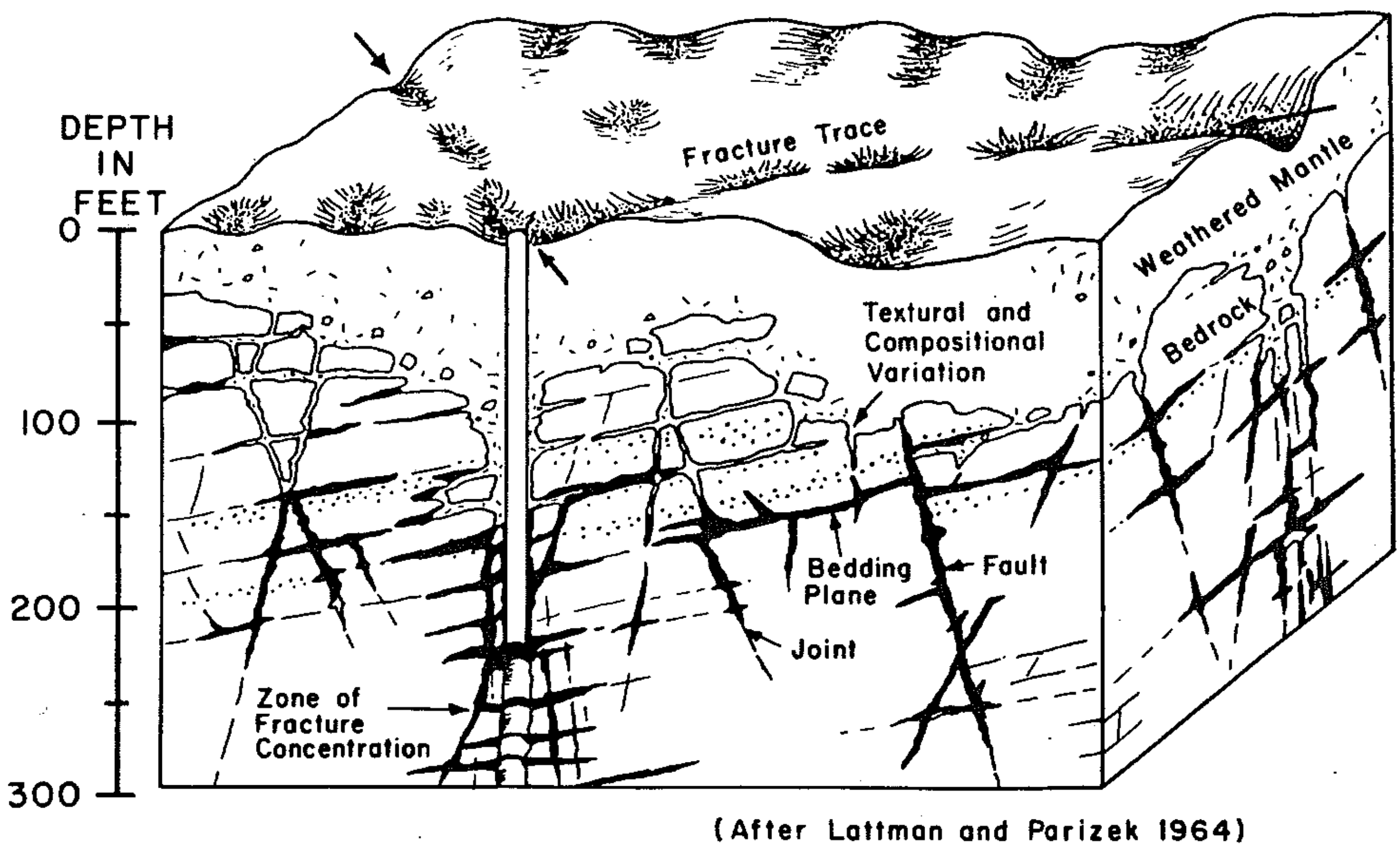


Fig. 10 - Block Diagram showing geologic factors that may account for cavern distribution.

(Table IV)

Geologic Unit	Occurrence/Topography	Hydrologic Characteristics
Martinsburg Shale Omb	Upper (Ramseyburg) member forms prominent ridges, with abundant rocks ledges, thin, coluviated soil cover, with isolated pockets of glacial drift. Valleys are usually long and narrow, Member forms smooth, rolling hills and underlies poorly drained valleys. Soil cover thin (less than 15 feet) to absent, with local deposits of glacial drift up to 50 feet thick.	Well yields generally prove to be adequate for domestic needs, with most wells exceeding 3 gpm. Yields often improve with proper well development or stimulation.Some very good well yields with poor drainage.Lower (Bushkill) near faults and near fold axes; yields of 100 gpm have been reported. Thick overburden may help contribute to good sustained yields. Most water-bearing seams shallower than 200 feet, with some seams up to 400 feet deep.
Jacksonburg Formation Ojb	Forms subdued topography between rock Kittatinny terrain and smooth, rolling Martinsburg terrain. Outcrops infrequent, but soil cover may be thin. May receive significant runoff from adjacent units. Locally thick deposits of drift up to 30 feet thick may occur.	Yields generally poor to moderate, 5 to 20 gpm, but generally adequate for domestic supplies; most wells exceed 10 gpm. Yields tend to be higher in lower part, with occaisional yields of 100 gpm.
Ontelaunee Formation Oo	Forms an irregular, hummocky to rocky, terrain with bedrock exposures. Soil cover generally thin to absent, but thicker in depressions.	Yields poor to moderate, with better yields in lower member. Frequent dry holes and very marginal wells in upper (Harmonyvale) member. Yields may range from poor to fair (3 to 20 gpm) in lower
Epler Formation Oe	Forms a steep, elevated rocky terrain with many bedrock exposures. Typical limestone "pinnacle-and-trough" topography, with thin soil in shallow depressions and intervening rocky pinnacles.	Yields range from poor to fair, 1 to 20 gpm. Yields improve near top and bottom of formation, orwhere blue limestone facies is present. Yields particularly poor where strata are steeply inclined.
Rickenbach Formation Or	Forms a subdued topography that increases in relief toward overlying Epler Formation. Chert blocks in upper (Hope) member form rocky pinnacles. Many sinkholes, marshes and undrained depressions and springs in upper member; largest sinkholes in state occur in this unit. Lower (Lower Rickenbach) member is subdued with frequent, small rock exposures and thin to moderately deep soil cover. Sinkholes somewhat common, springs may occur.	Yields range from poor to good. Yields better in upper (Hope) member, with most wells yielding 10 to 50 gpm, but highly variable. Yields in lower member poor to fair, 3 to 20 gpm, with occaisional good yields near upper member. Locally yields reported as high as 200 gpm.
Allentown Formation Ca	Highly variable topography. Upper (Upper Allentown) member forms irregular, steep, rocky terrain with bedrock pinnacles and shallow soil cover in intervening depressions. Numerous small sinkholes may occur. Lower (Limeport) member forms benched topography, with lowest units underlying stream valleys or wetlands, and middle and upper units forming rocky terraces with shallow to moderate soil cover and subdued rocky exposures. Numerous large springs and sinkholes occur in lower member, with largest springs in state occuring here.	Yields highly variable. Yields in upper member poor to fair, 3 to 25 gpm, with occaisional dry holes; most wells barely adequate for domestic needs. Yields in lower member good to prime, with most wells yielding between 10 and 50 gpm. Frequent wells in lower member in excess of 100 gpm, with some yields exceeding 500 gpm.

(Table IV) *cont.*

Geologic Unit	Occurrence/Topography	Hydrologic Characteristics
Leithsville Formation Cl	Variable topography. Upper (Walkill) member underlies stream valleys and marshes. Soil cover shallow to deep, usually with shallow water table. Middle (Hamburg) member forms topographic high separating lower and upper members. Hamburg terrain often a prominent ridge, sometimes steep, with shaley rock exposures or thin soil cover on dip slope. Lower (Califon) member rarely exposed, forms shallow depression with moderate to deep soil cover. Many sinkholes in lower unit.	Well yields range from moderate to prime, depending on unit encountered. Yields in lower and upper members good to prime, with typical yields from 10 to over 1000 gpm. Yields in middle member tend to be significantly lower, with some good yields of 50 gpm where conditions are favorable.
Hardyston Sandstone Ch	Forms smooth topographic bench at base of granitic uplands. Soil cover thin to moderate.	Well yields tend to be poor, with few wells finished in this unit.
Precambrian granitoid gneiss Pc	Forms prominent ridges with rocky prominences. Soil cover thin, often containing significant boulders. Colluvium is often thick on mountain flanks.	Well yields vary, depending on geologic unit encountered and geologic structure. Layered gneisses often more prolific than massive granitic units. Proximity to brittle faults may affect yield greatly.

TABLE IV. BEDROCK GEOLOGICAL UNITS, PHYSIOGRAPHY, AND HYDROLOGIC CHARACTERISTICS OF ROCKS OF FRELINGHUYSEN TOWNSHIP.

BEDROCK GEOLOGY AND LAND USE

Bedrock is a general term for the rock which is usually solid and underlies the soil or other unconsolidated surface material. If it is exposed on the surface, it is referred to as "outcrop". Basic rock strata that can be separated from other types by their age and composition are usually named after the locality where they were first found, such as the Allentown Formation, first identified in Allentown, Pennsylvania.

The **Bedrock Geology** map also shows faults, a structural characteristic of rocks that is formed when breakage and movement occur. There are many faults in Frelinghuysen, most of which are inactive at this time. Active faults are found in the region though, as evidenced by the many small earthquakes recorded in the surrounding areas, such as near Tranquility to the east.

In terms of land use, bedrock geology is important in that it controls where ground water occurs and determines stability of the environment. For instance, there are many unstable features associated with the Kittatinny Limestone, such as sinkholes and caves, that are the result of chemical and physical weathering. Bedrock geology thus helps us plan where to locate wells for water supply and where to exercise caution in undertaking construction. (fig. 11)

The chemical characteristics of the various bedrock types are important because they control the quality of the ground water found in them, and other important factors such as the occurrence of radon gas. The latter is usually associated with Precambrian granitic rocks, but is known to occur in the limestone and shale in other areas of New Jersey.

Pleistocene Surficial Deposits

The bedrock surface of the township has been modified by glaciation, as described above. The **Surficial Geology Map** shows the various types of glacial drift left by the advance and retreat of the last glacier to occupy New Jersey, The Wisconsin Ice Sheet.

deposits of stratified drift are found in the Paulins Kill Valley, and in the central part of the township in the vicinity of Johnsonburg, where they overlie limestone bedrock.

Poorly drained glacial *drift* includes glacial lake-bed deposits, glacial till and swamp deposits. Glacial lake-bed sediments were deposited downstream of melting ice, in

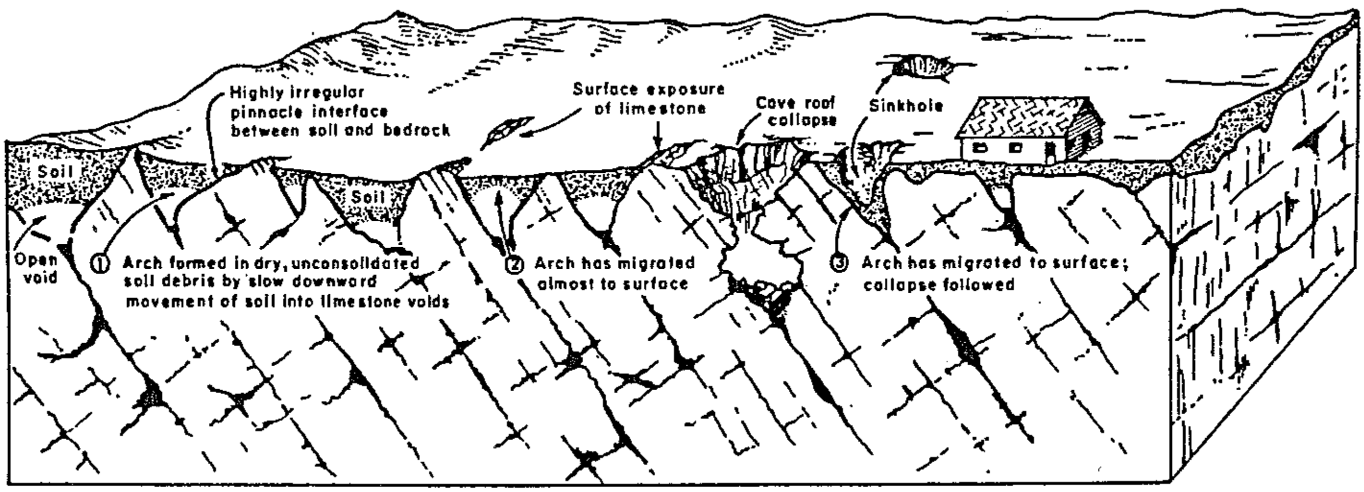


Fig. 11

Glacial deposits, or *drift*, are categorized on the basis of their dominant texture which are a function of the processes that formed the deposits. Meltwater carrying rock particles from the retreating glacier deposited coarse sediments, known as stratified drift, in high-energy environments such as streams and deltas, and fine-grained sediments in low-energy environments such as lakes, ponds and swamps. Deposits laid down directly by the ice in the absence of meltwater are heterogeneous and are labeled glacial *till*.

Stratified drift deposits are well sorted, tend to lack clay and silt, and are well drained. These deposits form prolific aquifers where they are sufficiently thick. Stratified drift permits good infiltration of water and serves to store ground water, often contributing large volumes of high-quality recharge to underlying bedrock aquifers. The well drained soils in the township are most often developed atop stratified drift deposits. The water table is often moderately deep in these deposits. The most significant

low-energy environments where fine silt and clay were permitted to settle out. These fine lake-bed sediments often underlie better drained stratified drift deposits, which often cause springs to form at the base of the sand and gravel deposits. The fine sediments also underlie the larger swamps in the region. Although thick in places, glacial lake-bed deposits do not constitute prolific aquifers but may supply water to some wells. Ground water in these sediments is often of objectionable quality due to a high content of organic material as well as high iron and sulfur concentrations in lake-bed sediments.

Glacial *till* is material deposited by gravity from the glacier as debris. Till deposits in the township are usually thin, although, in places, till may reach 25 feet in thickness. Till generally has a high clay content and, usually, a high percentage of gravel. The high clay content and poor grain-size sorting within the till reduce its permeability. This causes poor internal drainage and, often, a shallow seasonal water table within a few feet of ground surface.

(Table V)

Unit	Description	Hydrologic Characteristics
Qsd where	Glacial outwash, deposited mostly as deltas in glacial lakes (glacio-lacustrine deltas), or between the glacier and the valley walls, (kame terraces) or in channels within the glacier. Consists of cobbly pebble gravel, pebble gravel, pebble sand, coarse sand and, sometimes, silty sand. Usually well-sorted and stratified. Generally 20 to 50 feet thick, may reach thicknesses of up to 100 feet. Forms significant terraces in Paulins Kill valley. Forms isolated moderate to low profile landforms elsewhre. Often deposited atop finer glacial lake bed sediments (Qlb below).	High to moderate permeability. Constitute aquifers suitable for community and/or domestic needs sufficiently thick. Provide significant storage and recharge for underlying bedrock aquifers.
Qlb	Glacial lake bottom deposits, composed of laminated sand, silt and clay. Very flat surfaces, generally covered by peat. Generally 30 to 50 feet thick, but may exceed 100 feet in places.	Very low to low permeability. Constitute confing bed for underlying aquifers. Suitable for domestic needs on very limited basis, but few wells finished in this unit.
Qt	Glacial till, interpreted to be basal till, deposited directly by ice. Moderately to highly compacted. Low to moderate content of cobbles and boulders. Silty to silty sand matrix. Clasts and matrix derived primarily from the local bedrock. Usually occurs as a veneer up to 10 feet thick.	Moderate to low permeability. Generally too thin and discontinuous to form no able confining bed.
Qs	Swamp and bog deposits, consisting of peat and muck with silt and clay. Generally 5 to 20 feet thick, but may be thicker in some glacial lake basins.	Highly impermeable. Water table at surface, or local ponding above regional water table.
Qal	Alluvial deposits left by modern streams, consisting of silt, sand and boulder gravel, with peat and other organic matter on flood plains and along small streams. May contain minor amounts of swamp (Qs) deposits. Generally less than 10 feet thick.	Moderate to very low permeability, depending on organic content. Too thin to constitue aquifer or confining bed. Water table at or near surface most of the year.
Qc	Colluvial deposits on slopes, left by mass wasting of tills, alluvium, or glaciofluvial outwash.aquifers. May aid aquifer recharge, where permeable, especially over poor aquifers or where other surficial deposits are thin or absent.	Moderate to very low permeability, depending on clay content. Too thin and discontinuous to constitute aquifers. May aid aquifer recharge where permeable, especially over poor aquifers or where other surficial deposits are thin or absent.

TABLE V. DESCRIPTION AND HYDROLOGIC CHARACTERISTICS OF SURFICIAL SEDIMENTS

Other important surficial deposits within the township include post-glacial (or "Recent") stream alluvium and swamp deposits. The alluvial deposits are sediments laid down in modern stream valleys. Alluvium has a variable composition depending on the terrain being drained by the stream. Alluvium may have a high silt content or a high percentage of organic material - both of which reduce the permeability of the alluvial deposit. In most cases, the water table occurs at shallow depths within the alluvium. The deposits are usually thin.

Swamps are the remnants of glacial lakes and ponds caused by the melting of the glacier. Underlying glacial lake-bed sediments and/or impervious bedrock entrap surface drainage and form the swamp. The swamp deposits contain a very high percentage of organic material and the water table is at, or near, the surface most of the year.

For a description and general discussion of the hydrologic characteristics of the surficial deposits of the township see Table V.

SURFICIAL GEOLOGY AND LAND USE

A knowledge of geology pinpoints areas of mineral resources. In Frelinghuysen Township, several of these have been mined in the past and are a part of our cultural landscape. The area abounds in old lime kilns and gravel pits. If social costs are not too high, such areas should be reserved and development planned without their possible loss to future generations.

Knowledge of the correct surficial geology also helps us determine soil types. Since soil classification is in part linked to the parent geologic formation, knowledge of the classification of the geology affirms soil classifications.

Surficial units may also serve as aquifers. Several productive wells in the township draw water from the glacial drift. Table V. provides information on the ground-water potential of the surficial geologic units.

Major sources of Information

Bayley, W.S., Salisbury, R.D., and Kummel, H.B., *Descriptions of the Raritan Quadrangle, N.J.*, The Geological Survey of New Jersey, Folio No. 5, Trenton, N.J. 1914, 31 p. 5 pl.

Drake, Avery A. and Lyttle, Peter T., *Geologic Map of the Blairstown Quadrangle, Warren County, New Jersey,* U.S. Geological Survey Geologic Quadrangle Map GQ-1585, Reston, Va. 1985

Herman, Greg C. and Monteverde, Don H., *Tectonic Framework of Paleozoic Rocks of Northwestern New Jersey,* in Paleozoic Geology of the Kittatinny Valley and Southwest Highlands Area, N.J., Geologic Association of New Jersey Field Guide and Proceedings, Sixth Annual Meeting, October 20-21, 1989, 57 p., 3 pl.

Lewis, J. Volney and Kummel, Henry B., *The Geology of New Jersey,* N.J. Dept of Conservation and Economic Development, Bulletin 50, Geologic Series, Trenton, N.J., 1914 196 p.

Markewicz, Frank J. and Dalton, Richard J., *Stratigraphy and Applied Geology of the Lower Paleozoic Carbonates in Northwestern N.J.*; Guidebook for the 42nd Annual Field Conference of Pennsylvania Geologist, October 6-8, 1977, 117 p.

Miller, Joseph W., Jr., *Geology and Ground Water Resources of the Sussex County and Warren County Portion of the Tocks Island Impact Area,* New Jersey Department of Environmental Protection, Bureau of Geology and Topography, Bulletin 73, Trenton, N.J., 1974 143 p., 2 Pl.

Lattman, L. H., and Parizek, R. R., 1964, *Relationship between fracture traces and the occurrence of ground water in carbonate rocks: Jour. Hydrology,* v. 2, no. 2, p. 73-91.

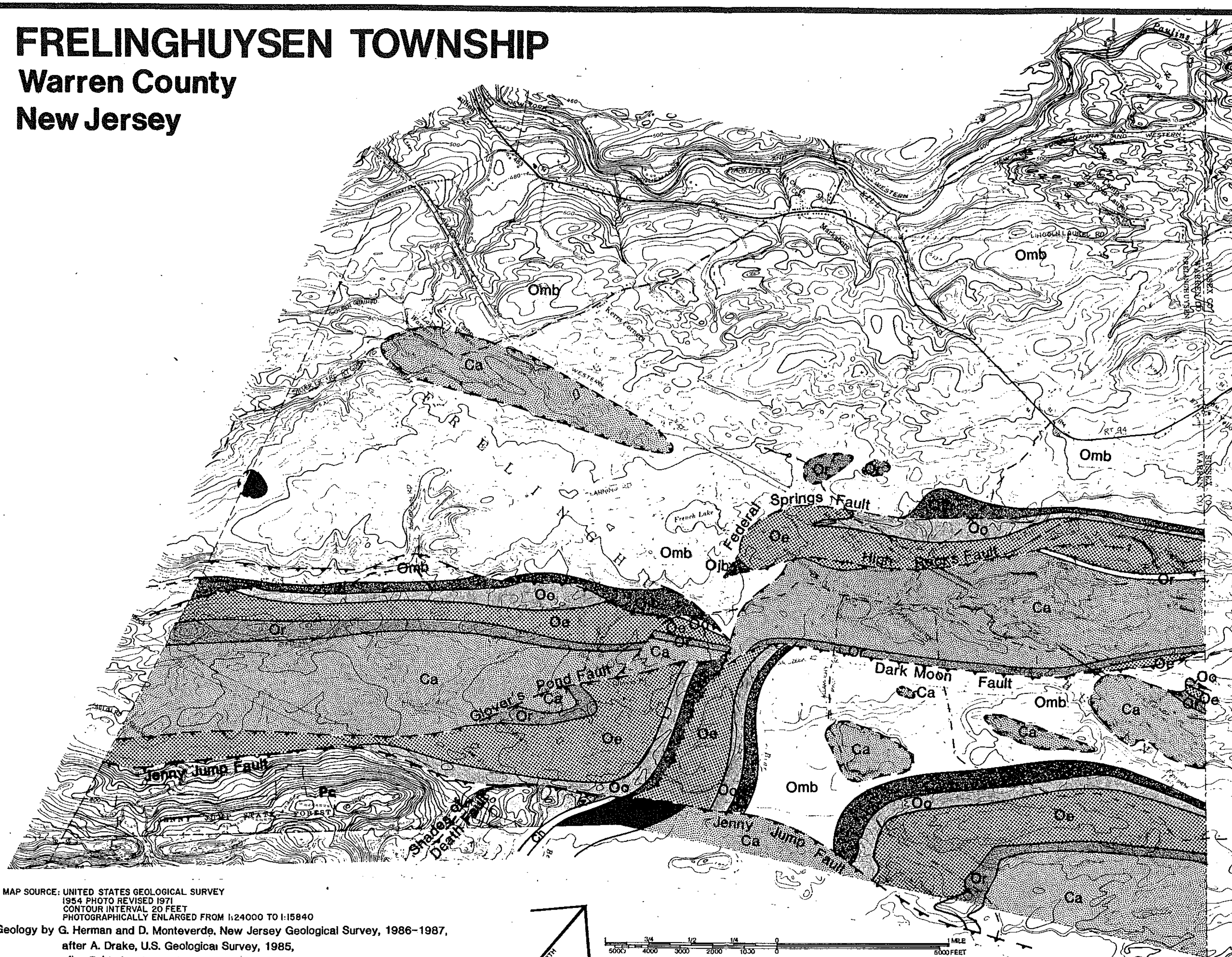
Parizek, R. R., et al., 1971, *Hydrogeology and Geochemistry of Folded and Faulted Rocks of the Central Appalacian Type and Related Land Use Problems,* Pa. State Circular 82, Earth and Mineral Sciences Experiment Station.

Ridge, John C., *The Surficial Geology of the Great Valley Section of the Ridge and Valley Province in Eastern Northampton County, Pa. and Warren County, N.J.,* M.S. Thesis, Lehigh U., Bethlehem, Pa., 1983 234 p. 17 Pl.

FRELINGHUYSEN TOWNSHIP

Warren County

New Jersey



BEDROCK GEOLOGY

Cambro-Ordovician Sedimentary Rocks

- Omb Martinsburg Shale
- Ojb Jacksonburg Limestone

Kittatinny Supergroup

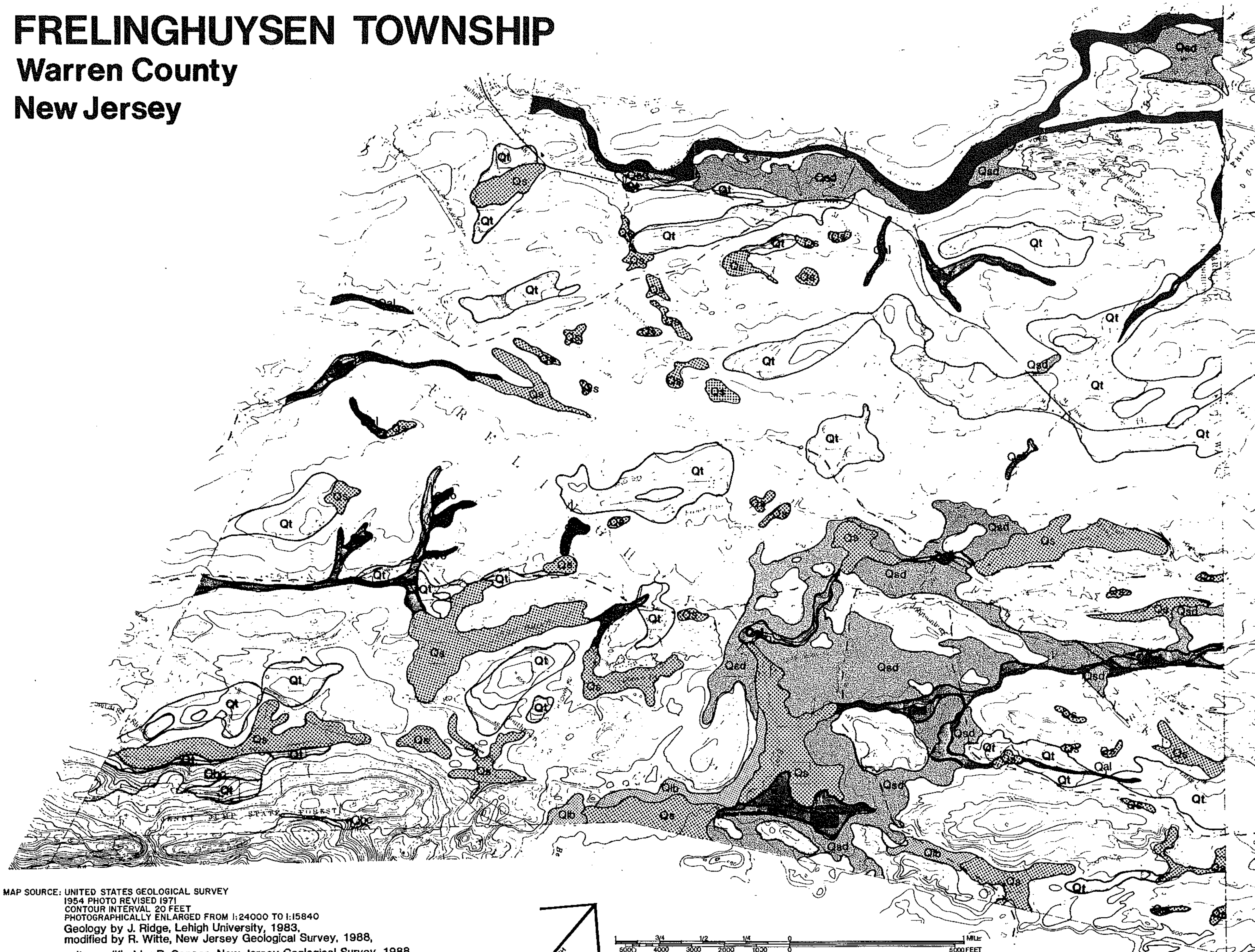
- Oo Ontelaunee Formation
- Oe Epler Formation
- Or Rickenbach Formation
- Ca Allentown Formation
- Leithsville Formation
- Ch Hardyston Quartzite
- Pc Undifferentiated gneisses and granitic rocks
- Fault

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

Geology by G. Herman and D. Monteverde, New Jersey Geological Survey, 1986-1987,
after A. Drake, U.S. Geological Survey, 1985,
after F. Markewicz and R. Dalton, New Jersey Geological Survey, 1972

ENVIRONMENTAL RESOURCES INVENTORY prepared December 1986 by the ENVIRONMENTAL COMMISSION

FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



SURFICIAL GEOLOGY

Qsd	Stratified Drift
Qlb	Lake Bed Sediments
Qt	Till
Qs	Swamp & Bog Deposits
Qco	Colluvium
Qbc	Boulder Colluvium
Qal	Alluvium
	Thin Discontinuous Deposits

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840
Geology by J. Ridge, Lehigh University, 1983,
modified by R. Witte, New Jersey Geological Survey, 1988,
units modified by R. Canace, New Jersey Geological Survey, 1988

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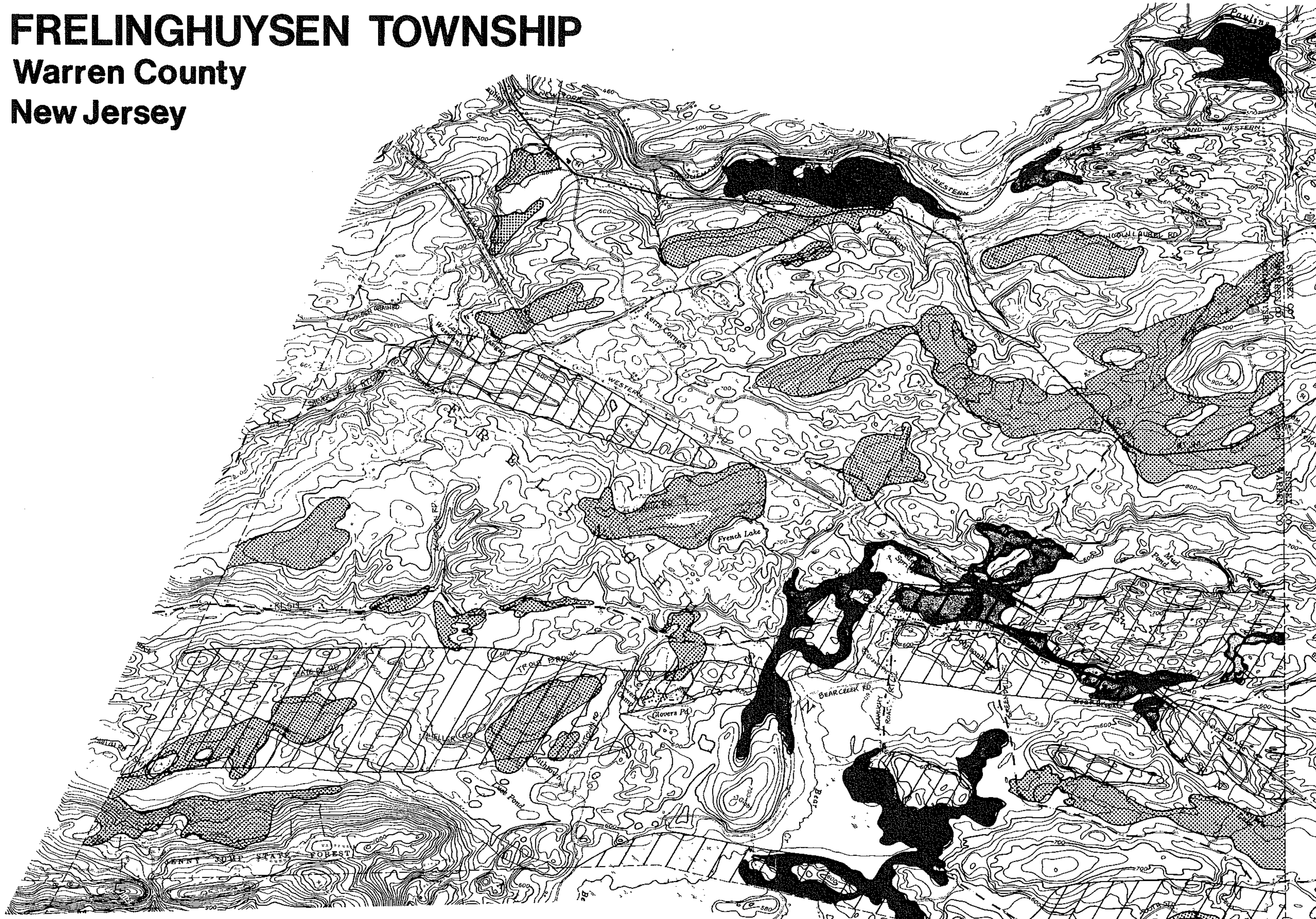
FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



AQUIFERS
AND AREAS of ENHANCED
GROUND-WATER RECHARGE

Areas of High Aquifer Recharge
Productive limestone aquifers exposed at the ground surface

Areas of Low Aquifer Recharge
Marginal limestone and shale aquifers exposed at ground surface

Areas of High Aquifer Recharge
Thick, well-drained sand and gravel deposits overlie productive limestone aquifers, enhancing ground-water recharge

Areas of Moderate Aquifer Recharge
Thick, well-drained sand and gravel deposits overlie marginal limestone and shale aquifers, enhancing recharge

Areas of Moderate Aquifer Recharge
Thick, moderately well-drained glacial till overlies productive limestone aquifers, slightly enhancing ground-water recharge

Areas of Low Aquifer Recharge
thick, moderately well-drained glacial till overlies marginal limestone and shale aquifers, slightly enhancing ground-water recharge

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

IN COOPERATION WITH THE NEW JERSEY GEOLOGICAL SURVEY
TRENTON, N.J.

NORTH

1 MILE 3/4 1/2 1/4 0 1 MILE
5000 4000 3000 2000 1000 0 5000FEET
Scale 1:15840

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SOILS

SOIL FORMATION

Soil is the product of a living environment and a vital factor in the productivity and sustainability of any region. In this first section of the chapter on soils, we will briefly cover the most basic aspect of the processes involved in soil formation; the properties of soils; factors which affect soil development; and classification of soils. It is hoped that such an introduction will be an aid to interpreting the **Soils map** which was prepared from *The Soil Survey of Warren County.*

Soil is a mixture of both inorganic decomposed rock and organic matter from plants and microorganisms. The soil-forming process begins with the mechanical and chemical weathering of solid rock. (fig.12). As fragments become finer and finer, they move downward by water infiltrating the ground. This process is called translocation. The layer from which the fragments are washed downward is called the eluvial layer. The lower zone into which the fragments settle is called the illuvial layer. It is this process of translocation which creates the differentiated soil horizons. Horizons vary in density, color, texture, and chemical composition (fig. 13).

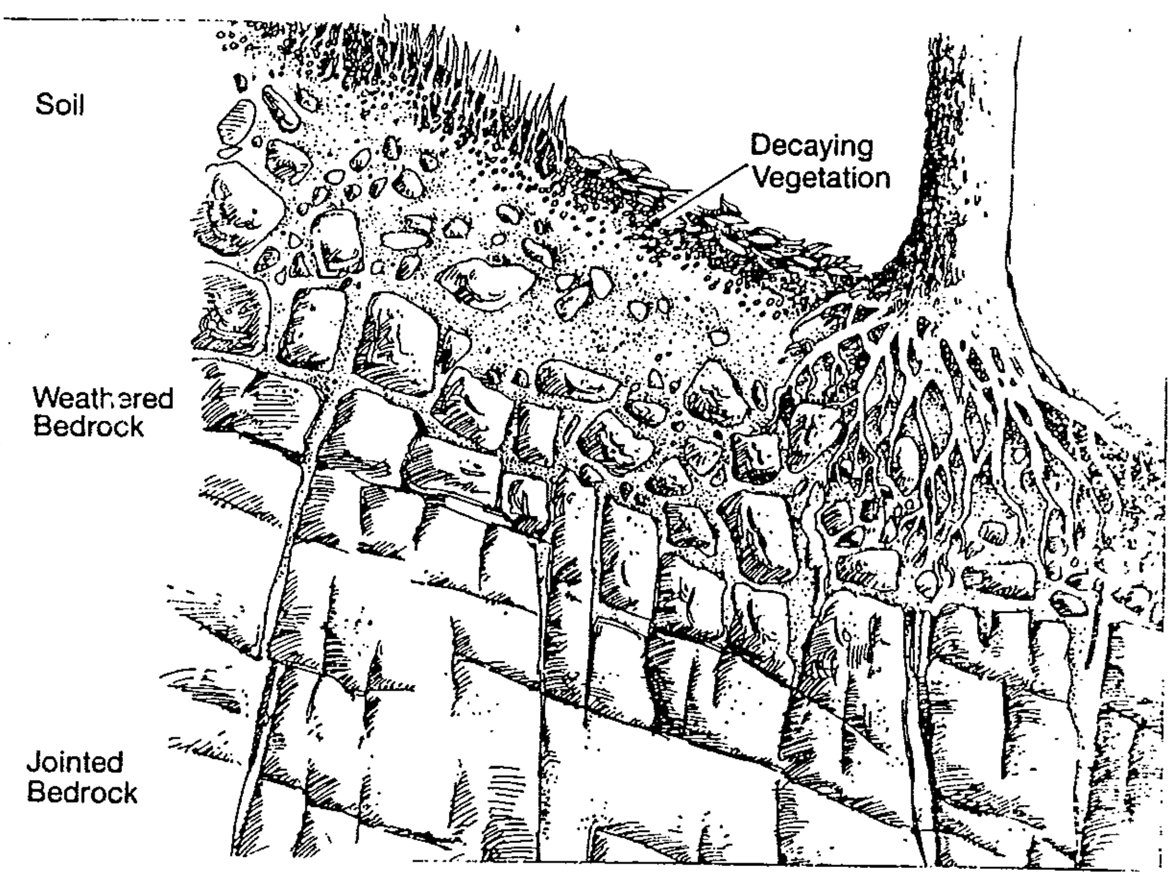


Fig. 12 - Chemical and Physical Weathering in the Soil Forming Process. (Oberland, see references)

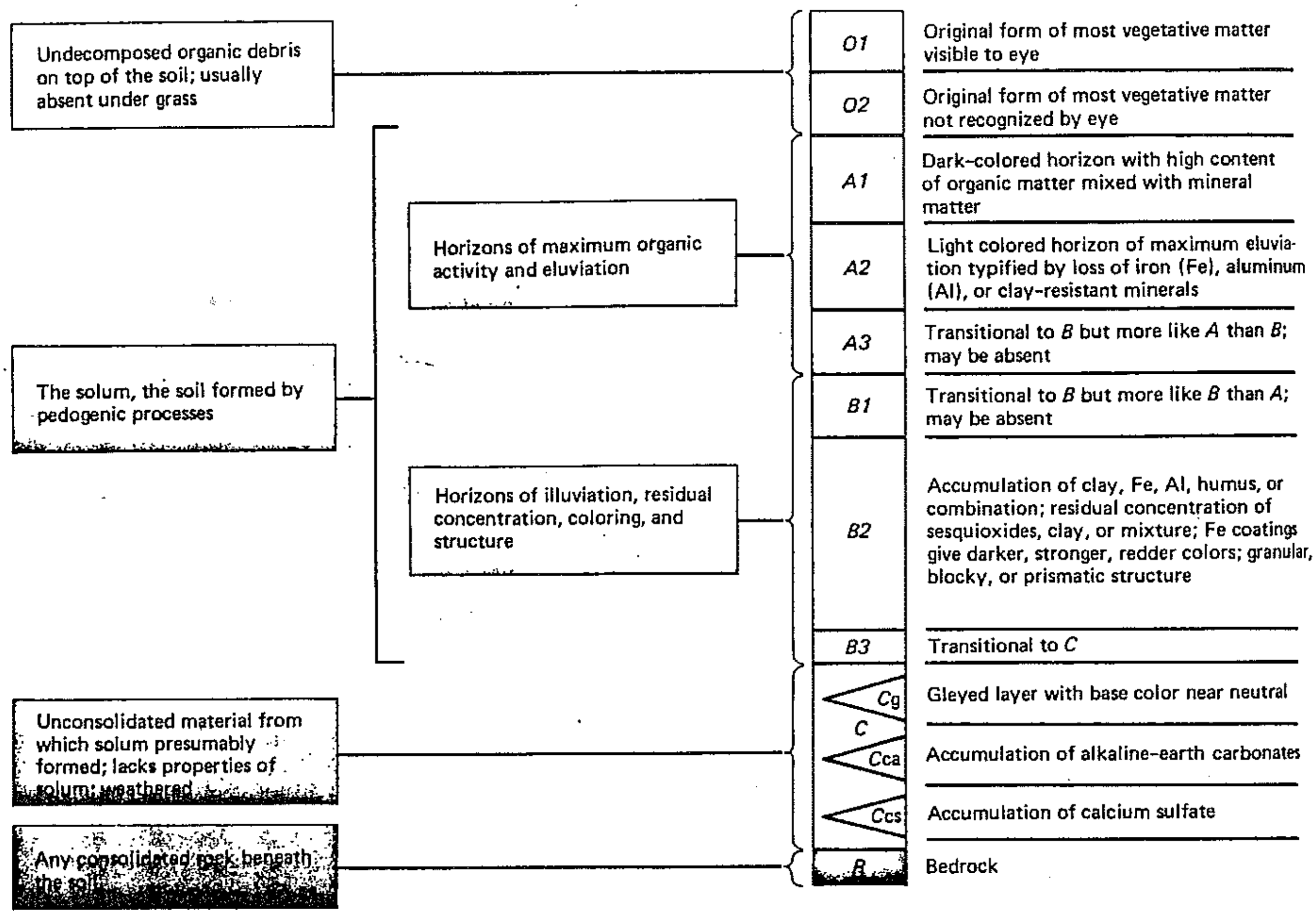
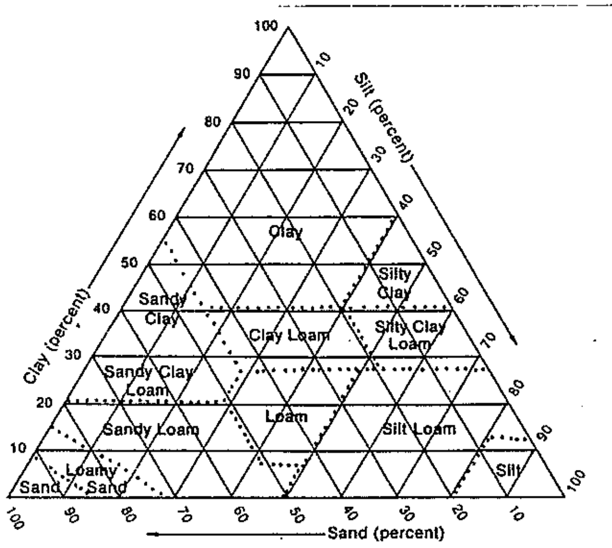


Fig. 13 - Soil Horizons Diagram (Oberlander, see references).

It has been stated that soil is the product of a living environment and, therefore, that it is the organic activity which creates true soil. Plants contribute the vegetative matter which fungi and bacteria change to humus; animals in the soil mix the humus with the inorganic mineral elements. Bacteria also help in converting the gaseous nitrogen into a substance which can be used by plants. These nitrogen-fixing bacteria are found on the roots of plants know as the legume family. Examples include clover, alfalfa, soybeans and peas.

SOIL PROPERTIES

Soil texture refers to the size distribution of the mineral particles which are found in the soil (Fig. 14).



The texture of a soil is determined by measuring the proportions of clay, silt, and sand in the inorganic part of the soil. Texture is measured by sifting the soil sample through a series of screens graded from coarse to fine. The soil texture triangle shown in the figure can be used to classify the texture of a soil sample once the percentages of the components are known. If a soil sample contains 30 percent clay and 40 percent sand, for example, it would be classified as a clay loam. (Doug Armstrong after E. M. Bridges, *World Soils*, © 1970, Cambridge University Press)

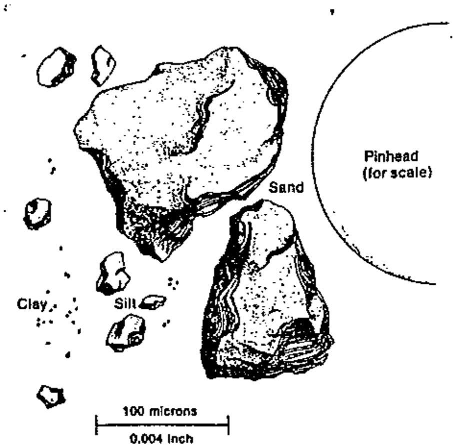


Fig. 14 - SOIL TEXTURE (Oberlander, see references).

Soil structure depends on the size and form of peds, which are the mass of mineral particles that cling together in a clump of soil.

Soil chemistry is closely related to the clay-humus complex within the soil. This is what we think of in terms of the fertility of a soil: the delicate balance where nutrients are chemically bound strongly enough not to wash away with infiltrating water, but bound weakly enough to be used by plants.

Soil color is a commonly used property for describing a soil. Color is determined almost entirely by the amount of organic matter and iron found in the soil and its state of oxidation or reduction.

The horizons within a soil are a distinctive sequence of layers which form the **soil profile**. There are five separate layers which can usually be distinguished (fig. 15).

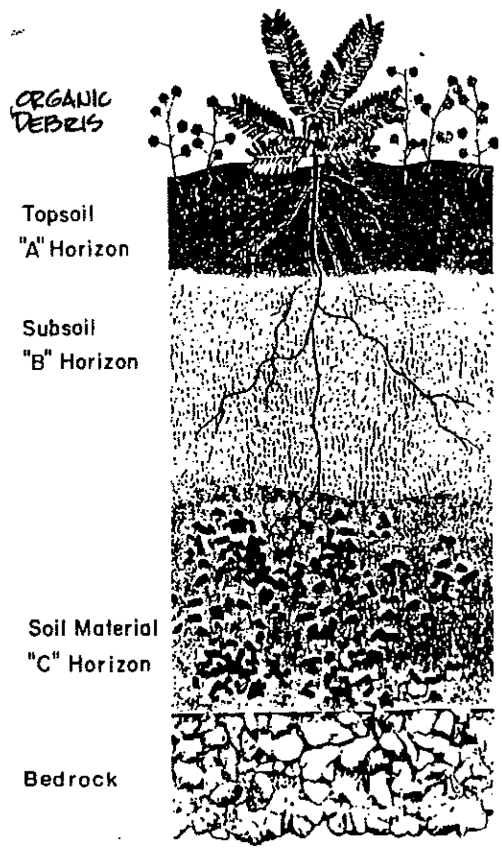


Fig. 15 - SOIL HORIZON

FACTORS AFFECTING SOIL DEVELOPMENT

The inorganic material (rock) from which a soil develops is called the **parent material.** The fertility of a soil, therefore, depends greatly on the available nutrients within the parent material. Limestone, which occurs extensively within the township, and basaltic lava are composed largely of soluble bases and can produce the most fertile soils.

The climate is a considerable factor in determining major soil types on a global scale. Our local climate produces soils associated with the **Mid-latitude Forest Region.**

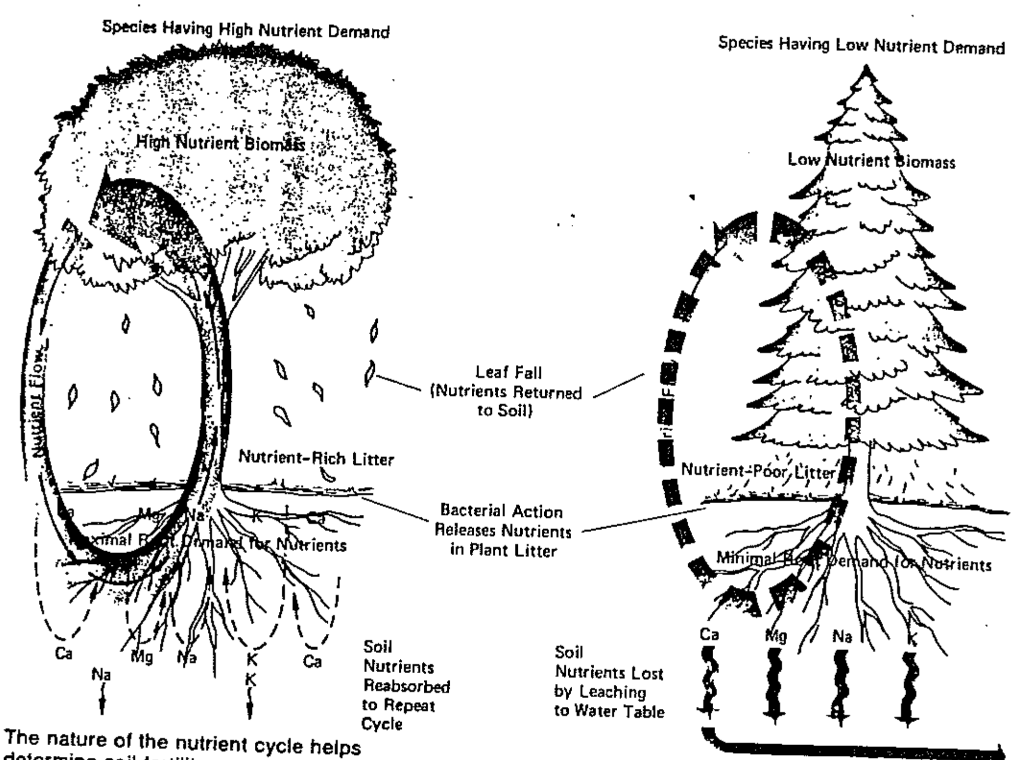
Since water and gravity are major transport systems of soils, site condition is another factor. Soils found on slopes are generally thinner, stonier, and lower in organic material than soils found on level or low-lying land.

The nutrient cycles of the various plant organisms affect the fertility of soils (fig. 16).

The dimension of time is a final factor to be mentioned. Though it can take a thousand years for decomposing leaf litter to produce one inch of topsoil, and many thousands of years of weathering processes on rocks to fragment soil particles to soil size, the leaching and eroding tendencies of soils can deplete an area of nutrients and materials in a matter of a few seasons. This points out the need for careful management and protection of soils. Once depleted or eroded, soils will not regenerate in a lifetime.

SOIL CLASSIFICATION

For the purposes of classification, soils are grouped into *soil series.* A series refers to soil formed from a particular type of parent material having horizons or layers that, except for the surface layer, have similar profile characteristics and arrangement with depth. Among the characteristics inventoried for soil series determination are: color, texture, structure, reaction (pH), consistence, and mineralogical and chemical composition.



The nature of the nutrient cycle helps determine soil fertility.

(left) Plant species with high nutrient demands prevent soluble compounds from being leached from the soil. The plant extracts nutrients and then returns them to the soil in the form of plant litter. The constant two-way exchange between the plant and the soil maintains a high saturation of nutrients in the soil.

(right) Plant species with low nutrient demands permit unused soil chemicals to be leached away and return few nutrients to the soil. Thus the soil's fertility declines. (Vantage Art, Inc.)

Fig. 16 - The Nutrient Cycle. (Oberlander, see references)

Soils in the landscape do not necessarily occur in pure units and often grade from one series to another. For the purpose of developing a soil survey, *soil mapping units* are utilized to indicate, in broader terms, a soil series or combination of soils, that can be shown at the scale of mapping for the defined purpose and objective for that particular map.

Soil mapping units normally contain *inclusions* of other soils which are outside the normal range of the named soil series. The mapping units are generally designed to reflect significant differences in the use and management capability of the soil.

Soil Classes Found In Frelinghuysen Township

1. Soils developed on glacial outwash or alluvium (Hazen, Hero, and Fredon soils)

   General occurrence and characteristics:

   - terraces adjacent to streams and deep valleys;
   - deep, nearly level to strongly sloping to very steep slopes;
   - loams, fine sandy loams, gravelly loams or cobbly loams.

   Hazen soils are found mainly in the southern half of the township, and occur adjacent to Trout Brook (a tributary of Beaver Brook), Bear Creek and other tributaries. In the northern half of the township Hazen loam and gravelly loam can be found mainly along the Paulins Kill between Marksboro and the Sussex County line. Hazen soils are well-drained, deep soils on slopes ranging from zero to 25%.

   Hero soils almost always occur adjacent to Hazen soils on stream terraces but, unlike the Hazen soils, they are only moderately well drained with a high seasonal water table. Flooding is a hazard, particularly where the ground is nearly level. Slopes range from zero to 8%.

   Fredon soils are deep, poorly drained and, like Hazen and Hero soils, occur on stream terraces and in depressions. Slopes range from zero to 3%. In the township they occur only along the southern boundary with Allamuchy Township, with the exception of two isolated spots at Mud Pond in the Bear Creek floodplain and in the northeastern corner.

2. Organic deposits and alluvium (Carlisle, Adrian, Wayland, and Middlebury soils)

   General occurrence and characteristics:

   - on floodplains and depressions in valleys;
   - deep and nearly level;
   - surface layer ranges from muck to silt loam.

   Both Carlisle and Adrian Soils are nearly level and occur in depressions. They are poorly drained muck soils. Carlisle soils occur in glacial lake beds, bogs and swamps. In Carlisle soils, the organic matter is more than 51 inches thick and black in color. Adrian muck is also nearly level, very poorly drained soil occurring in former glacial lake beds, swamps and on some floodplains. Typically black in color, the muck is 18 to 50 inches deep over sandy mineral material. In Frelinghuysen Township, Adrian muck occurs only in the Bear Creek floodplain, while Carlisle muck is scattered throughout the township, but occurs more frequently in the western half of the township. Both soils are subject to frequent flooding where adjacent to perennial streams and in undrained areas where the water table is at or near the surface most of the time. Minor soils include very poorly drained Halsey and Wayland soils on floodplains; they are also associated with Chippewa and Hazen soils.

   Wayland and Middlebury soils occur in the lowest spots on floodplains, and in most areas are subject to frequent flooding and seasonal high water tables. Wayland soils are deep, nearly level and very poorly to poorly drained, while Middlebury soils are moderately to somewhat poorly drained. Minor soils included are moderately well drained Hero soils, very poorly drained Halsey soils and well-drained Hazen soils. These soils are well suited to wetland wildlife habitats.

3. Soils that form in glacial till and material from weathered bedrock (Annandale, Bath, and Washington, Parker, Wassaic, Nassau, Edneyville, Bartley, Chippewa, Lyons, and Venango Soils)

   General occurrence and characteristics:

   - stony soils and rock outcrops common;
   - developed on shallow to deep tills;
   - composition may differ, e.g. shale, slate, limestone, granite rocks or other may dominate;

   3a) *Soils generally associated with limestone*

   The Washington and Wassaic soils are well drained soils found in limestone areas and on hillsides and in valley areas. The Wassaic soils are moderately deep, with slopes ranging from nearly level to steep. The Washington soils are deep and gently sloping to steep. Outcroppings of bedrock consisting of exposed limestone beds may be found throughout and most areas have been cleared for farming purposes.

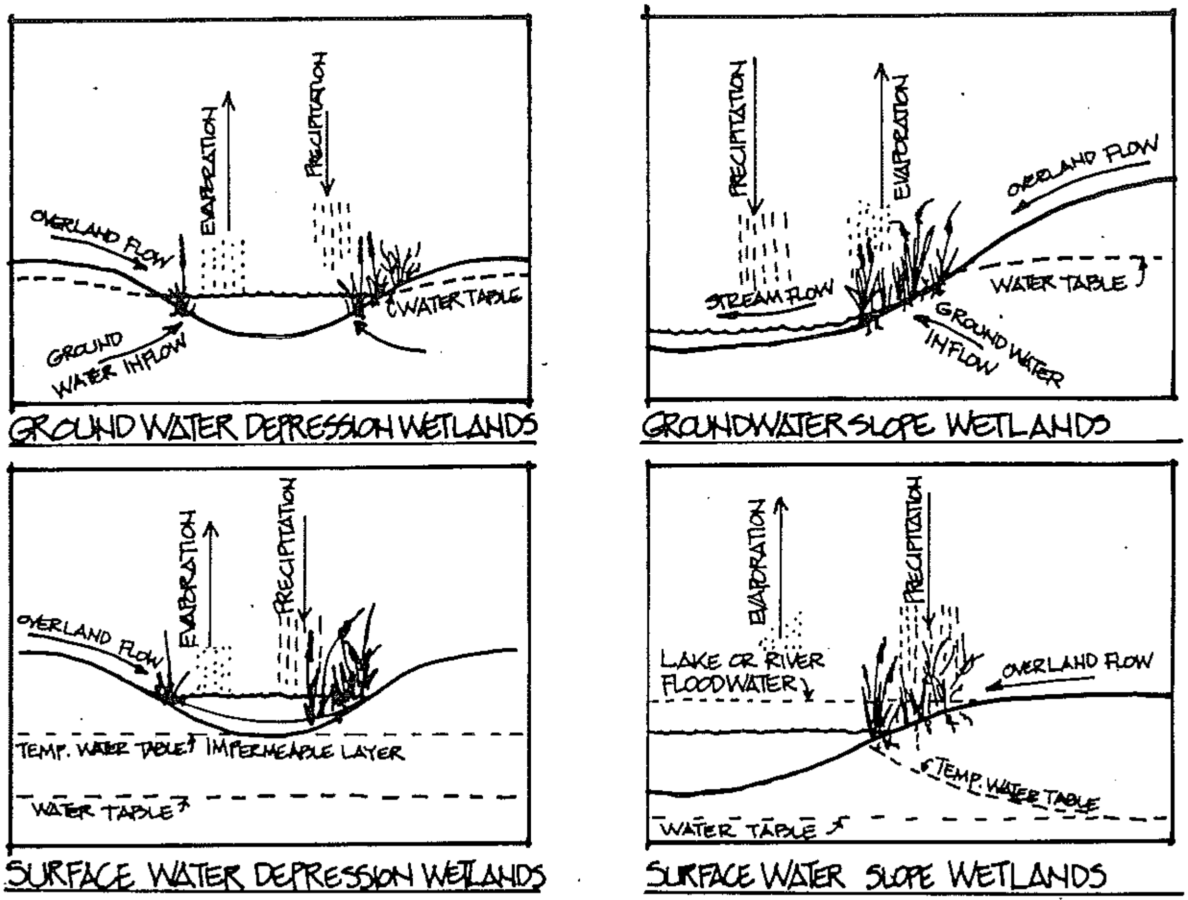


Fig. 17A - Hydrology of ground-water and surface water wetlands. (redrawn from *Wetlands of New Jersey*)

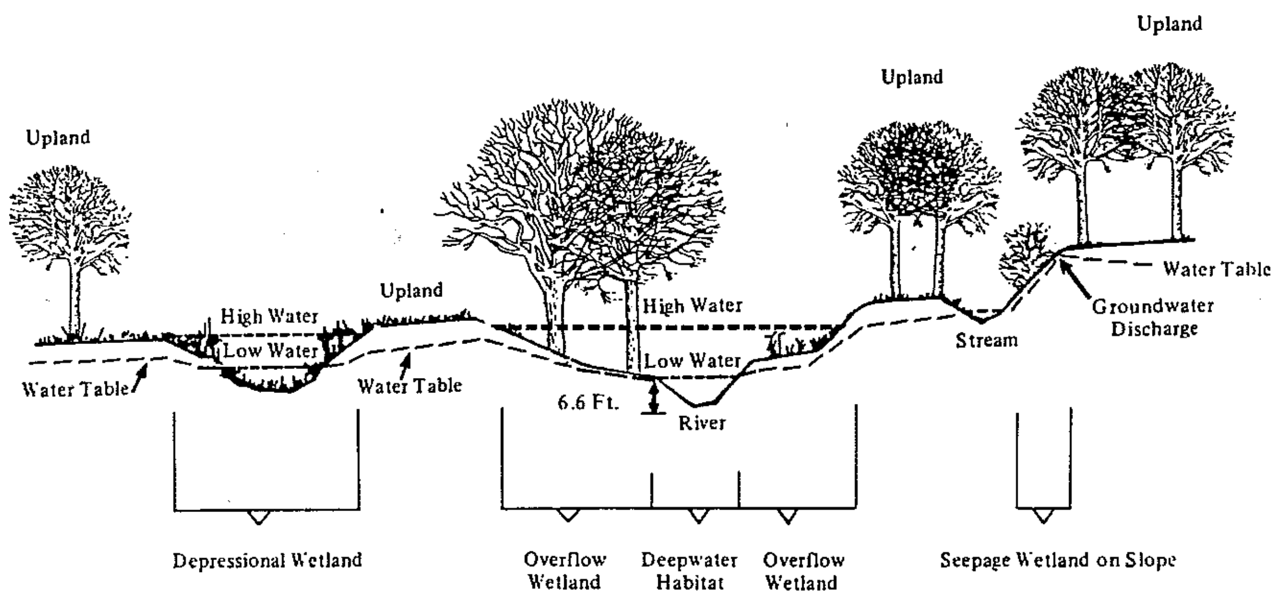


Fig. 17B - Schematic diagram showing wetlands, deepwater habitats, and uplands on the landscape. (from *Wetlands of New Jersey*)

Poorly drained and very poorly drained Lyons soils occur in the low positions of the landscape. Moderately well drained Bartley soils are also associated with Washington and Wassaic soils.

3b) *Soils generally associated with shales*

Bath soils are deep loamy soils. They generally have restricted permeability in the subsoil. Nassau soils are shallow to bedrock and excessively drained. Both soils occur on gently sloping to very steep hillsides and on hilltops. While most Bath soils have historically been used for cropland, Nassau soils are more often used for pasture or woodland. Minor outcrops may be found associated with Nassau soils.

In depressions, on toe slopes, and along drainage ways, somewhat poorly drained Venango, and poorly to very poorly drained Chippewa soils can be found. Chippewa soils have reduced permeability in the subsoil.

Poorly and very poorly drained Lyons soils can be found along the larger drainage ways.

3c) *Soils generally associated with gneiss*

Edneyville and Parker soils are found on the major ridges in the upper side slopes and on plateaux. They are formed over gneiss bedrock. Edneyville soils are deep and well drained. Parker soils are modereately deep and somewhat excessively well drained. Edneyville soils are found on gentle to steep slopes, while Parker soils are on steep to very steep slopes. Rock outcrops are found associated with these mapping units, with very thin soil mantles adjacent to rock outcrops or on ridges. Due to steep slopes, rockiness and exposed rock outcrop, most of the Edneyville and Parker soils are in Woodlands. A few areas of Annandale soils occur on the toe slopes; these are deep, well drained soils with limited permeability in the subsoil restricting land use.

4. Soils generally associated with wetlands (Adrian, Carlisle, Chippewa, Halsey, Lyons, Fredon, Wayland and Venango Soils)

Hydric soils have been defined by the United States Department of Agriculture's Soil Conservation Service (1982) as soil that is either:

(1) saturated at or near the soil surface with water that is virtually lacking free oxygen for significant periods during the growing season, or;

(2) flooded frequently for long periods during the growing season.

Undrained hydric soil mapping units are a key attribute for identifying wetlands in the Township. Wetlands do exist as inclusions on soils not mapped as hydric.

Hydric soils naturally develop in wet depressions, on floodplains, on seepage slopes and along margins of open waters and support the growth and reproduction of hydrophytes (wetland vegetation). They are separated into two major categories on the basis of soil composition: (1) Organic soils (muck, peat and mucky peat); and (2) Mineral soils in standing water and/or saturation to within 1 1/2 feet of the surface for significant periods. Soil saturation may result from low-lying topography, ground water seepage, or the presence of a slowly permeable layer (e.g. clay, confining bed, fragipan or hardpan). Hydric mineral soils are predominantly grey in color with variable mottling of bright colors while hydric organic soils are predominantly black or dark brown often without mottling.

In Frelinghuysen Township, three major groups have been identified by the National Wetlands Inventory (*Wetlands of New Jersey*, U.S.D.I. Fish & Wildlife Service, July 1985): (1) soils that nearly always display consistent hydric conditions (Adrian, Carlisle, Chippewa, Halsey, Lyons, Wayland, Middlebury and Fresh Water Marsh); (2) soils displaying consistent hydric conditions in most places (Fredon,); and (3) alluvial soils as mapped by the soil surveys which may also be classified as hydric for purposes of wetlands classification (Venango).

The vast majority of wetlands are characterized by dense growth of plants adapted to existing hydrology, water chemistry, and soil conditions. The presence of "hydrophytes" is one of the three key attributes of wetland definition because vegetation is the most conspicuous feature of wetlands and one that can readily be identified in the field. The other two wetland characteristics, i.e. hydric soils already mentioned and hydrology, are not as easily recognized and often require considerable scientific expertise or long-term study for accurate identification. Figure 17B shows a schematic diagram of wetlands, deepwater habitats, and uplands on the landscape. Note the differences in wetlands due to hydrology and topographic position. Figure 17A shows the hydrology of ground-water versus surface water wetlands.

In Frelinghuysen Township hydric soils and wetlands are scattered throughout the township, including large areas along some of our major waterways such as Bear Creek and Trout Brook. The Frelinghuysen Township Planning Board and Committee recognized the value of freshwater wetlands to the quality of life by incorporating a wetlands ordinance into the revised Land Development Ordinance, adopted in May 1987.

SOILS AND LAND USE

Soils, along with water and air, are the precious commodities that give life to our planet. Soil purifies our water, sustains green plants (which are at the foundation of our food chain), provides oxygen, and filters pollutants from the air. Good soil management is the key to a healthy, productive environment. It is the responsibility of everyone in a community that is entirely reliant on ground water to maintain a viable soil layer to insure that our underground water reserves remain pure and that we maintain our ability to produce food. In order for a community to maintain agriculture, soil management must be a high priority.

In land-use planning, the distribution of soil types on a parcel of land helps determine the best place for buildings, ponds, crops, landscape vegetation, septic disposal systems, roads, retention basins, etc. It is more effective and economical to pay attention to the natural limitations imposed by different soils than to try to attempt to modify soils or remedy problems created by improper land use.

Proper land use planning starts with an inventory of the soils on a site. The map entitled **"Soils"** shows their distribution in the township. The physical characteristics and land use are discussed in detail in the Warren County Soil Survey (U.S. Department of Agriculture, 1979). Some of the more important land uses, such as building and septic system installation, are summarized in the tables that follow. Included in this inventory are interpretive maps showing the erodibility and drainage characteristics. All of the soils in Frelinghuysen Township - except a small, localized area of Palmyra Gravelly, Sandy Loam Complex (PaB) - have severe limitation for septic system installation.

Soil maps give a quick overview of the types of soils identified by the Soil Conservation Service's survey. They yield vast amounts of information to aid us in planning for development consistent with the natural features of a site. They also help us to identify sites which should not be developed or developed with great care such as sites with highly erodible soils or those which are obviously wet or periodically inundated. Soil maps are not site specific but serve as a guide for general land planning. For development on a specific site, test borings and pits are often necessary to determine the exact capability of soils to support the proposed development.

Soil types are categorized by the texture and size of particles (sand, loam or clay), by the slope involved (indicated by the letters A,B,C,D,E,F at the end of the individual soil key) and by the presence or absence of bedrock at, near or on the surface. Thus the symbol WaB refers to the Wassaic Soil Series, 3-8% slope. (fig. 18).

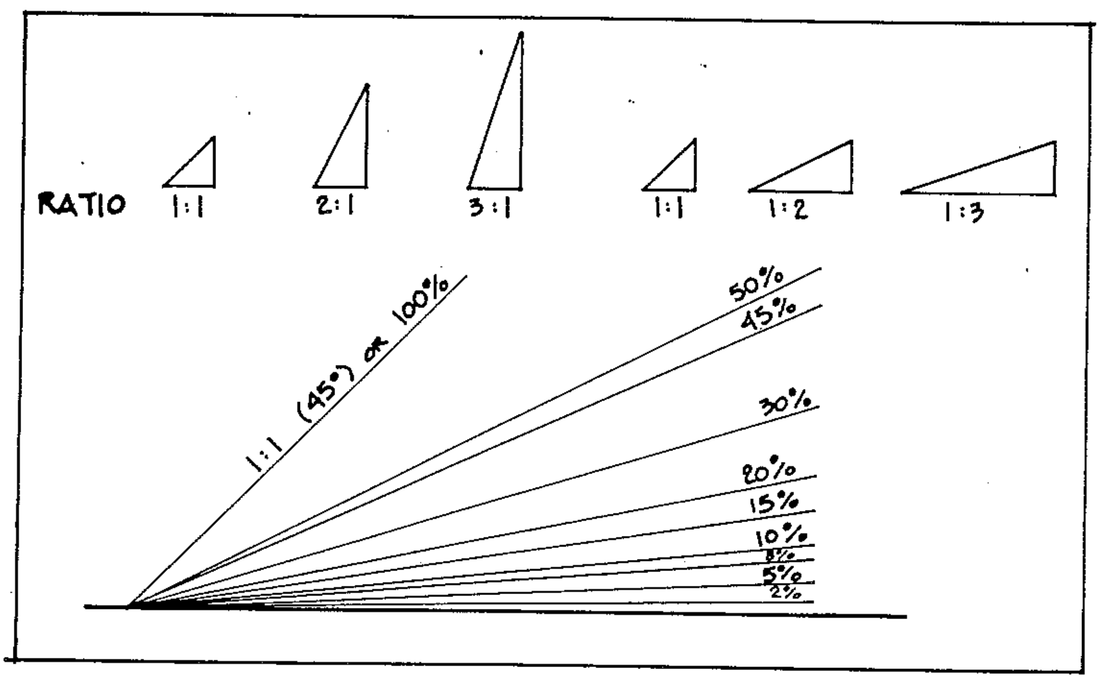


Fig. 18 - Angle of Slopes - Expressed in ratio and percentage. Comparison.

The use and cost of developing land are strongly influenced by slope. The six slope classes used in Northern New Jersey are:

A 0-3%	**D** 15-25%
B 3-8%	**E** 25-35%
C 8-15%	**F** 35% & greater.

The suitability of soils for building depends in part on their capacity to drain water. Soils which are too permeable (such as sands and gravels) may permit sewage to run through too quickly to be purified, thereby polluting wells and groundwater. Soils which are not permeable enough (such as clays) will cause sewage to seep to the surface creating wet, smelly, and unsanitary conditions. The same may be true of areas which have bedrock close to the surface. The engineering properties of soils - even on minor slopes - may cause slumping, settling, and sinking of roads and buildings, resulting in constant maintenance problems. Soils with desirable engineering properties will provide good stable support for buildings and roads and will erode less. (See Appendix "A" for soil limitations for specific land uses).

Soil Erosion

Sediment from erosion is the largest pollutant of surface waters. Sediments fill in stream channels thereby reducing their ability to carry storm waters. Not only is sediment a primary pollutant, it also carries absorbed pollutants such as pesticides, as well as oils and leads from road run-off. Sediment-loaded streams and brooks not only affect water quality but also aquatic life by damaging bottom organisms on the stream bed that are essential to their survival.

Erosion in our area occurs most often from the action of running water (as rain or snow) or wind. Many soils, once eroded, have a lower infiltration rate than in their uneroded state, thereby reducing groundwater recharge.

A generalized history of soil erosion shows that it was lowest in pre-colonial days, and that it increased as settlers began farming, fell with the decrease in agricultural activity during the late 1800's and early 1900's, and then increased sharply during the suburban construction boom, by far exceeding levels at the peak of the agricultural period. The Soil Erosion and Sedimentation Control Act of 1975 attempts to control erosion by providing that any lot larger than 5000 square feet (except for a single lot for one residential dwelling) must be certified by the local Soil Conservation District. If the municipality adopts a soil erosion and sedimentation ordinance which conforms with state standards, it may also certify the control plan.

Soils shown on the SCS Soil Survey Map are rated for their susceptibility to erode, however, due to the scale of the SCS maps, they are not site specific or precise enough for site review. Since experience has shown that most problems from erosion occur during the initial stages of the development process, the Planning Board should ensure that all subdivision and site plans contain adequate designs to minimize damage from soil erosion and sedimentation. Failure by a developer to provide such information constitutes reason to deny the application.

Erodibility is a measure of the likelihood of mechanical removal of soil by gravity, wind and stormwater runoff. The **Soil Erosion Hazard map** reveals that more than one-half of the township is underlain by soils with a moderate to severe potential for erosion. Erosion is an extremely important consideration in managing soil because, as discussed above, the time it takes to generate a soil is measured in tens of thousands of years, yet soils can be lost through improper management in one single day.

The actual amount of erosion is influenced by several factors: the type of soil, the steepness or flatness, as well as the length of slope; rainfall and wind intensity and duration; existing vegetation; and erosion control practices. These practices might include terracing, mulching, quick-growing ground cover, constructing small detention basins which act as sediment traps, and staging construction whereby only a portion of a large site is disturbed and exposed at one time.

The soil series primarily associated with a high erosion hazard are shown on the map and are the Bath, Hazen and Nassau soils. Bath soils are susceptible because they tend to be thin, rocky, and are usually found on steep slopes. Hazen and Nassau soils derive their susceptibility to erosion from being deep and gravelly, and are found on moderate to steep slopes. A severe erosion hazard is primarily associated with the Nassau Rock Outcrop complex (NF), and the Bath Gravelly Loam (Bf). Other deep, well-drained soils that are considered highly erodible include the Annandale, Hazen and Washington Gravelly Loams. The severe erodibility category also includes a Parker soil (Pb) which occurs only in minor amount in the southern tip of the township. A moderate susceptibility to erosion is associated with Nassau, Bath, and the Hazen Gravelly Loams found on shallower slopes.

Soil Drainage

Soil drainage is a vital control on land use. The most common use associated with soil drainage characteristics is the installation of subsurface sewage disposal systems, or septic systems. Soil drainage is an important consideration, of course, in agricultural uses, as well as building foundations, roads, silvaculture, ponds, landscaping, recreation, and other land use categories. Soil drainage is also an important factor in ground-water recharge, with those areas that drain the fastest generally constituting the most important recharge areas.

The map entitled **Natural Soil Drainage**, is an interpretive map that shows the soil drainage characteristics in the township.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

While the majority of the soils in the township can be characterized as well-drained, poor subsoil drainage is common. Several soils associated with glacial stratified drift can be characterized as having excessive drainage. Excessively drained soils belong mostly to the Nassau series and drain so rapidly that no excess water is present in the soil during any season.

Depth to Bedrock

The **Depth to Bedrock Map** identifies areas of shallow bedrock. Depth limits the use of those areas for development. The location of roads, ponds, buildings with basements or on slabs are affected by the shallowness of bedrock. Additionally, depth to bedrock will influence septic systems location since bedrock too close to the surface may deflect sewage back to the surface, creating unsanitary conditions or contaminate the water supply.

Hydric Soils and Wetlands

To early settlers and to us, until recently, the abundance of nature seemed limitless. Today we know that the bounties of nature are not limitless and that if humans are to continue to survive, they can no longer think of themselves as outside the ecosystem. (Ecosystem is here defined as a unit of plants and animals, and their physical and chemical environment, in which no one part exists independently of the others).

Freshwater wetlands play an integral part in maintaining the quality of life through material contribution to the water quality of the township, its economy, food supply, and fish and wildlife resources by:

(1) Protecting subsurface and potable drinking water supplies from contamination by hazardous chemicals from road runoff, lawns and agricultural operations thus serving to purify surface water and groundwater resources (fig. 19);

(2) Providing a natural means of flood and storm damage protection through absorption and storage of water during high runoff periods and through the reduction of flood crests, thereby protecting against the loss of life and property (fig. 20);

(3) Serving as a buffer zone between dry land and water courses, thereby retarding soil erosion; and

(4) Providing essential breeding, spawning, nesting and wintering habitats for a major portion of the township's fish and wildlife, including migrating birds, endangered species, as well as commercially and recreationally important wildlife.

As of May 16, 1988, freshwater wetlands are protected and regulated by law in New Jersey (N.J.A.C. 7:7A). This law was amended in July 1989 to include transition buffers of varying dimensions depending on the classification of a specific wetland:

> Class I - wetlands of exceptional resource value (those which discharge into FW-1 and FW-2 waters (trout production and maintenance waters) and those which are present habitats for rare and endangered species;
>
> Class II - wetlands of intermediate resource value, not defined as either exceptional or ordinary, and;
>
> Class III - wetlands of ordinary value which are isolated and do not drain into an inland lake, pond, river or stream and which are more than 50% surrounded by development and less than 5,000 square feet in size (100 x 50 ft.). Included in this class are drainage ditches, swales or detention facilities. Although no buffer is required by State law, nevertheless, it does not prevent a municipality from obtaining drainage easements from property owners if obstruction of the

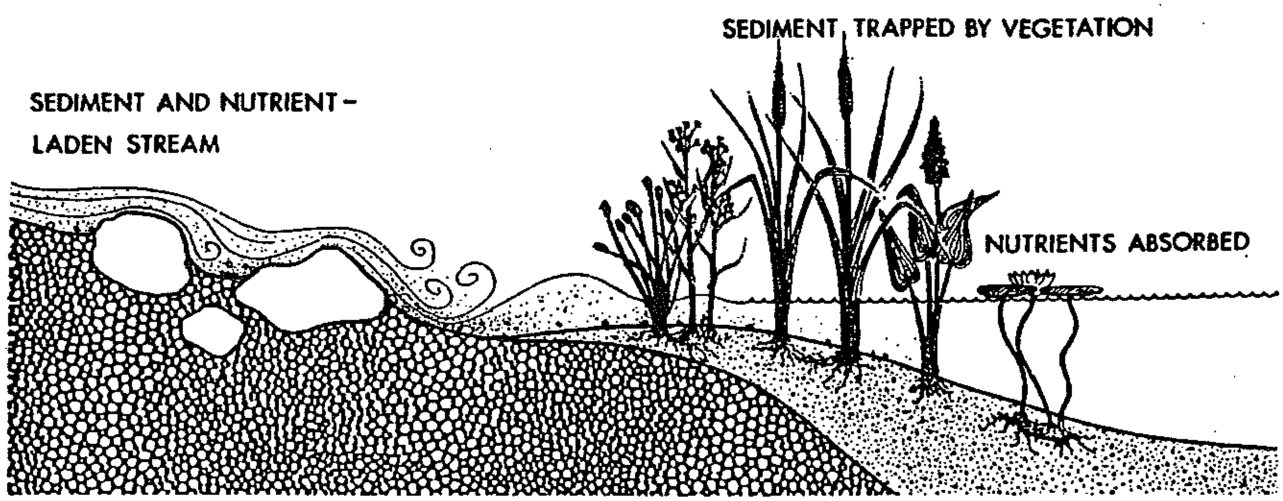


Fig. 19 - Wetlands purify water.

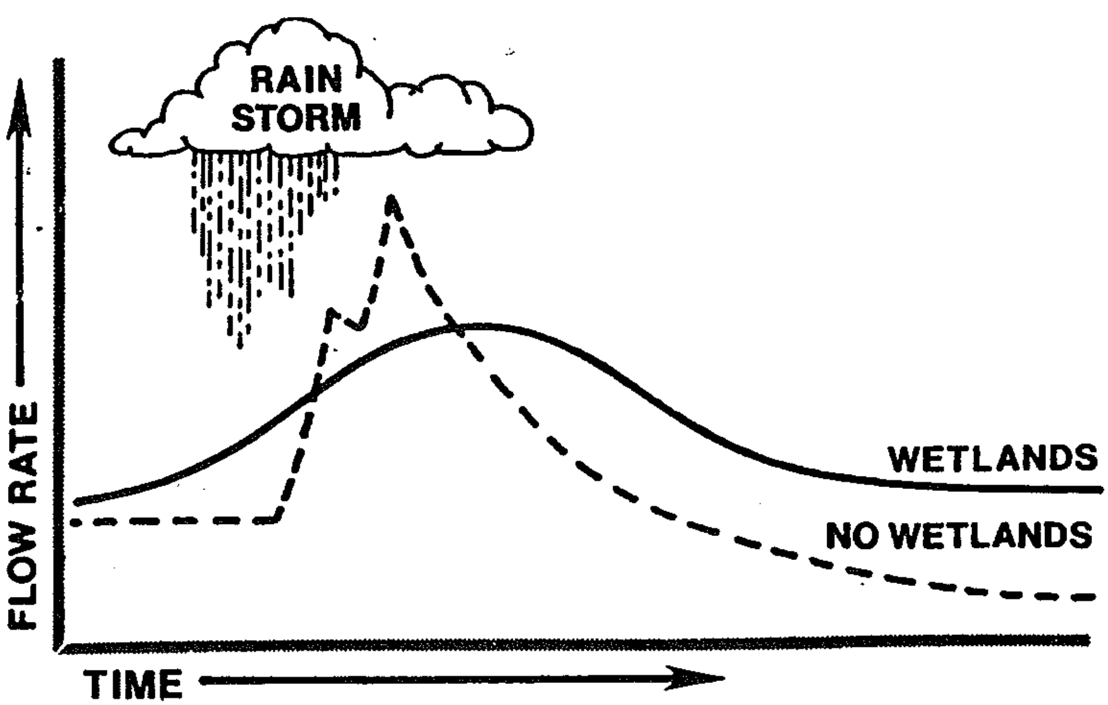


Fig. 20 - Wetlands reduce peak flows. (from *Wetlands of New Jersey*)

drainage would create property damage elsewhere.

The following activities in a freshwater wetland are regulated:

(1) The removal, excavation, disturbance or dredging of soil, sand, gravel, or aggregate material of any kind;

(2) The drainage or disturbance of the water level or water table;

(3) The dumping, discharging or filling with any material;

(4) The driving of pilings;

(5) The placing of obstructions; or

(6) The destruction of plant life which would alter the character of a freshwater wetland, including the cutting of trees except the approved harvesting of forest products pursuant to N.J.A.C. 7:7A-2.5 (a) 2.

The term "regulated activity" includes the discharge of dredged or fill material into State open waters.

For land use purposes, hydric soils present many problems for development of any kind. Limitations are: seasonally high water tables; frequent flooding; low bearing strength; the possibility of severe subsidence; ground water seepage; inability to absorb and process septic effluent; and high frost action potential. Ignoring these limitations is very costly both to developers and to municipalities in the long run.

The obvious value of hydric soil and wetland areas has been outlined above. The less tangible values - recreational, educational, scientific and aesthetic - would make it apparent that these areas should be conserved and preserved for these uses. While many of us readily grasp the importance of preserving forests, sand dunes and lakes for their aesthetic value alone, we remain blind to the less obvious charms of a healthy swamp. However, with our increased knowledge about the structure, functions and uses of wetlands in their natural state, we are now able to assess the ecological, economic and social consequences of developing in those sensitive areas and use what we have learned to the benefit of all.

Major sources of information

Balfour, E.B., *The Living Soil*, New York: Devin-Adair Co. 1950

Hamaker, John D., in *The Survival of Civilization*, California: Hamaker-Waver Pub.: New York. 1982

Horowitz, Elinor L., *Our National Wetlands, an Interagency Task Force Report*, U.S. Gov't. Printing Office, Wash. D.C. 1978

N.J. Dept. of Community Affairs, Div. of Local Govt. Services, Local Planning Assistance Unit, *A guide to the Environmental Aspects of the Local Planning Process*, Trenton, N.J., Sept. 1976.

N.J. Dept. of Environmental Protection, *Water Resources News*, Fall 1987, V. 3, No. 4. 1987

N.J. Dept. of Environmental Protection, *Freshwater Wetlands Protection Act Rules, N.J.A.C. 7:7A*, Adopted May 16, 1988, Division of Coastal Resources, Trenton, N.J. 1988

Non-tidal Wetlands Protection: A Handbook for Maryland Local Governments, 1983. (Source unknown)

Oberlander, Theodore M. and Muller, Robert A., *Essentials of Physical Geography Today*, New York: Random House. 1982

Rutgers University, *Watershed Management Strategies for New Jersey*, Cook College, N.J. Agricultural Experimental Station Publication H-17505-1-89, April 1989.

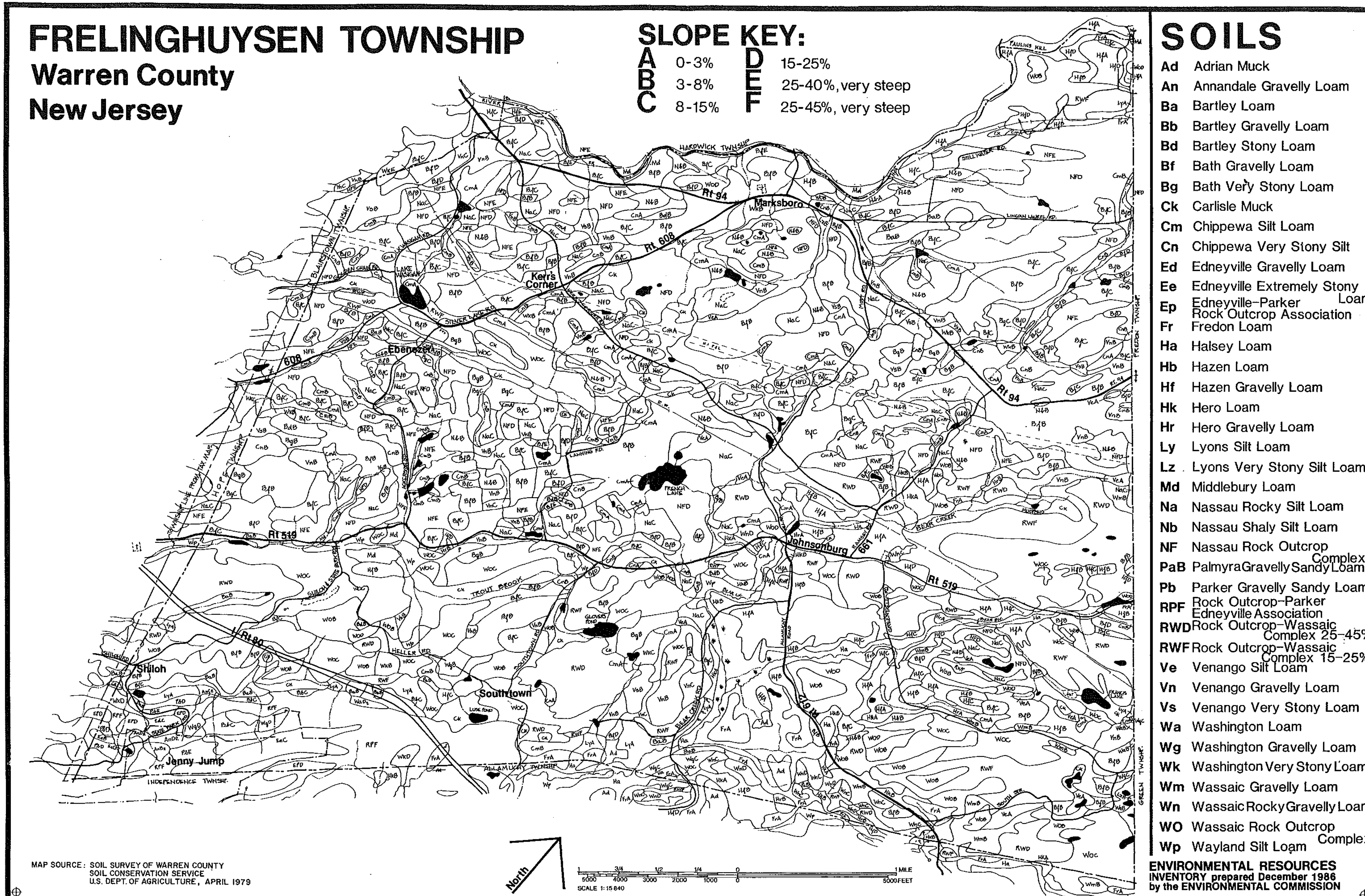
Steila, Donald, *The Geography of Soils*, Prentice-Hall: Englewood Cliffs, N.J. 1976

Thurow, Charles, Toner, William, and Erley, Duncan, *Performance Controls for Sensitive Lands, A practical Guide for Local Administrators*, ASPO Planning Advisory Service, Report No. 307 and 308.

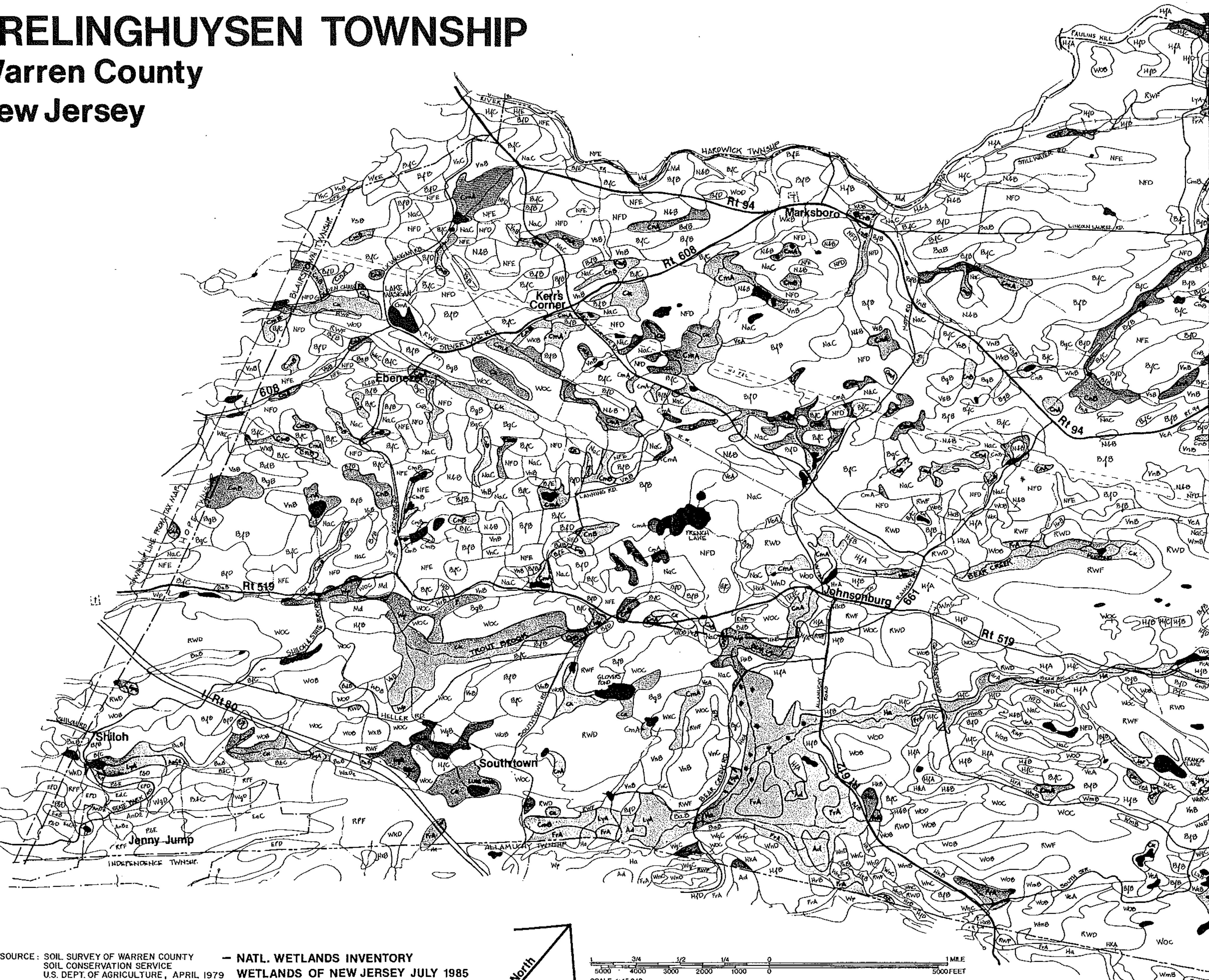
R.W. Tiner, *Wetlands of New Jersey. National Wetlands Inventory*, U.S. Fish & Wildlife Service, Newton Corner, MA. July, 1985

U.S. Dept. of Agriculture, *Soil Survey of Warren County, N.J.*, Soil Conservation Service.

U.S. Environmental Protection Agency, *Non-point Source Pollution in Surface Water*, NERC No. 680/4-75-004. 1975


FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey
SLOPE KEY:
A 0-3%
B 3-8%
C 8-15%
D 15-25%
E 25-40%, very steep
F 25-45%, very steep
SOILS
Ad Adrian Muck
An Annandale Gravelly Loam
Ba Bartley Loam
Bb Bartley Gravelly Loam
Bd Bartley Stony Loam
Bf Bath Gravelly Loam
Bg Bath Very Stony Loam
Ck Carlisle Muck
Cm Chippewa Silt Loam
Cn Chippewa Very Stony Silt
Ed Edneyville Gravelly Loam
Ee Edneyville Extremely Stony Loam
Ep Edneyville-Parker Rock Outcrop Association
Fr Fredon Loam
Ha Halsey Loam
Hb Hazen Loam
Hf Hazen Gravelly Loam
Hk Hero Loam
Hr Hero Gravelly Loam
Ly Lyons Silt Loam
Lz Lyons Very Stony Silt Loam
Md Middlebury Loam
Na Nassau Rocky Silt Loam
Nb Nassau Shaly Silt Loam
NF Nassau Rock Outcrop Complex
PaB Palmyra Gravelly Sandy Loam
Pb Parker Gravelly Sandy Loam
RPF Rock Outcrop-Parker Edneyville Association
RWD Rock Outcrop-Wassaic Complex 25-45%
RWF Rock Outcrop-Wassaic Complex 15-25%
Ve Venango Silt Loam
Vn Venango Gravelly Loam
Vs Venango Very Stony Loam
Wa Washington Loam
Wg Washington Gravelly Loam
Wk Washington Very Stony Loam
Wm Wassaic Gravelly Loam
Wn Wassaic Rocky Gravelly Loam
WO Wassaic Rock Outcrop Complex
Wp Wayland Silt Loam
HARDWICK TWNSHP
Rt 94
Marksboro
Rt 608
Kerr's Corner
Lake Naskan
Ebenezer
608
French Lake
Johnsonburg
Rt 519
Bear Creek
Trout Brook
Rt 80
Shiloh
Southtown
Jenny Jump
INDEPENDENCE TWNSHP
ALLAMUCHY TWNSHP
GREEN TWNSHP
FREDON TWNSHP
North
SCALE 1:15 840
MAP SOURCE: SOIL SURVEY OF WARREN COUNTY
SOIL CONSERVATION SERVICE
U.S. DEPT. OF AGRICULTURE, APRIL 1979
ENVIRONMENTAL RESOURCES
INVENTORY prepared December 1986
by the ENVIRONMENTAL COMMISSION

FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



MAP SOURCE: SOIL SURVEY OF WARREN COUNTY
SOIL CONSERVATION SERVICE
U.S. DEPT. OF AGRICULTURE, APRIL 1979

— NATL. WETLANDS INVENTORY
WETLANDS OF NEW JERSEY JULY 1985

HYDRIC SOILS

GROUP I
(Nearly always hydric condit.)

ADRIAN	Ad
CARLISLE	Ck
CHIPPEWA	Cm, Cn
HALSEY	Ha
LYONS	Ly, Lz
WAYLAND	Wp

GROUP II
(Nearly consistent hydric condit.)

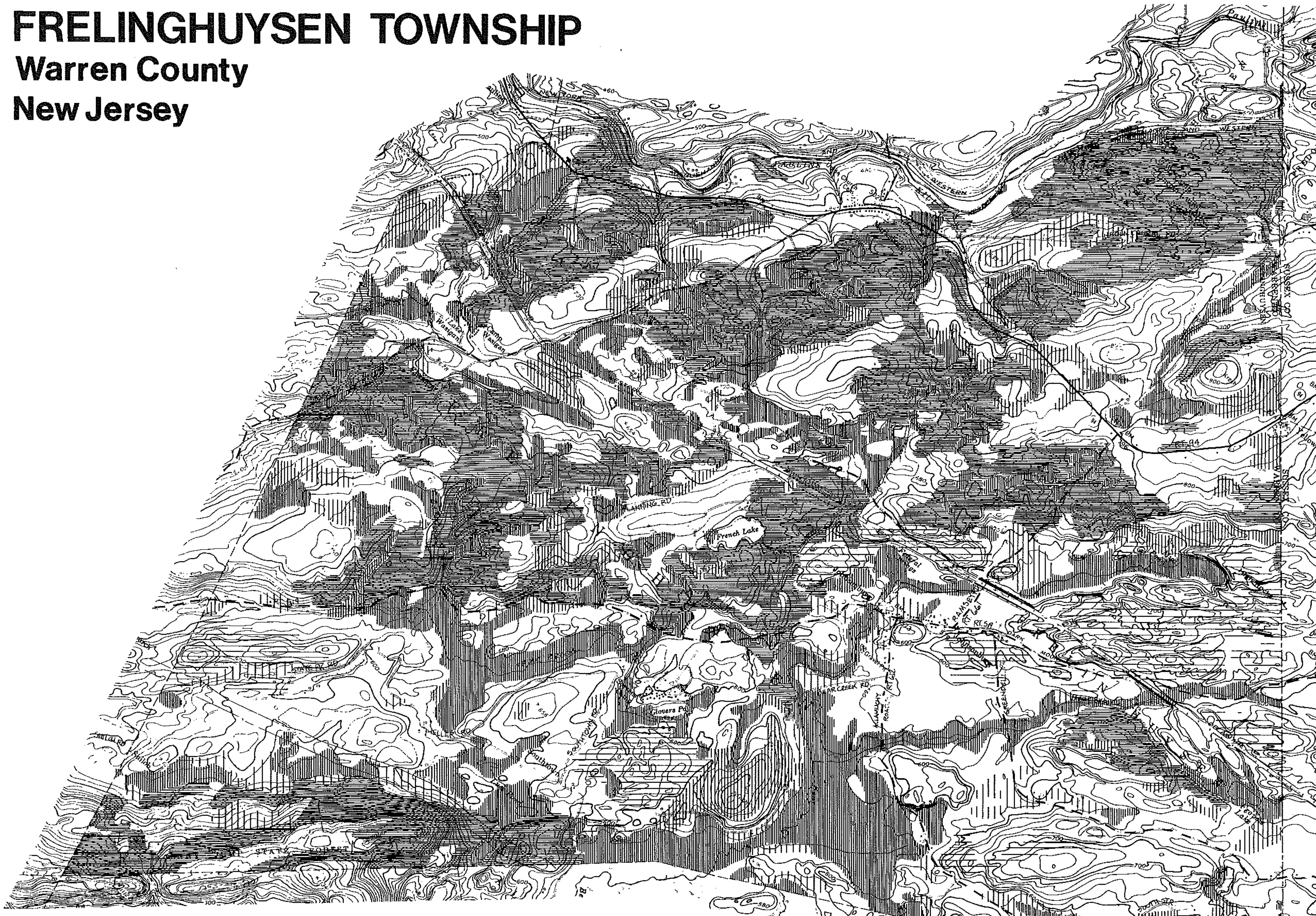
FREDON	FrA

GROUP III
(To be verified in field)

VENANGO	VeA, VnB, VnC, VsB

ENVIRONMENTAL RESOURCES INVENTORY prepared December 1986 by the ENVIRONMENTAL COMMISSION

FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



NATURAL SOIL DRAINAGE

- Excessively drained
- Excessive to Well drained
- Well drained
- Moderately Well drained
- Somewhat poorly drained
- Poorly to Very Poorly drained

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

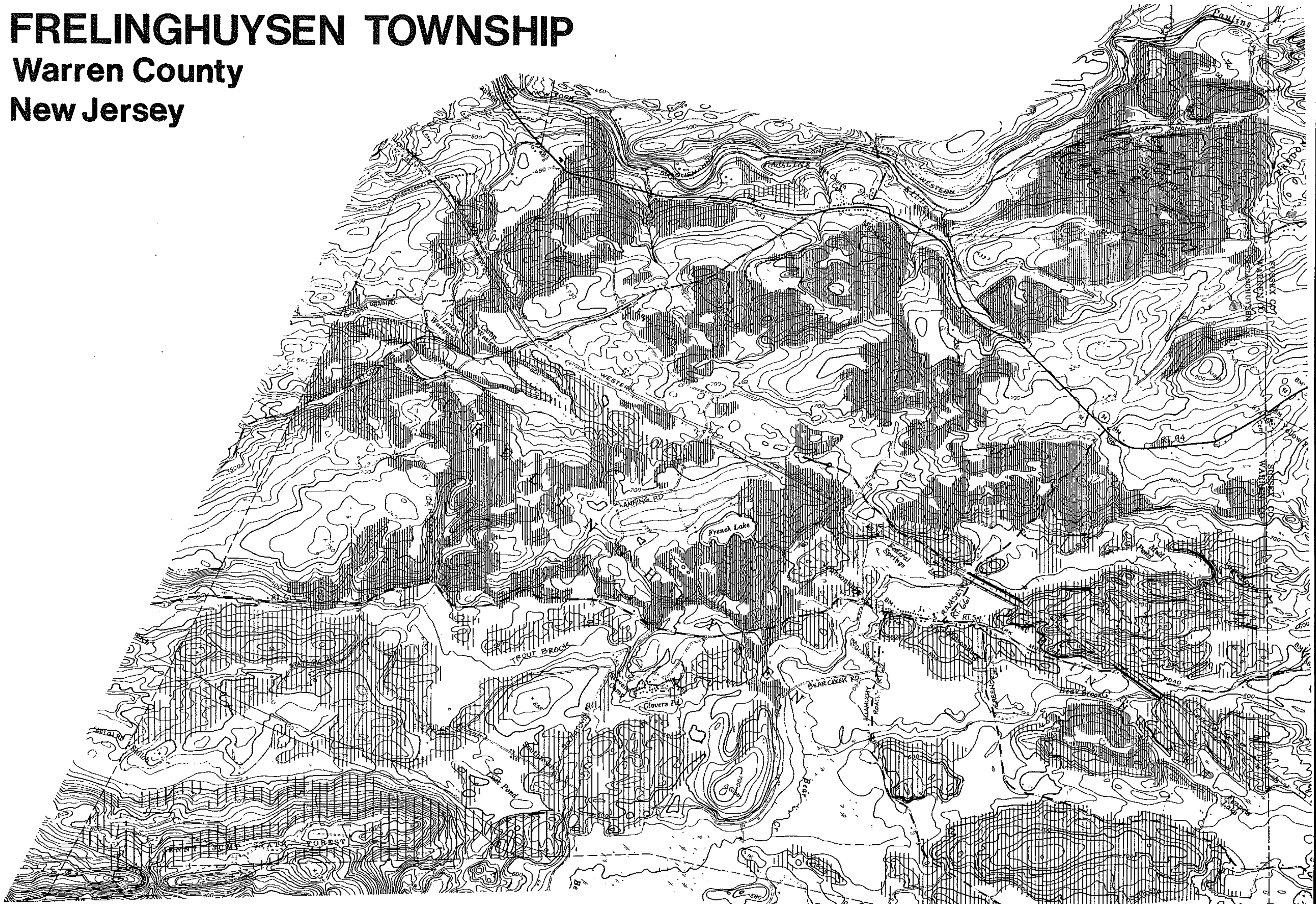
AND THE SOIL SURVEY OF WARREN COUNTY
SOIL CONSERVATION SERVICE-U.S.D.A.-1979

NORTH

3/4 1/2 1/4 0 1 MILE
5000 4000 3000 2000 1000 0 5000 FEET
Scale 1:15840

ENVIRONMENTAL RESOURCES
INVENTORY prepared December 1986
by the ENVIRONMENTAL COMMISSION

FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



DEPTH TO BEDROCK

- 10 - 20 Inches
- 20 - 40 Inches
- 40 - 60 Inches
- 60 Inches +

MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

AND THE SOIL SURVEY OF WARREN COUNTY
SOIL CONSERVATION SERVICE - U.S.D.A. 1979

NORTH

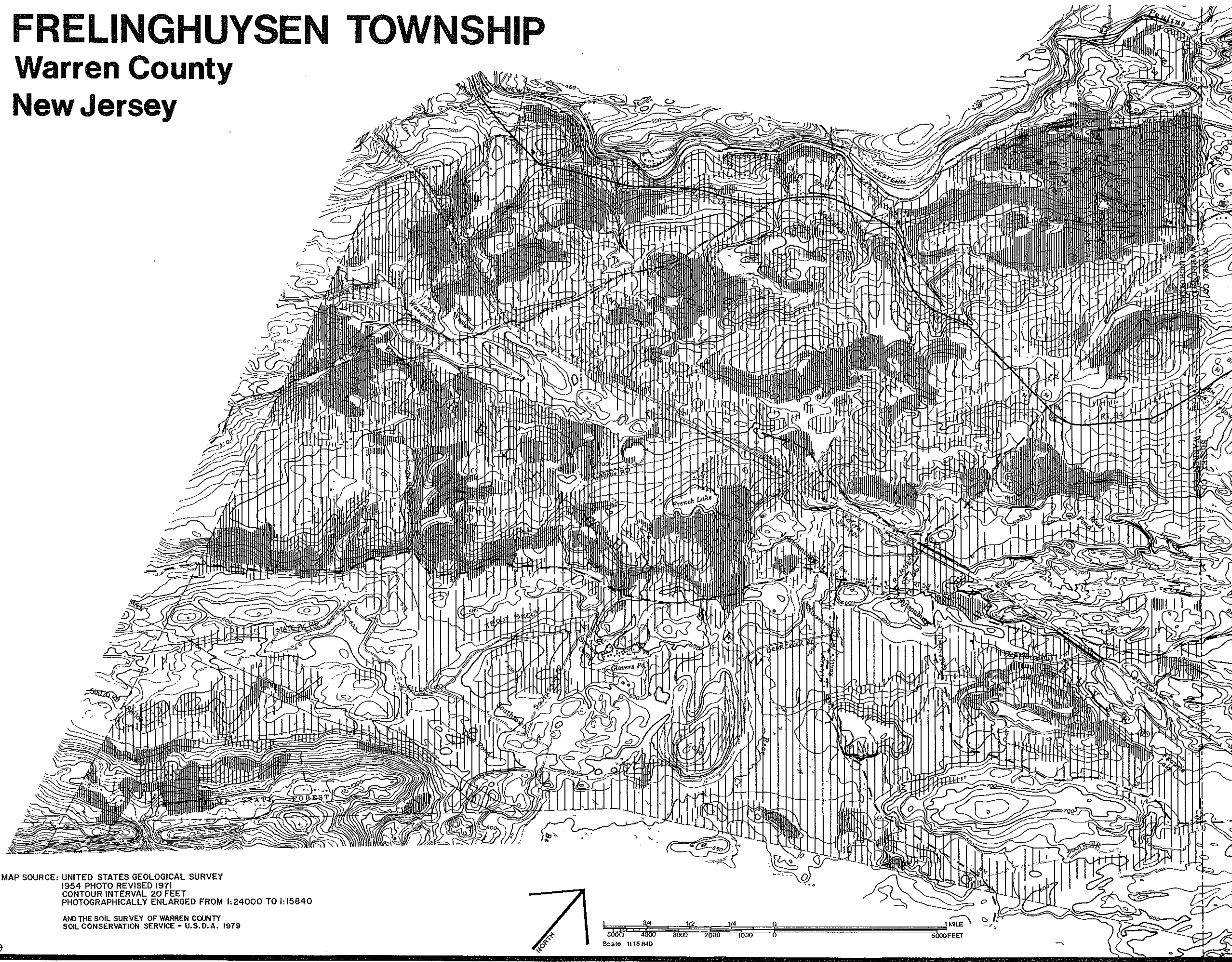
3/4 1/2 1/4 0 1 MILE
5000 4000 3000 2000 1000 0 5000 FEET
Scale 1:15 840

ENVIRONMENTAL RESOURCES
INVENTORY prepared December 1986
by the ENVIRONMENTAL COMMISSION

FRELINGHUYSEN TOWNSHIP

Warren County

New Jersey



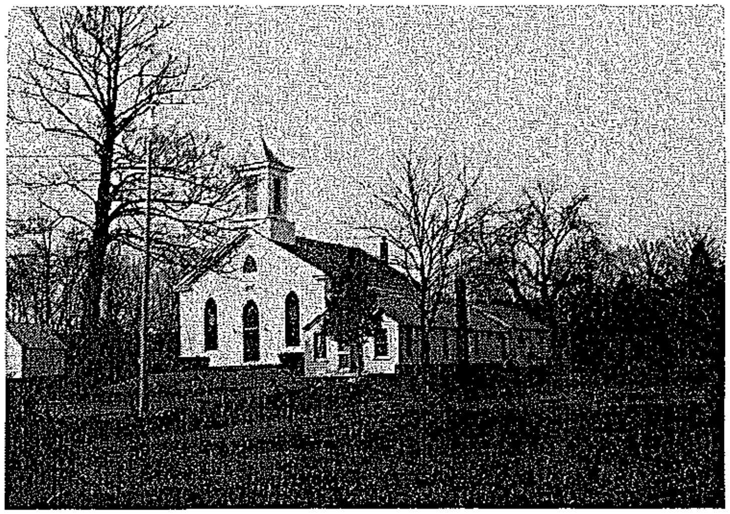
SOIL EROSION HAZARD

- severe
- moderate
- slight

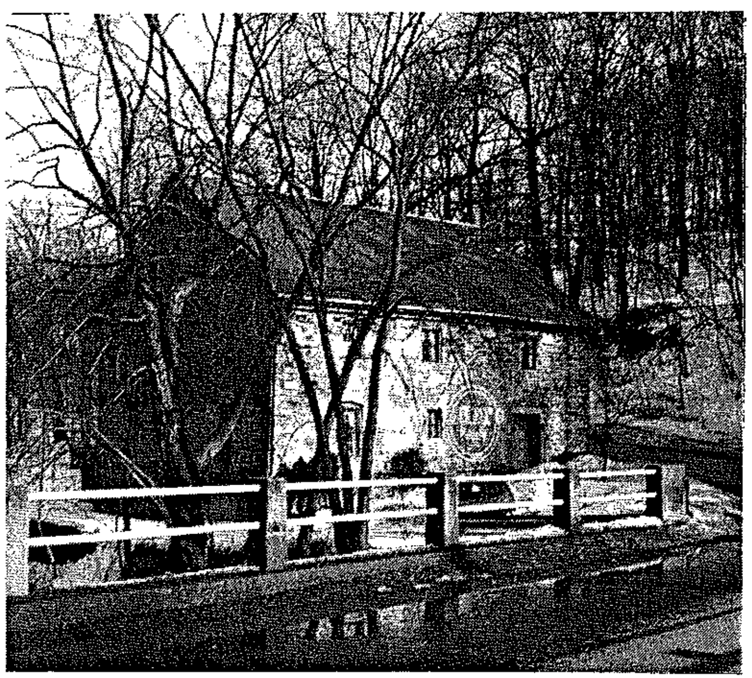
MAP SOURCE: UNITED STATES GEOLOGICAL SURVEY
1954 PHOTO REVISED 1971
CONTOUR INTERVAL 20 FEET
PHOTOGRAPHICALLY ENLARGED FROM 1:24000 TO 1:15840

AND THE SOIL SURVEY OF WARREN COUNTY
SOIL CONSERVATION SERVICE - U.S.D.A. 1979

ENVIRONMENTAL RESOURCES
INVENTORY prepared December 1986
by the ENVIRONMENTAL COMMISSION



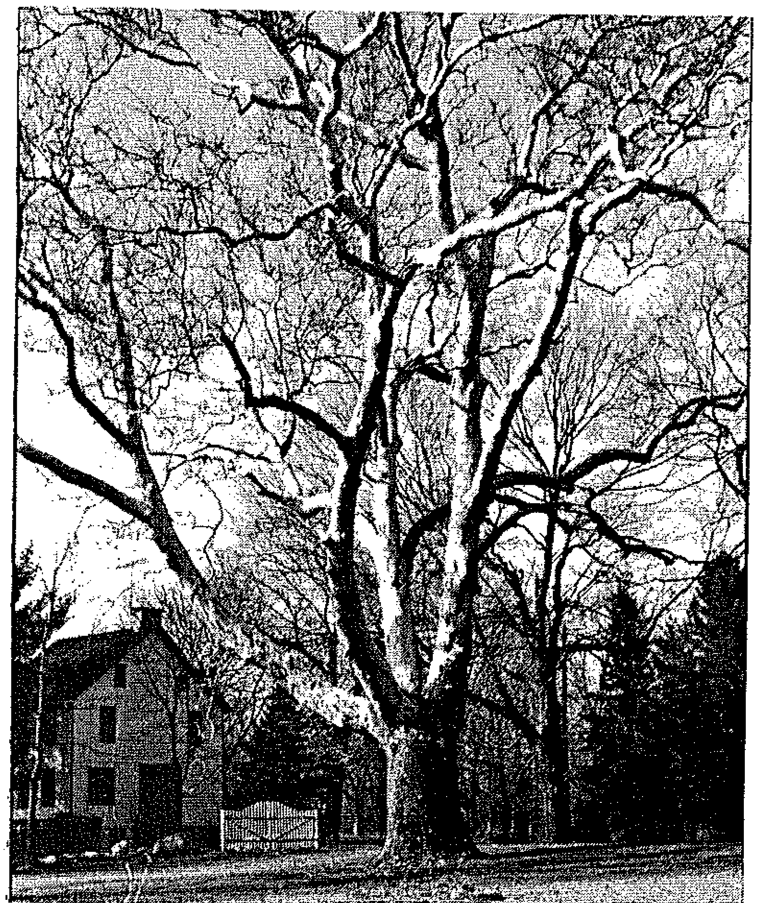
Old Stone Bridge across Paulinskill, Stillwater Road.



Marksboro Mill, 1760.

PART II.

PLANT AND WILDLIFE RESOURCES



Historic Buttonball Tree at Kerr's Corner

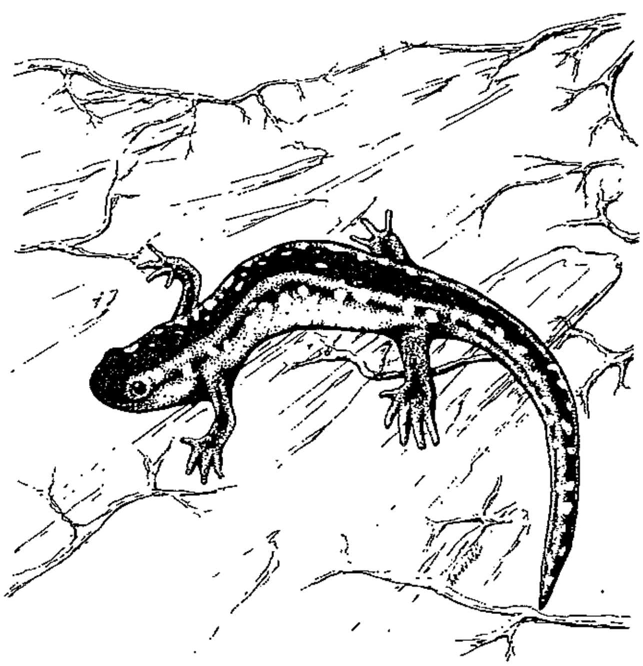
INTRODUCTION

The information so far provided in this inventory has described the specific character and history of the geology, soils, climate and hydrology of this region as a basis for understanding its carrying capacity for living systems.

Whether we speak of the living communities of vegetation (flora) or of the communities of insects, birds, reptiles, fish or mammals (fauna), the abundant and diverse species are totally dependent upon the soils, water and air systems. Equally important, the flora and fauna provide the essential links for sustaining the air, water and nutrient cycles upon which the quality of life for humans ultimately depends.

The flora and fauna of this region have emerged, adapted, and contributed to the natural vitality of this region over the past 10,000 years. Since the recession of the last glaciation, the Wisconsin Ice Age, the diversity of life has been sustained and regenerated by the integral functioning of the entire community of living system with each other.

Frelinghuysen Township is connected by the geological and biological history to the vast region of the Appalachian Ridge and Valley and the Delaware River System. As such, it is also linked to the diverse communities of plant and animal life which have heretofore contributed to the natural regeneration of the entire region.



Spotted Salamander

Over the last 300 years since European settlement, the region has changed dramatically. At the present time, its rural and agricultural character may be further altered as the pressures of development increase throughout the northeastern urban corridor. Wise judgment and decisions must be made at the municipal level to assess the potential and limits of growth. The overall health, security and well-being of the human community is dependent on the health, security and well-being of the natural systems. Thus, township planning must be based on the inherent limitation of these systems to survive within the scope and diversity of habitat in which the renewal of air, water and nutrients can take place.

This inventory lists the native species of vegetation of our township, as well as the specific terrains which sustain them. These habitats are the natural setting in which the birds, fish, reptiles and mammals exist.

This inventory also lists species of plant and wildlife so highly stressed that their survival is endangered. At Federal, State and Municipal levels, enlightened leaders are urged to protect and enlarge the conditions by which these species can be brought to balance. Those species are given special emphasis in this inventory.

Within the overall context of New Jersey's land mass, this region still preserves an abundant and diverse community of vegetation and wildlife. It is this fragile vestige of wilderness that is at a critical moment. It can be responsibly preserved as our legacy to the future. It is hoped that this inventory of species will become its own best protection against the short-term gains of economic growth.

VEGETATION

INTRODUCTION

Frelinghuysen Township is blessed with a large amount of open space and variety of habitats which support an abundance of vegetation. Some of this vegetation grows in so-called critical areas and has to be carefully protected to avoid undesirable effects such as flooding, soil erosion, and contamination of ground water.

The accommodation of an ever larger population, together with the trend toward more commercial and residential use of land each year, means that, each year, less natural vegetation is left. An important action of man that has an impact on vegetation is lumbering. When trees are cut selectively, forests will show little change in species composition; clear cutting, on the other hand, may change the composition of a forest so that is becomes quite different from what it was before it was first cut. Other than glaciation and its accompanying climatic change, man has had the greatest impact on vegetation. For example, Indians for years routinely set fires to the forests so as to create habitats for game; they recognized that many types of game, such as deer, prefer open woods to the dense forests. They also used fire to drive game. Thus, contrary to popular belief, the first European settlers to come to New Jersey and to this area did not find a vast expanse of virgin forest. Although the Indians' use of indiscriminate fires had a marked impact on vegetation, the European settlers and their descendants truly disturbed the vegetation. With the increase in population pressure, especially in the last few years, land values have increased astronomically and, as a consequence, farmland has been sold to builders and developers. There are now only a handful of working farms; and many of the open fields that presently are not used as building sites or horse pastures, are reverting to their natural state though various stages of successive vegetation.

ECOLOGICAL SUCCESSION

When a field that had been cultivated is left abandoned, the first plants to grow successfully are those with short lives. Of these, ragweed is the most abundant. Also, common invaders in the first year are the wild radish and wintercress; the latter can be seen in May and June as a blanket of yellow blooms. By the second year, more dominant plants such as the perennial goldenrods and asters develop. Other herbs start to grow in the field. One of the most common is a high-growing wild grass known as Little bluestem. Less common, but conspicuous for their flowers, are Queen Anne's lace, common mullein, daisy and black-eyed Susan. This herbaceous cover may persist for several years and then the seeds of woody shrubs and trees successfully germinate in the field and grow taller than the herbs. The first woody plant to show up conspicuously is the red cedar (Juniperus virginiana). As these trees get well established, they are joined by seedlings of other trees such as red maple (Acer rubrum), wild black cherry (Prunus serotina), white ash (Fraxinus americana) and staghorn sumac (Rhus typhina). In addition, lower growing shrubs such as gray dogwood, autumn olive, blackberries, wineberries, and black haw are interspersed with young trees.

In twenty to thirty years, either the grasses crowd out the showy flowering herbs or the trees shade them out. In about fifty years, the once-abandoned field will have been transformed to an open woodland of fairly tall trees. The trees of the first stage of the succession will have been eliminated as they are not tolerant of shade, and the trees whose seedlings can tolerate some shade - such as oaks, maples, ash and hickories - will become dominant. Eventually, the trees block out so much light that only young trees of such species as hemlock, beech, and maple can survive. In the temperate zone this is known as the climax forest. In Frelinghuysen Township, this stage has been reached in a few isolated areas whereas, in most of the township, this may never occur due to activities of man such as lumbering and clearing for pasture and development. Areas of climax forest can be seen along Southtown Road, the Presbyterian Camp site, Jenny Jump State Park, and other spots in the Mud Pond vicinity. Because of their rarity and beauty, these forests deserve some protection.

BENEFITS OF VEGETATION

Without vegetation, humans would not have developed at all in their present form. Oxygen in the atmosphere developed only after the advent of plant life, as a product of photosynthesis. Plants are the first link in the food chain (fig. 21); they are able, via photosynthesis, to transform non-living materials into organic foods. Thus, man depends upon plants as the initial source for all his food as well as for much of the material used for his shelter and clothing. Man may eat plants directly or indirectly when he eats meat from animals which, in turn, depend on plants as their initial source of food. While man is totally dependent on vegetation, his actions usually are destructive to vegetation. In addition to being physiologically and economically essential to humans, plants have great aesthetic value, improve man's environment and contribute to his

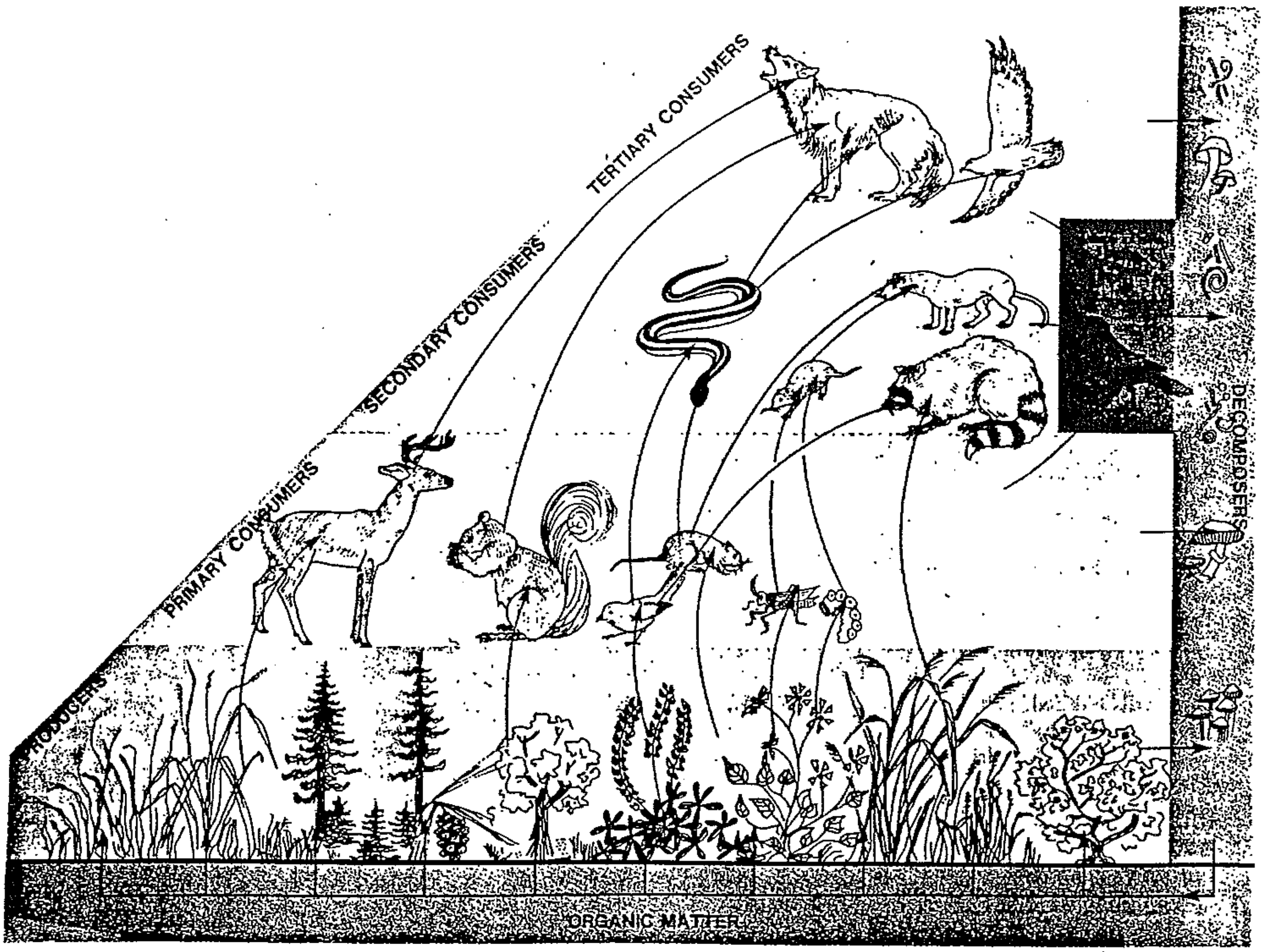


Fig 21 - Food Web (from *Ecological Planning for Farmlands Preservation.* See references)

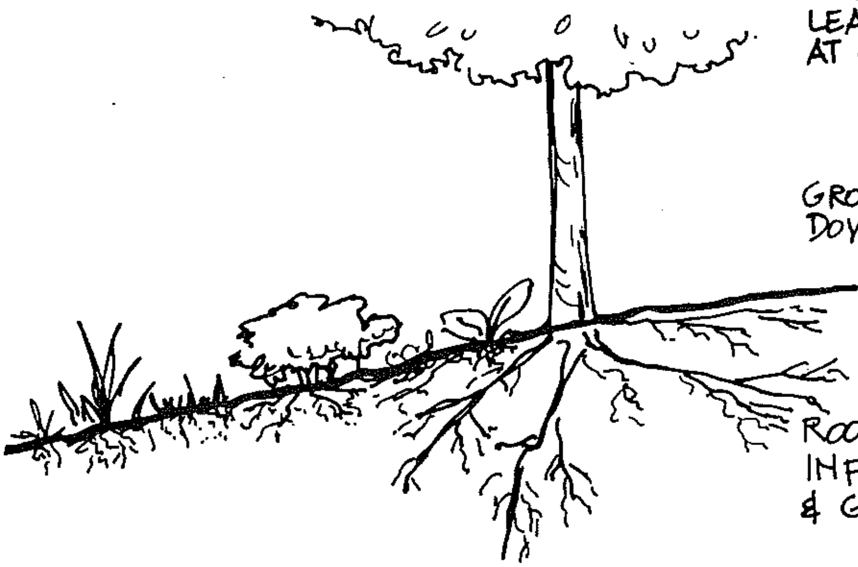


Fig 22A - Vegetation slows down run-off

mental health. People, to escape from the many stresses of life today, seek the change of pace that woodlands, lakes and gardens offer.

Forests and other plant cover on slopes prevent erosion and the loss of soil nutrients. Also, forest vegetation increases the rate at which water infiltrates into the soil and thus aids in the recharge of aquifers. As little as 5% of the rain falling on a forested area will run off into streams and rivers. Vegetation anchors the soil so that wind and water cannot carry it away. Flood plains adjacent to streams and rivers, with their typical vegetation, slow down flood waters and lessen the hazards of downstream flooding. (fig. 22A and 22B).

Woodlands, marshes, swamps and abandoned fields with their thickets and herbaceous ground cover provide diverse habitats for many species of animals, including many game animals. Birds and mammals can live, breed and find sufficient food such as berries, nuts and herbage in these habitats.

Plants also serve as traps for air-borne dust, and carbon and ash particles (fig. 23). Rain washes these trapped particles to the ground where they become part of the soil. By absorption, plants remove noxious gases, carbon dioxide, carbon monoxide, sulfur dioxide and odor from the air. Free oxygen and water vapor are added to the atmosphere as by-products of photosynthesis.

Vegetation ameliorates the extremes of temperature in summer and winter. A forest canopy can lower summer temperatures as much as 21° F. (fig. 24). Appropriate plantings of trees and shrubs lessen the impact of severe winds (fig. 25).

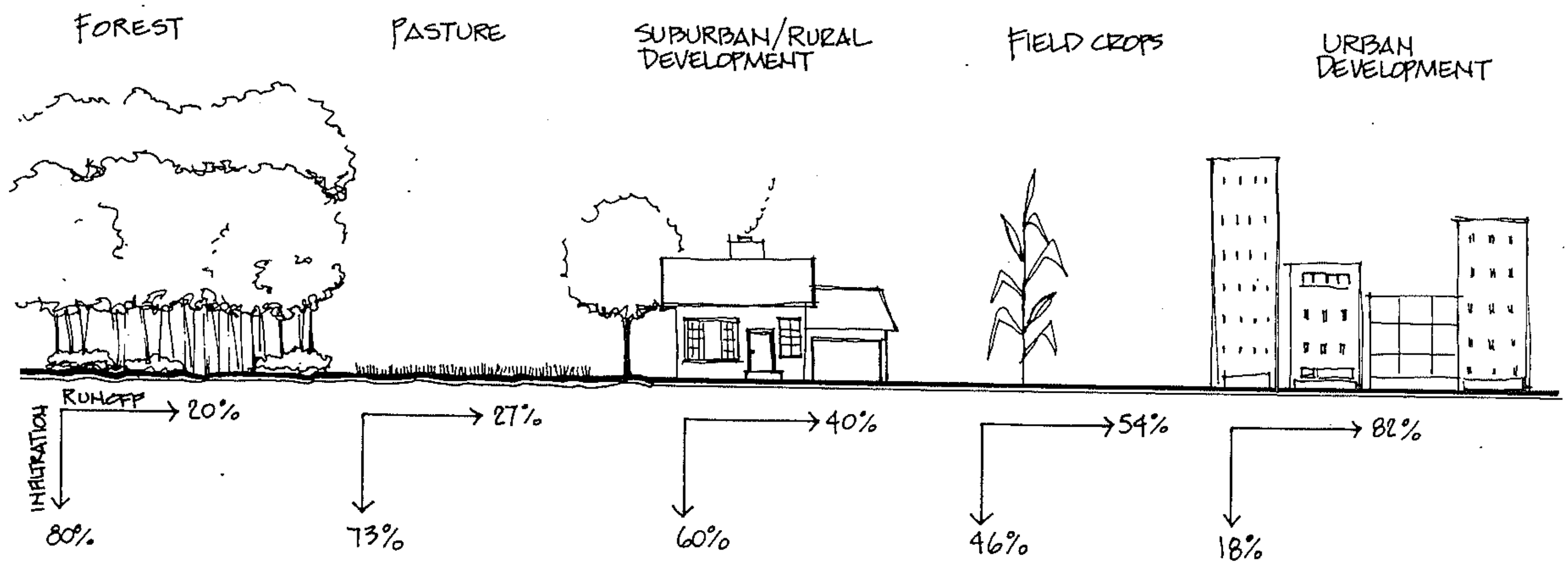


Fig 22B - Proportion of run-off and infiltration for various land uses. (all storm and soil conditions being equal).
(redrawn from *Getting It All Together*, see ref.)

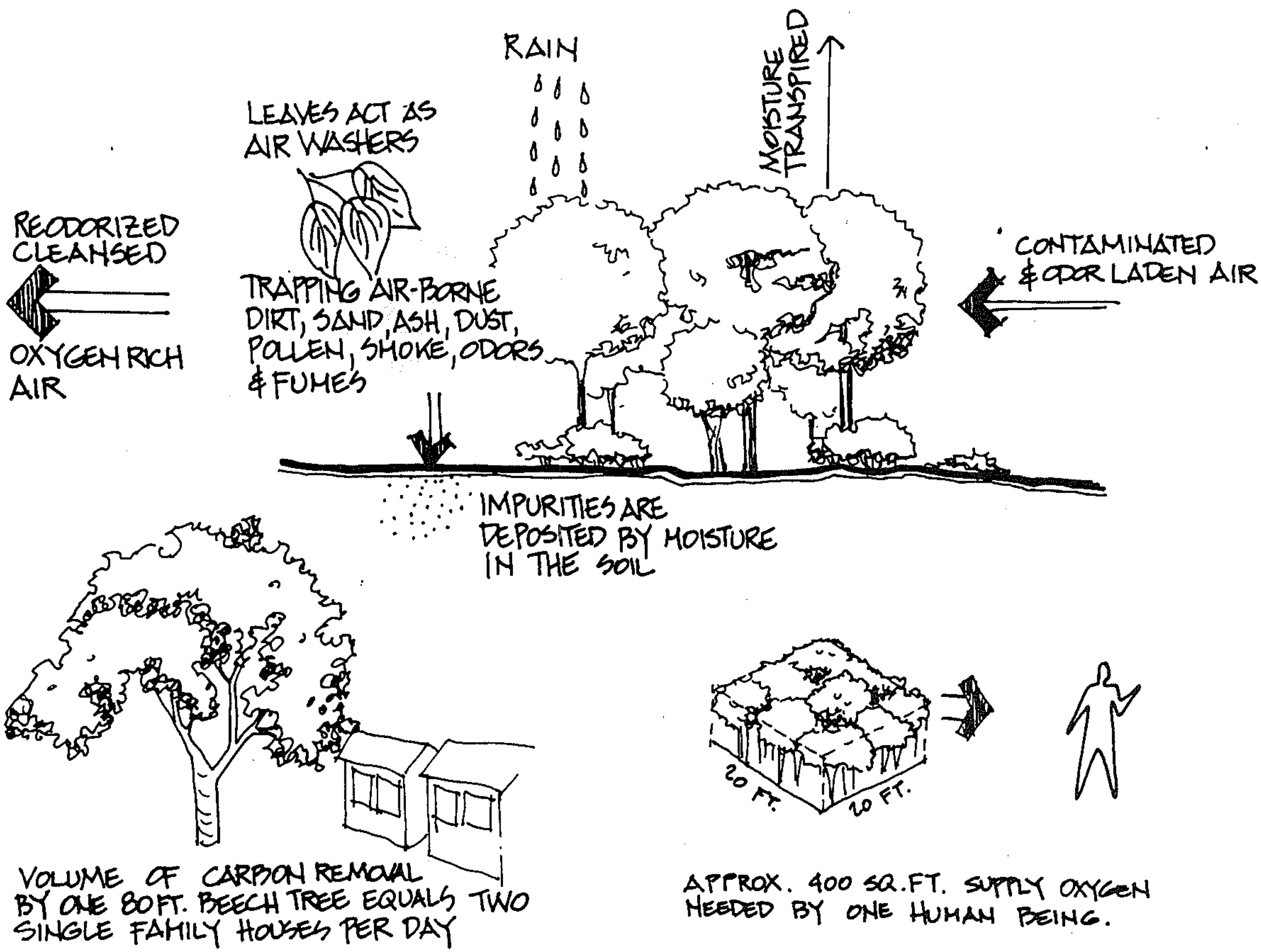


Fig 23 - Vegetation oxygenates, dilutes, filters, cleanses and reodorizes contaminated air.

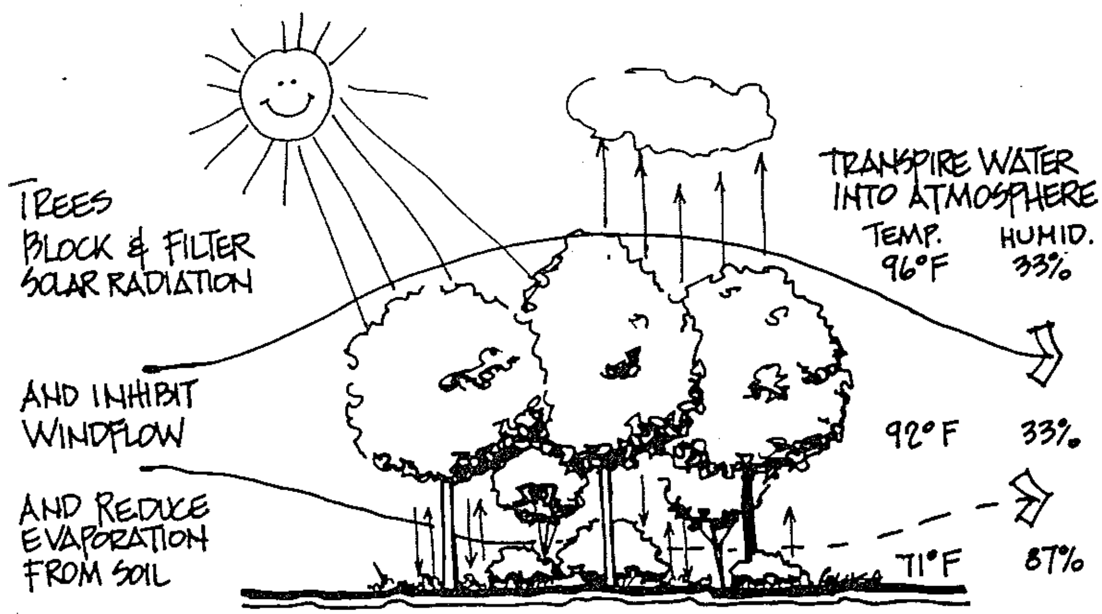
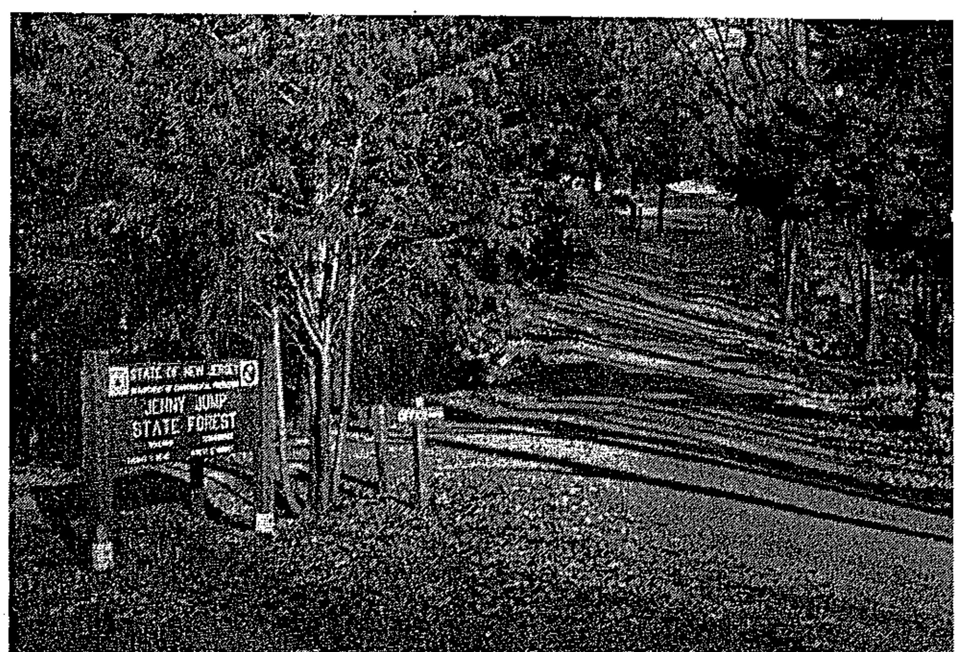


Fig 24 - Vegetation reduces temperature extremes. The relatively high humidity and low evaporation rate act to stabilize temperature, keeping it lower than surrounding air during the day and preventing it from dropping greatly at night. (redrawn based on G. Robinette, 1972).

Vegetation buffers (trees and hedges) reduce noise and provide barriers against unwanted sights and glare from lights. Traffic along a busy highway can generate as much as 72 decibels of sound and each 100 feet of woodland vegetation can absorb six to eight decibels of sound intensity.



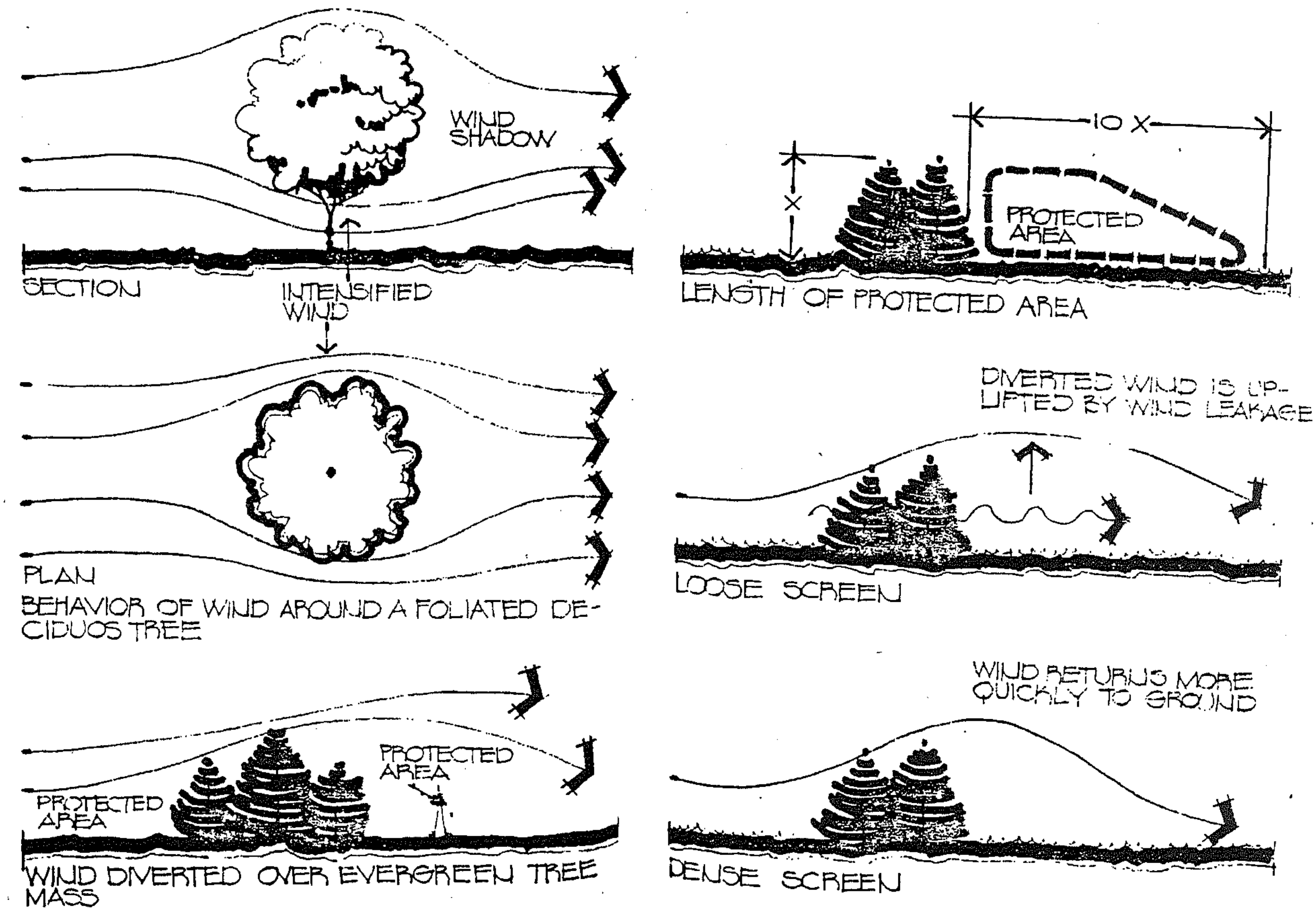


Fig 25 - Vegetation reduces wind impact. (from N.K. Booth, see references).

CHARACTERISTIC WOODLANDS

Frelinghuysen Township lies in the physiographic province known as the Ridge and Valley which occupies the northwestern corner of the state and is the region with the highest elevation in New Jersey. The Ridge and Valley terrain supports a distinct type of forest because of the bedrock underlying it. In general, the soil covering the ridges is poor, acid, often stony, and does not usually support abundant vegetation. The soil layer is thin on the ridges with bedrock exposed in many places. In contrast, the soils in the valleys, derived from limestone and shale that were covered by glacial till, are, for the most part, deeper, more fertile, and well drained.

The vegetation existing in any given area is dependent on terrestrial habitat with its characteristic soils. In Frelinghuysen Township, the habitats include freshwater marshes, flood plains, mesic uplands (ravines, valleys, flat slopes), steep slopes of higher elevations, and rock outcrops. Hazen-Hero-Fredon, Wassaic-Washington Rock Outcrop, and Annandale-Washington-Califon are good soils for woodlands. Bath-Nassau soils are only fair and Carlisle-Adrian soils are poor as they are found in wetlands.

In an area undisturbed by man diversity of vegetation is dependent solely on variety of plant habitats with each habitat having its characteristic or dominant species. For example, the characteristic appearance of upland vegetation is that of a forest because the most abundant or dominant species are trees. Forests may differ also in the growth that occurs under the tallest trees. They may, or may not, have a lower level of smaller growing trees (understory), and, in addition, they may, or may not, have a well-developed shrub layer. A shrub is a plant with multiple woody stems and is lower than the understory. Also, the herbs (non-woody plants) may form an abundant cover on a forest floor or may be conspicuously absent. Of the forest cover that now remains on the well-drained uplands in Frelinghuysen Township, the most common is the mixed oak forest (Table VII). Before the early 1900's, this forest was known as the Oak-Chestnut forest as chestnut trees were as abundant then as oaks.

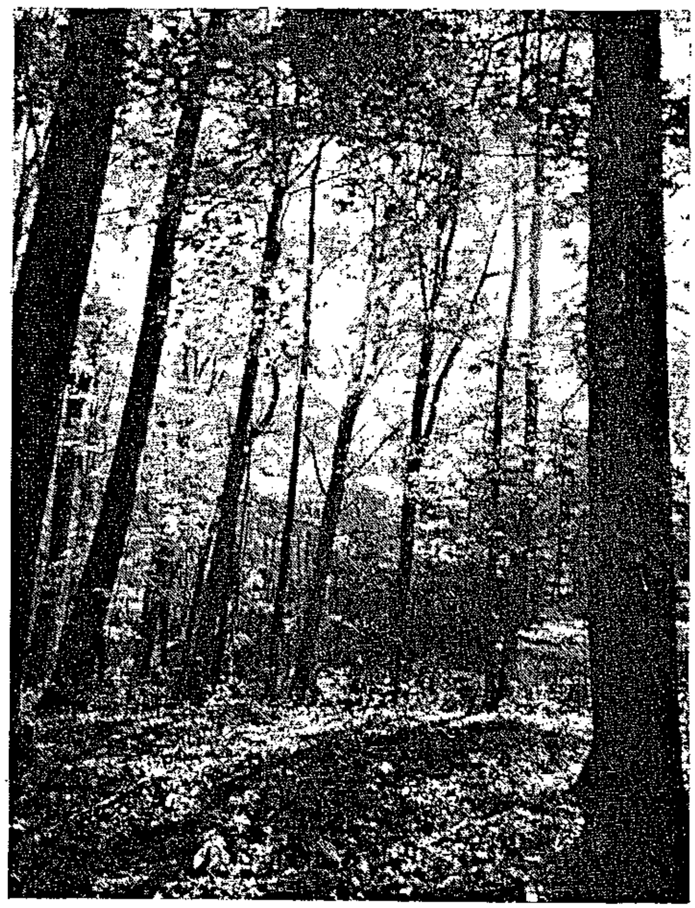
Much of the fertile limestone valleys in Frelinghuysen have been cleared of natural vegetation. It is on such sites that the Sugar Maple-Mixed Hardwood and Mixed Oak forests flourish. (Table VIII).

Although the chestnut oak tree grows in the mixed oak upland forest, it is not one of the abundant trees in this type of forest. But on slopes at higher elevations, the chestnut oak becomes the most important tree in the plant community. It appears to be able to reproduce and develop better than other oaks under drier and poorer soil conditions at higher elevations.

The wetlands-marshes, bogs and swamps - each have a distinctive vegetation. (Table IX). Since no trees grow in marshes, they have the appearance of grassy fields. Swamps, on the other hand, do have a distinctive canopy.

Table VI lists typical mesic upland habitats found in Frelinghuysen Township and successional vegetation if stages of succession are undisturbed.

Appendix "C" provides plant inventories for specific areas within the Township.



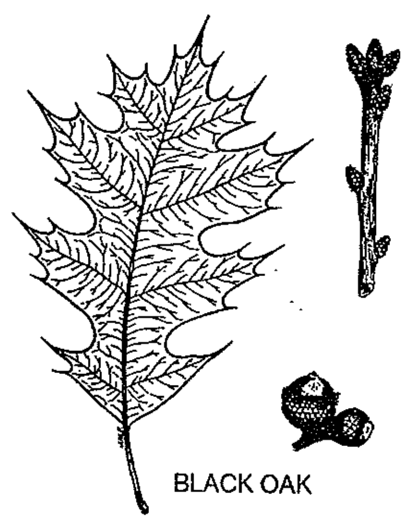
Characteristic Woodland

(Table VI)

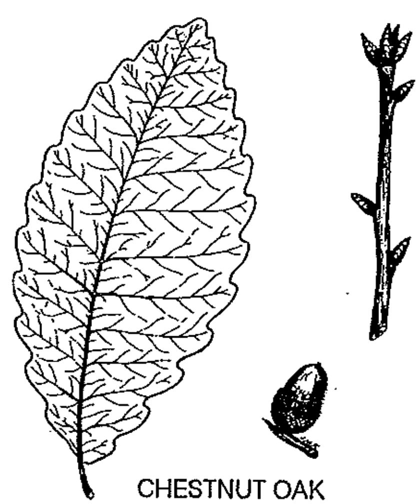
Successional vegetation Stages of succession	Community Structure	Forest types growing on undisturbed mesic upland (flats, slopes, hilltops, and ravines in Appalacian Ridge and Valley Provine) **Mixed oak**	**Sugar Maple mixed hardwoods**	**Hemlock-Mixed hardwoods**
annual herbs ragweed wild radish yellow rocket ⇓	Tree dominants	red oak white oak black oak	sugar maple	hemlock and few others
perennial herbs aster golden rod ⇓ Initial woody invaders: ⇓ red cedar gray birch large-toothed aspen wild cherry red maple shrubs ⇓	Other typical trees	chestnut oak scarlet oak hickories red maple ash beech tulip tree white oak tulip tree other	sweet birch yellow birch basswood beech ash red maple red oak red maple	sweet birch yellow birch basswood beech ash red oak sugar maple
young woodland and mixed oak or tulip tree stand	tree understory (dominant)	dogwood dogwood ironwood sassafras hophornbeam iron weed	hophornbeam sassafras	few
	shrubs	viburnum spicebush others	viburnum spicebush others	few
	herbs	many spring and fall herbs	many spring and fall herbs	few partridge berry mosses

TABLE VI. MESIC UPLAND HABITATS IN NEW JERSEY

WHITE OAK



BLACK OAK



CHESTNUT OAK

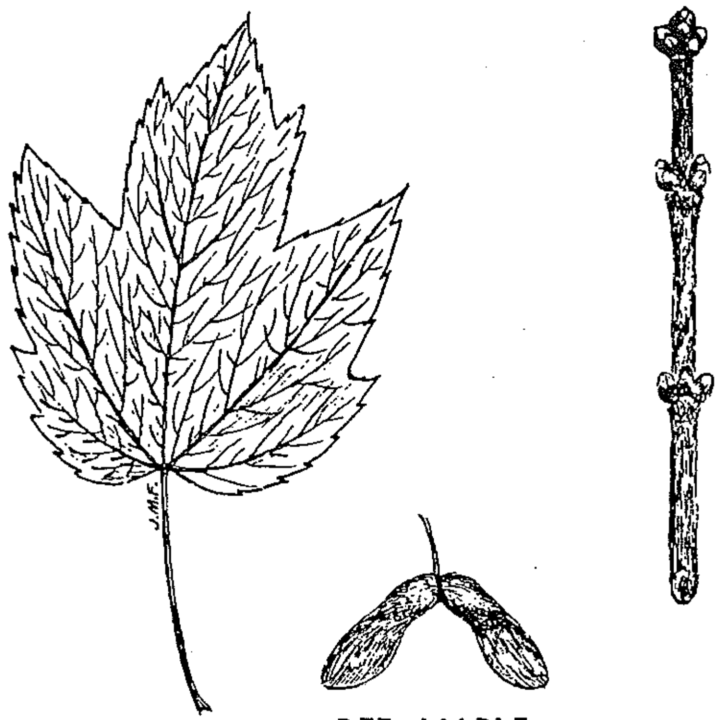
(Table VII)

Tree dominants

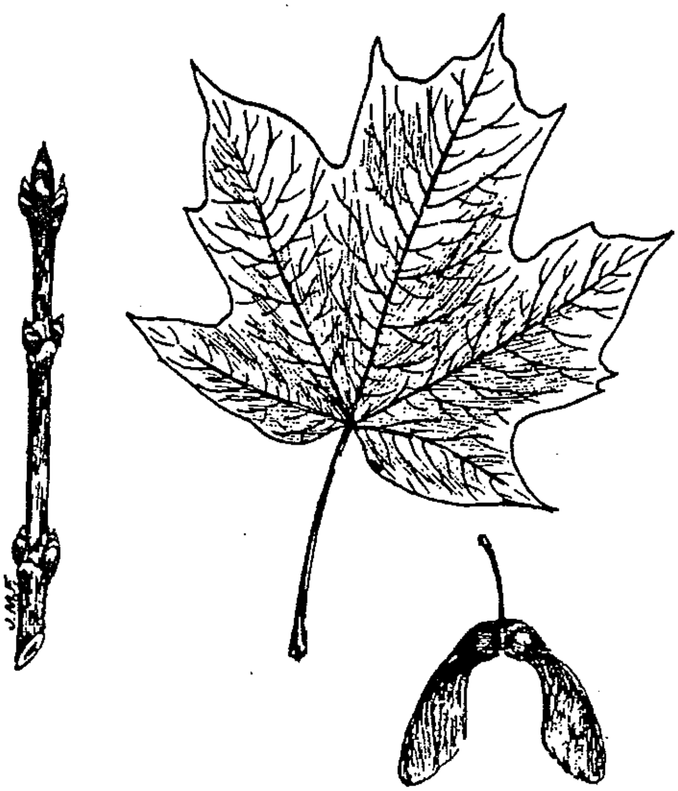
Quercus rubra	Red oak
Quercus alba	White oak
Carya ovata	Shagbark hickory
Fraxinus americana	White ash

Other typical trees

Acer saccharum	Sugar maple
Acer rubrum	Red maple
Carya glabra	Pignut hickory
Liriodendron tulipifera	Tulip poplar
Juglans nigra	Black walnut
Quercus coccinea	Scarlet oak
Sassafras albidum	Sassafras
Prunus serotina	Black cherry
Ulmus americana	American elm



RED MAPLE
(Acer rubrum)



SUGAR MAPLE
(Acer saccharum)

Tree understory

Cornus florida	Flowering dogwood
Ostrya virginiana	Eastern hophornbeam
Carpinus caroliniana	Ironwood
Viburnum prunifolium	Black haw

Shrubs

Cornus alternifolia	Alternate-leaved dogwood
Cornus racemosa	Gray dogwood
Lindera benzoin	Spicebush
Prunus virginiana	Chokecherry
Ribes (many species)	Brambles (raspberry, wineberry,etc.)
Sambucus canadensis	Elderberry

Vines

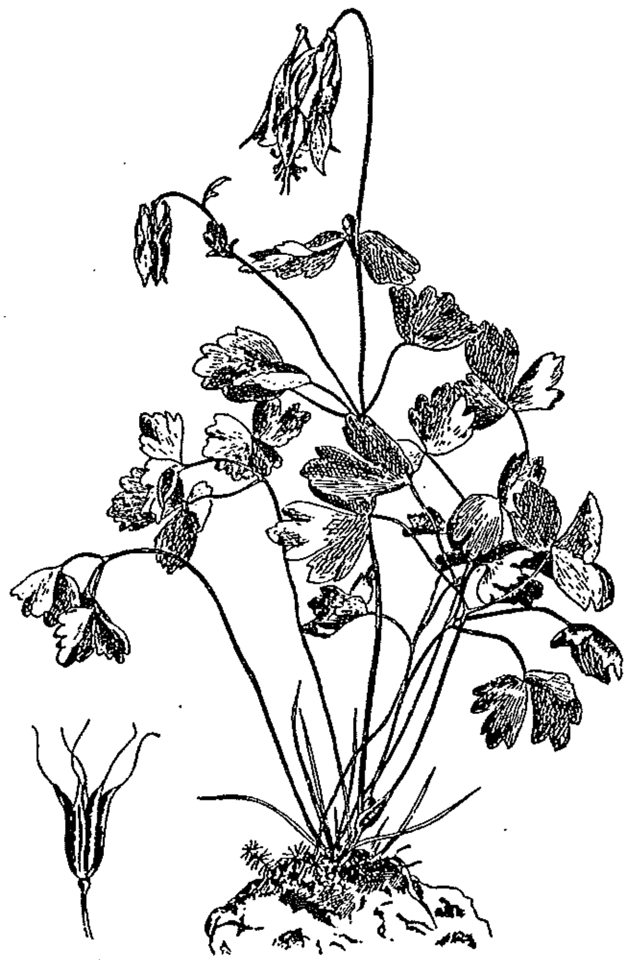
Rhus toxicodendron	Poison ivy
Parthenocissus cinquefolia	Virginia creeper

Herbs (occur where specific conditions exist, i.e. full shade, partial shade, moist depressions, dry rocky slopes, etc.)

Adiantum pedatum	Maidenhair fern
Anemone thalictroides	Rue anemone
Aquilegia canadensis	Wild columbine
Asarum canadense	Wild ginger
Aster nova angliae	New England aster
Arisaema triphyllum	Jack-in-the-pulpit
Dryopteris marginalis	Marginal shield fern
Eupatorium fistulosum	Joe Pye weed

Table VII. PLANTS FOUND IN OAK-HICKORY FORESTS

Eupatorium perfoliatum	Boneset
Geranium maculatum	Wild geranium
Geranium robertianum	Herb-robert
Hepatica americana	Hepatica, liverwort
Heuchera americana	Alumroot
Lobelia siphilitica	Blue lobelia
Maianthemum canadense	Canada mayflower
Oxalis corniculata	Yellow wood sorrel
Pedicularis canadensis	Wood betony
Polygonatum biflorium	Solomon's seal
Podophyllum peltatum	Mayapple
Symplocarpus foetidus	Skunk cabbage
Impatiens pallida (wet)	Pale jewelweed
Impatiens capensis (moist)	Spotted jewelweed
Viola canadensis	Canada violet
Viola pubescens	Downy yellow violet
Geum aleppicum	Yellow avens
Hieracium venosum	Hawkweed
Linaria vulgaris	Butter-and-eggs
Phytolacca americana	Pokeweed
Smilacina racemosa	False Solomon's seal
Polystichum acrostichoides	Christmas fern
Thelypteris hexagonopter	Broad beech fern
Uvularia sessilifolia	Bellwort, wild oats



Fruit.

WILD COLUMBINE.—*Aquilegia canadensis.*

Rootstock.

SOLOMON'S-SEAL.—*Polygonatum biflorum.*

(Table VIII)

Tree dominants

Acer saccharum	Sugar maple

Other typical trees

Acer rubrum	Red maple
Betula lenta	Black birch
Betula lutea	Yellow birch
Betula papyrifera	Gray birch
Fagus grandifolia	American beech
Fraxinus americana	White ash
Quercus alba	White oak
Quercus borealis	Northern red oak
Liriodendron tulipifera	Tulip poplar
Nyssa sylvatica	Black gum
Tilia americana	American basswood
Prunus serotina	Black cherry

TULIPTREE
(Liriodendron tulipifera)

Tree understory

Carpinus caroliniana	Ironwood (American hornbeam)
Ostrya virginiana	Hophornbeam
Cornus florida	Flowering dogwood
Alnus serrulata	Smooth alder

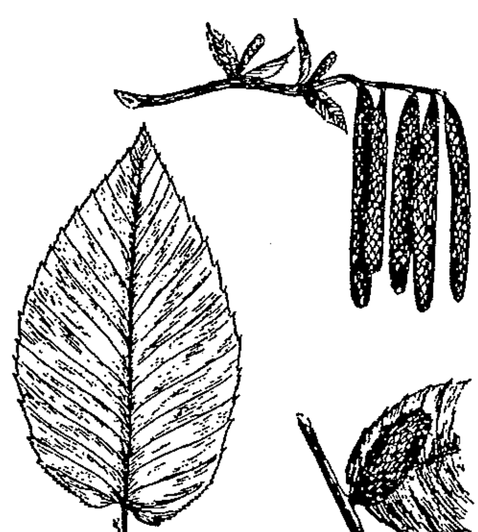
Shrubs

Cercis canadensis	Redbud (rare)
Cornus alterniflora	Alternate-leaved dogwood
Hamamelis virginiana	Witch hazel (rare)
Lindera benzoin	Spicebush
Lonicera varieties	Honeysuckle
Ptelea trifoliata	Hop-tree
Rubus, many	American red rasberry, black rasberry, wineberry (escaped)
Staphylla trifolia	American bladdernut
Ilex verticillata	Black alder (winterberry)
Viburnum acerifolium	Mapleleaf viburnum
Viburnum prunifolium	Black haw
Zanthoxylum americanum	Prickly ash

Vines

Parthenocissus quinquefolia	Virginia creeper
Lonicera japonica (foreign invader)	Hall's (Japanese) honeysuckle
Vitis, many	Grape
Rhus toxicodendron	Poison ivy
Celastrus scandens	American bittersweet
Rubus flagellaris	Common dewberry
Clematis virginiana	Virgin's bower

YELLOW BIRCH
(Betula lutea)

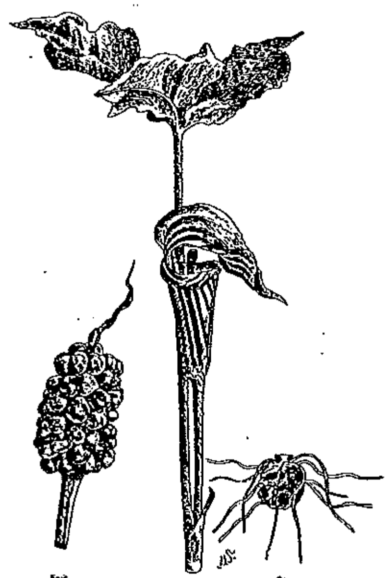


SWEET BIRCH
(Betula lenta)

Herbs (ground layer)

Common plants

Arisaema triphyllum	Jack-in-the-pulpit
Carex laxiflora	Sedge
Carex plantaginea	Plantain-leaved sedge
Claytonia virginica	Spring beauty
Dentaria laciniata	Cut-leaved toothwort

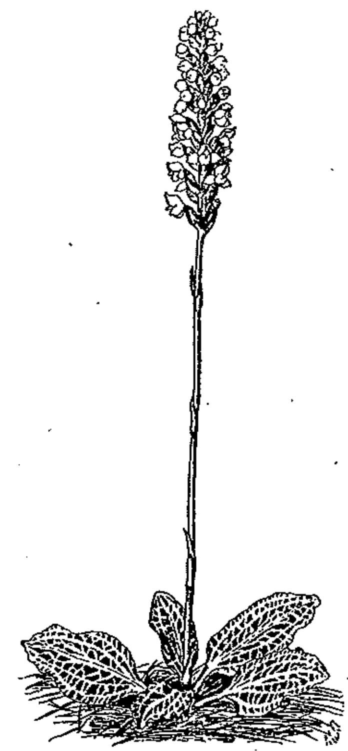


JACK-IN-THE-PULPIT.—*Arisaema triphyllum.*

Dryopoteris spinulosa	Spinulose wood fern
Erythronium americanum	Yellow trout lilly
Galium aparine	Shining bedstraw
Osmorhiza claytoni	Hairy sweet cicely
Podophyllum peltatum	Mayapple
Polygonatum pubescens	Solomon's seal
Smilacina racemosa	False Solomon's seal
Solidago flexicaulis	Broad-leaved goldenrod
Sanguinaria canadensis	Bloodroot
Viola pensylvanica	Smooth yellow violet
Viola pubescens	Downy yellow violet
Viola blanda	Sweet white violet
Viola rostrata	Long-spurred violet
Viola papilionacea	Common blue violet

Others

Actaea pachypoda	White baneberry ("doll's eyes")
Adiantum pedatum	Maidenhair fern
Allium tricoccum	Wild leek
Anemone quinquefolia	Wood anemone
Anemonella thalictroides	Rue anemone
Allium canadense	Wild garlic
Asarum canadense	Wild ginger
Athyrium filix-femina	Lady fern
Athyrium thelypteroides	Silvery spleenwort
Botrychium virginianum	Rattlesnake fern
Cardamine douglassii	Purple cress
Caulophyllum thalictroides	Blue cohosh
Cimicifuga racemosa	Black snakeroot
Chimaphila umbellata	Pipsissewa
Cypripedium acaule	Pink lady's slipper (rare)
Cypripedium reginae	Showy lady's slipper (very rare)
Cypripedium calceolus var. parviflorum	Small lady's slipper (rare)
Dicentra cucullaria	Dutchman's breeches
Dryopteris marginalis	Marginal shield fern
Disporum lanuginosum	Yellow mandarin (rare)
Epigaea repens	Trailing arbutus (rare)
Eupatorium purpureum	Sweet Joe-Pye-weed
Fragaria virginiana	Common strawberry
Galium triflorum	Fragrant bedstraw
Geranium maculatum	Wild geranium
Habenaria viridis	Bracted orchid (rare)
Goodyera pubescens	Downy rattlesnake plantain (rare)



RATTLESNAKE-PLANTAIN.—*Goodyera pubescens.*

TABLE IX. WETLANDS VEGETATION (BOGS, MARSHES, SWAMPS)

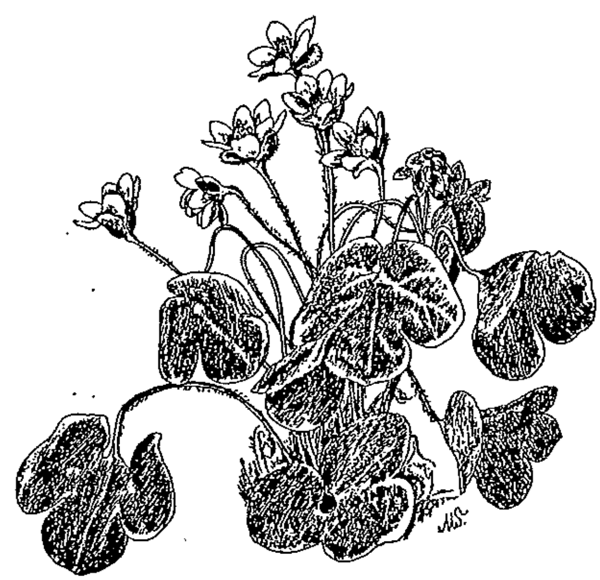
(Table VIII – cont.)

INTERRUPTED FERN
a Cluster of sporangia b Showing veining

Hepatica acutiloba	Hepatica liverwort
Heuchera americana	Alumroot
Hypoxis hirsuta	Yellow star grass
Lobelia siphilitica	Great lobelia
Malanthemum canadense	Wild lily-of-the-valley
Mitchella repens	Partridgeberry
Monotropa uniflora	Indian pipe
Orchis spectabilis	Showy orchid (rare)
Osmunda claytoniana	Interrupted fern (rare)
Panax quinquefolium	Ginseng (very rare)
Panicum latifolium	Broad-leaf panic grass
Penstemon digitalis	Beardtongue
Poa sysvestris	Woodland bluegrass
Polygonatum biflorum	Solomon's seal
Polystichum acrostrichoides	Christmas fern
Polypodium vulgare	Common polypody
Saxifraga virginiensis	Early saxifraga
Sedum ternatum	Wild stone crop
Sisyrinchium angustifolium	Blue-eyed grass
Thalictrum dioicum	Early meadow-rue
Thalictrum polygamum	Tall meadow-rue
Trillium cernuum	Nodding trillium
Uvularia perfoliata	Bellwort
Lycopodium complanatum	Ground cedar
Lycopodium obscurum	Tree clubmoss

TABLE VIII. PLANTS FOUND IN SUGAR MAPLE/MIXED HARDWOODS (MESIC FOREST)

EVERGREEN WOOD FERN



HEPATICA.—*Hepatica americana.*

(Table IX)

A. Cattail Marsh

Dominant - Cattail
Other Herbs:

- Wild rice *(Zinzania aquatica)*
- Reed grass *(Phragmites sp.)*
- Bulrush *(Scirpus sp.)*
- Swamp loostrife *(Lythrum virgatum)*
- Arrowhead *(Sagittaria sp.)*
- Arrow-arum *(Peltandra virginica)*
- Blue flag *(Iris versicolor)*
- Spike rush *(Eleocharis sp.)*
- Bur reed *(Sparganium sp.)*
- Water dock *(Rumex sp.)*
- Sedges *(Carex sp.-many)*
- Marsh fern *(Thelypteris thelypteriodes)*
- Swamp milkweed *(Asclepias incarnata)*
- Jewelweed *(Impatiens pallida)*
- Sensitive fern *(Onoclea sensibilis)*
- Swamp thistle *(Cirsium sp.)*
- New York ironweed *(Vernonia nove-boracensis)*

B. Red maple swamp: (Palustrine forested wetland, characterized by woody vegetation taller than 20 feet)

Dominant tree - Red maple (Acer rubrum)
Other trees:

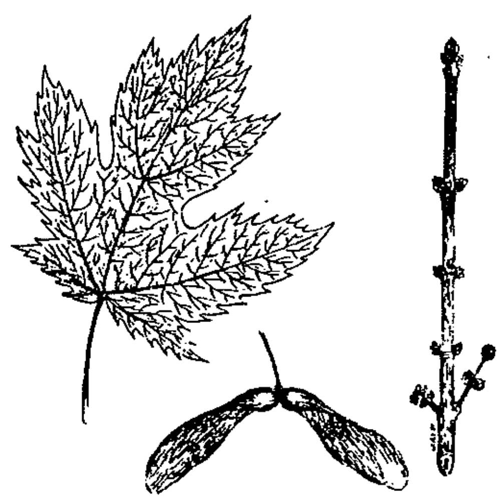
- White ash (Fraxinus americana)
- Silver maple (Acer saccharinum)
- Black willow (Salix nigra)
- Sycamore (Platanus occidentalis)
- American elm (Ulmus americana)
- Black cherry (Prunus serotina)
- Ironwood (Carpinus caroliniana)
- Yellow birch (Betula alleghaniensis)
- Basswood (Tilia americana)

Shrubs:

- Spicebush (Lindera benzoin)
- Dogwood (Cornus amomum & stolonifera)
- Alders (many)
- Winterberry (Ilex verticillata)
- Poison ivy (Rhus radicans)

Common herbs:

Skunk cabbage; jewelweed; marsh marigold tussock sedge and other sedges; asters, bugleweed; smartweeds; jack-in-the-pulpit, goldenrods (many); false nettle; cinnamon fern; royal fern; sensitive fern



SILVER MAPLE
(Acer saccharinum)

TABLE IX. WETLANDS VEGETATION (BOGS, MARSHES, SWAMPS)

Representative plant communities in Frelinghuysen Township may be found in the following areas:

I. Johnsburg Nature Area (Mud Pond) - Northern Hardwood forest

II. Between Lincoln Laurel Road and Route 94 - Upland Forest on shale

III. Bear Creek at Bear Creek Road - Typical swamp wetland with red maple dominating

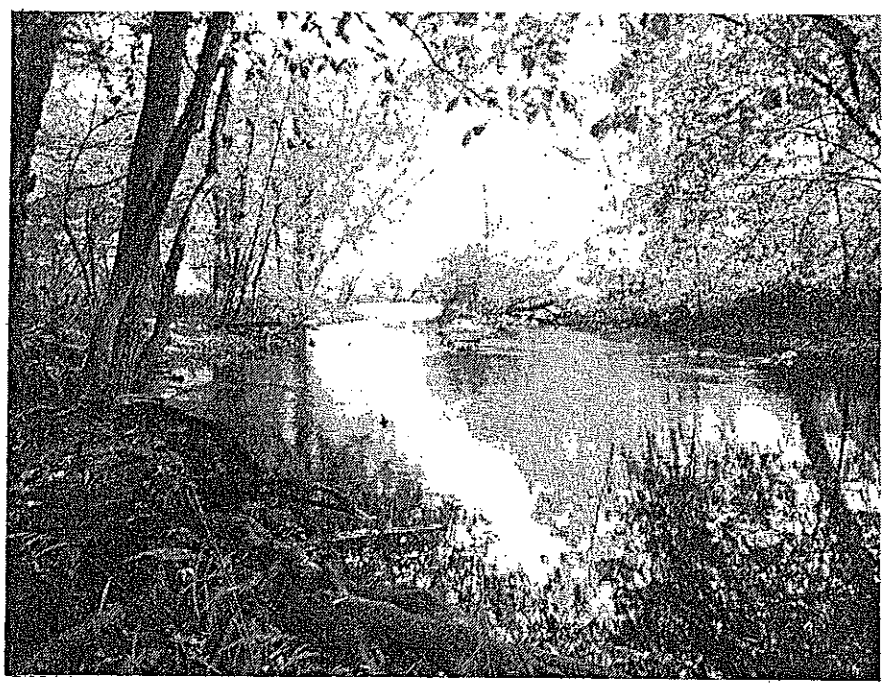
IV. Jenny Jump State Park - Upland mixed forest/conifers and hardwoods, especially many varieties of oak, hemlock, arrowwood, and striped maple, with mountain laurel at the north-west facing summit.

V. Along the Paulins Kill- Examples of lowland forest may be found, with sycamore, red maple, tulip poplar and black birch as dominant species.

Major sources of information

Kittredge, Joseph, *Forest Influences - The Effects of Woody Vegetation on Climate, Water and Soil.* Dover Publications, Inc., New Edition, 1948, p. 253.

Robichaud and Buell, *Vegetation of New Jersey,* Rutgers University Press, 1973 p. 275.



Typical Habitat along the Paulinskill River.

WILDLIFE

Wildlife that occurs in Frelinghuysen Township is listed below, by class order, and sub-order. The habitat(s) with which each animal is associated follow the name of the animal. The status of several important organisms is listed as well, in parentheses. The following abbreviations are used:

Habitats:

(AG) Agricultural land

(CF) Coniferous forest (mainly hemlock, spruce, pine and juniper)

(DF) Deciduous forest (oak, hickory, maple, beach, elm, locust)

(FM) Freshwater marsh

(G) Grassland, meadow, cropland

(LPR) Lakes, ponds, rivers

(MM) Open woodland, residential and agricultural areas; man-made and disturbed areas

(OF) Open fields

(OP) Partly open country with scattered trees and shrubs (overlaps with deciduous forest)

(ROF) Rocky open fields and slopes

(WDF) Wet open fields; wet deciduous forest

(WG) Wet meadows

(WOP) Wet open country with scattered trees and shrubs.

Status (species without one of the following designations do occur in Township):

(P) Indicates that it is possible the animal can be found within 20 miles of Frelinghuysen Township.

(T) Indicates animals which may become endangered if conditions surrounding the animals begin or continue to deteriorate.

(E) Indicates endangered species whose prospects for survival in the State are in immediate danger due to loss or change of habit, over-exploitation, predation, competition or disease.

(* indicates that the animal has been seen or otherwise positively identified through its tracks by P. Armstrong, former ranger, Wildlife Preserves).

A. REPTILES (Class Reptilia)

(Reported Reptiles are referred to in Peterson's Field Guide, except Bog Turtles reported by Robert Cartica of New Jersey Department of Environmental Protection).

1. TURTLES (Order Chelonia)

a. Common Snapper *Chelydra serpentina.* LPR.Widespread; mud-bottomed waters.

b. Bog (reported*) (E) *Clemmys muhlenbergi.* WG, FM. Sunlit marsh meadows and springs.

c. Wood (T) *Clemmys insculpta.* AG, LPR, WG. Woodland streams, marshes and farmlands.

d. Spotted *Clemmys Cleguttata.* WDF, LPR. Floodplains, beaver ponds.

e. Common Musk *Sternotherus odoratus.* LPR. Ponds, canals, streams.

f. Eastern Painted *Chrysemys picta.* LPR, FM. Shallow, weedy freshwater areas.

g. Eastern Box *Terrapene carolina.* WDF, OF. Damp forests, old fields and floodplains.

2. LIZARDS (Sub-order Lacertilia)

a. Five-lined Skink (reported*) *Eumeces fasciatus.* DF. Damp woods with leaf litter.

b. Northern Fence Lizard *Sceloporus undulatus.* OP. Dry woodlands and brushlands.

3. SNAKES (Sub-order Ophidia)

a. Eastern Smooth Earth Snake *Haldea valeriae.* DF. Moist deciduous forest..

b. Red-bellied (reported*) *Storeria occipitomaculata.* DF, WG. Hilly woodlands and damp meadows.

c. Northern Brown *Storeria dekayi.* WDF, WG. Pond edges, grassed and wooded wetlands.

d. Northern Water *Natrix sipedon.* LPR. All freshwater.

e. Eastern Garter *Thamnophis sirtalis.* OF. Old fields, moist wetlands.

f. Eastern Ribbon *Thamnophis suritus.* WG. Damp meadows, edge of ponds and streams.

g. Eastern Hognose *Heterodon platyrhinos.* G, OP. Sandy areas, grassy woodland, edges.

h. Eastern Worm *Carphophis amoenus.* WOF. Hillside near streams, moist forests.

i. Northern Ringneck *Diadophis punctatus edwardsii.* ROF. Rocky wooded hillsides, old fields.

j. Northern Black Racer *Coluber constrictor.* ROF. Old fields, rocky slopes.

k. Eastern Smooth Green *Opheodrys aestivus.* WG, OF. Stream banks, marshes, old fields.

l. Eastern Rough Green *Opheodrys aestivus.* Southern species.

m. Black Rat *Elaphe obsoleta.* RAG. Rocky wooded hillsides, farmlands. (1) black, (2) yellow, (3) gray.

n. Eastern Milk *Lampropeltis doliata triangulum.* ROF. Various. Rocky wooded hillsides and old fields.

o. Northern Copperhead *Agkistrodon contortrix mokasen* RDF. Rock outcrops and ravines in forests, including edge of flood plains.

p. Timber Rattlesnake (E) *Crotalus horridus horridus.* Rocky, wooded slopes.

B. AMPHIBIANS (Class Amphibia)

1. NEWTS (Genus *Triturua*)

a. Eastern New (*Redeft*"). WDF, LPR. Shallow, weedy ponds and lakes, moist woodlands.

2. SALAMANDERS (Order *Urodeles*)

a. Spotted *Ambystoma maculatum.* LPR,OF. Woods, hillsides near water.

b. Jefferson *Ambystoma jeffersonianum.* WDF. Moist, deciduous woodlands.

c.Marbled *Ambystoma opacum.* WDF, LPR. Temperate ponds.

d. Red-backed or Lead-backed *Plethodon cinereus.* DF,CF. Deciduous to coniferous forests.

e. Slimy *Plethodon glutinosus.* WDF. Moist ravines, wooded floodplains, shale banks.

f. Northern Red *Pseudotriton ruber.* LPR,OF. Springs, cool mountain streams, see pages; adjacent woods and lowlands.

g. Long-tailed (T) (very common locally)*Surycea longicauda.* WDF. Cave entrances, springs, brooks and floodplains.

h. Northern Two-lined Toads

(1) Eastern Spade-foot *Scaphiopus holbrookii.* OP, AG, OF. Sandy gravelly or loamy soils, from farmland to forests.

(2) American Toad *Bufo americanus.* OP, MM. Diverse. From residential gardens to forests.

(3) Fowler's Toad *Bufo woodhous fowleri.* OP. Sandy areas near freshwater.

(4) Tiger Toad

3. FROGS (Order *Anura*)

a. Northern Spring Peepers *Hyla crucifer.* WOP, WDF. Shrubs near temporary.

b. Eastern Gray Treefrog *Hyla versicolor.* WDF. Trees (Shrubs) near woodlands and permanent water bodies.

c. Cricket Tree *Acris crepitans.* WOP. Mudflats, edges of shallow ponds, streams, floodplains.

d. New Jersey Chorus ? Interject ? *Pseudocris triseriata kalmi.*

e. Upland Chorus *Pseudocris triseriata feriarum*

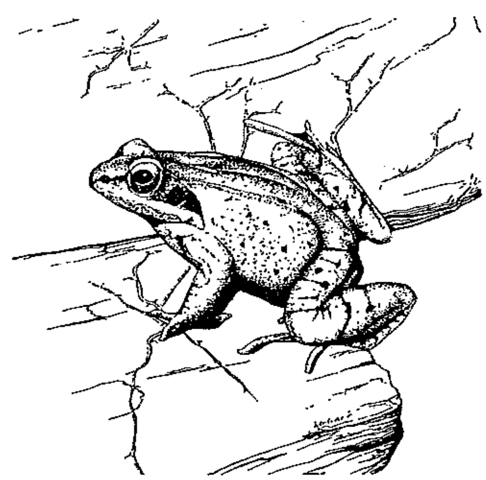
f. Pickerel Frog *Rana palustris.* LPR, WG, OF. Cool clear woodland streams, ponds adjacent to wet meadows.

g. Green Frog *Rana clamitans.* FM, LPR. Wetlands and streams.

h. Wood Frog *Rana palustris.* WDF. Damp shady woodlands.

i. Bull Frog *Rana catesbeiana.* LPR. Permanent body of water.

j. Leopard, Grass, or Meadow Frog *Rana pipiens.* Damp meadows, herb layer, edge of streams and ponds.



C. MAMMALS (Class *Mammalia*)

1. **OPPOSUM** *Didelphis marsupialis* (Order *Marsupiala*). AG, DF. Farmland, forests, usually near water.

2. INSECT EATERS (Order *Insectivora*). WOP, WG. Moist soil in grassland, shrub areas and forests.

a. Masked Shrew (P) *Sorex cinereus*

b. Smoky Shrew (P) *Sorex fumeus*

c. Long-tailed Shrew

d. Short-tailed Shrew. *Blarina brericauda*. Wide range of land habitats.

e. Least Shrew. *Cryptotis parva*. Open fields, freshwater marshes.

f. Hairy-tailed Mole (P) *Parascalops breweri*

g. Eastern Mole *Scalopus aquatious*. G. Moist sandy soil in grassy areas.

h. Star-nosed Mole *Condylura cristata*. G. Moist, low-lying soil.

3. BATS (Order *Chiroptera*)

a. Little Brown Bat *Myotis lucifugus*. AG. OF. Caves, hollow trees, barns, wooded areas and water.

b. Keen's Bat *Myotis keenii*. OF

c. Silver-haired Bat *Lasionycteris noctivagans*. hollow trees near water, forests.

d. Eastern Pipistcelli *Pipistrellus subflarus*

e. Big Brown Bat *Eptesious fuscus*. AG, OF. Caves, hollow trees, barns, (in summer), forests.

f. Red Bat *Lasiurus borealis*

g. Hoary Bat *Lasiurus cinereus*

4. RABBITS & HARES (Order *Lagomorpha*)

a. Eastern Cottontail* *Sylvilagus floridanus*. OP, FM. Edge old field, forests and swamps.

b. New England Cottontail *Sylvilagus transitionalis*

c. Snowshoe Hare (P) (reported in Green Township). DF, FM, OP. Northern forests, swamps, brush areas.

5. RODENTS (Order *Rodentia*)

a. Eastern Chipmunk* *Tamias striatus*. MM, OP. Gardens, shrubs, forested areas.

b. Woodchuck* *Marmota monax*. OP, AG. Forest edge, rocky edge, rocky areas, roadsides.

c. Gray Squirrel* *Sciurus carolinensis*. DF. Deciduous forest, suburbs, parks.

d. Red Squirrel *Tamiasciurushudsonicus*. CF. Mountain forests (Pines and Spruce).

e. Southern Flying Squirrel *Glaucomys volans*. DF, CF. Deciduous and mixed forests, snags.

f. Beaver* *Castor canadensis*. LPR. Streams bordered by poplars and birches.

g. Deer Mouse (P) White-Footed *Peromyscus leucopus*. OP. Diverse habitats, primarily uplands.

h. Eastern Wood Rat* *Neotoma magister*. WG. Open swamps and rocky areas.

i. Norway Rat (introduced) *Rattus norvegicus*. AG, MM. Barns, dumps.

j. Black Rat (") *Rattus rattus*

k. House Mouse (") *Mus musculus*. MM. Buildings.

l Gapper's Red-backed Mouse *Chlethrionomys gapperi*. WDF. Forests, usually moist.

m. Meadow Vole* *Microtus pennsylvanicus*. AG. Hay fields with dense vegetation, forst edge.

n. Pine Vole *Microtus pinetorum*. OF. Forests with thick humus layer and loose soil.

o. Muskrat *Ondatra zibethicus*. FM. LPR. Marshes, ponds, slow streams with cattails and reeds.

p. Southern Bog Lemming *Synaptomys cooperi.* FM, WG. Bogs and wet meadows with heavy vegetation.

q. Meadow Jumping Mouse *Zapushudson zapus hudsonius.* G. Meadows.

r. Woodland Jumping Mouse *Napaeozapus insignis*

6. CARNIVORES (Order *Carnivora*)

a. Coyote* *Canis latrans.* OP. Open fields, brush.

b. Red Fox *Vulpes fulva.* AG, OP. Farmlands, forests with open areas.

c.Gray Fox *Urocyon cinereoargenteus.* OP. Open woodlands.

d.Black Bear* *Euarctos americanus.* DF, WDF. Mountaqin forests, swamps.

e. Eastern Racoon* *Procyon lotor.* WDF. Bottom lands, forest edge of streams.

f. Short-tailed Weasel *Mustela erminea.* DF. Forests, near water.

g. Long-tailed Weasel *Mustela frenata.* G. OP. Open fields, forest edge near water.

h. Mink *Mustela vison.* OP. LPR. Along river, streams and lakes.

i. Striped Skunk* *Mephitis mephitis.* AG, OP. Farmlands, open forest and brush areas, usually near water.

j. River Otter* *Lutra canadensis.* LPR. Rivers, streams, lakes and associated.

k. Bobcat* *Lynx rufus.* DF, WDF. Forests, swamps.

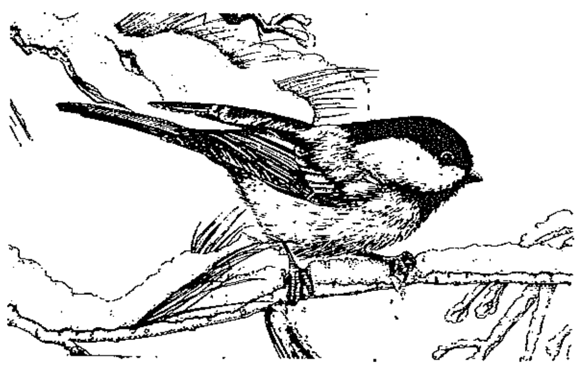
7. EVENTOED, HOOFED MAMMALS (Order *Artiodaetyla*)

a. White-tailed Deer *Odocoileus virginianus.* DF, FW, OF. Forests, swamps adjacent old fields.

BIRDS SIGHTED IN FRELINGHUYSEN TOWNSHIP

English (House) Sparrow *Passer domesticus*
Chipping Sparrow *Spizella passerina*
Ipswich Sparrow (migration) *Passerculus princeps*
Song Sparrow *Melospiza melodia*
Fox Sparrow *Passerella iliaca*
Field Sparrow *Spizella pusilla*
Vesper Sparrow *Pooecetes gramineus*
White-throated Sparrow *Zonotrichia albicollis*
White-crowned Sparrow *Zonotrichia leucophrys*
Tree Sparrow *Spizella arborea*
Golden-crowned Sparrow *Zonotrichia atricapilla*
(the third one to be reported in N.J.)

Common Crow *Corvus brachyrhynchos*
Turkey Vulture *Cathartes aura septentrionalis*

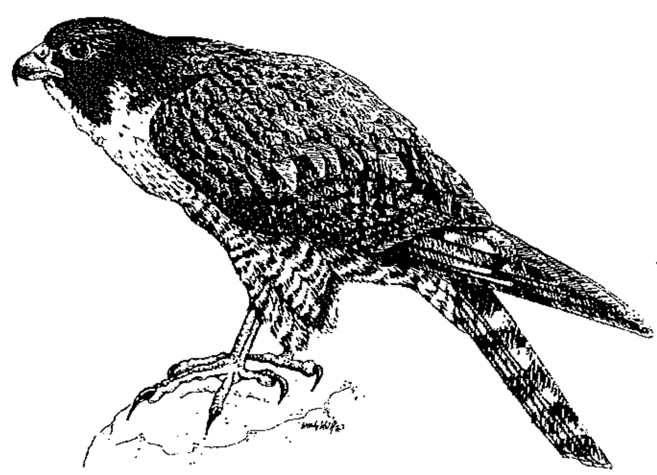


Starling *Sturnus vulgaris*
Evening Grosbeak *Hesperiphona vespertina*
Rose-breasted Grosbeak *Pheucticus ludovicianus*
Slate-colored Junco *Junco hyemalis*
Mockingbird *Mimus polyglottos*
Mourning Dove *Zenaida macroura*
White-winged Crossbill *Loxia leucoptera*
(Winter and only once)

Common Purple Grackle *Quiscalus quiscula*
Eastern Meadowlark *Sturnella magna*
Bobolink *Dolichonyx oryzivorus*
Robin *Turdus migratorius*
Eastern Bluebird *Sialia sialis*
House Wren *Troglodytes aedon*
Carolina Wren *Thryothorus ludovicianus*
Myrtle Warbler *Dendroica coronata*
(now listed as Yellow-rumped Warbler)

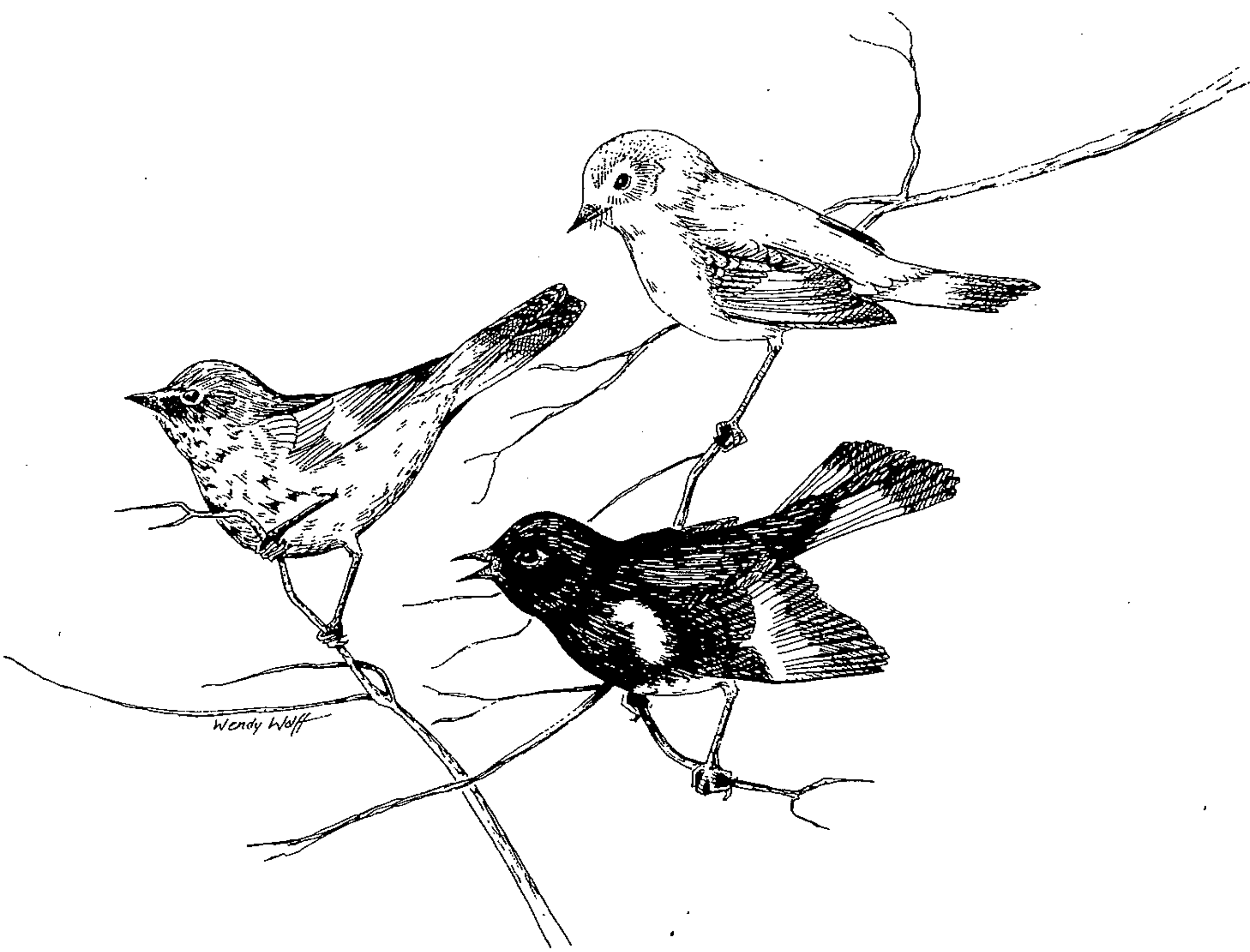
American Redstart *Setophaga ruticilla*
Yellow Warbler *Dendroica petechia*
Cape May Warbler (during migration) *Dedroica tigrina*
Yellow-breasted Chat *Icteria virens*
Ruby-crowned Kinglet (winter only) *Regulus calendula*
Golden-crowned Kinglet (winter only) *Rugulus satrapa*
Brown Creeper *Certhia familiaris*
Blue Jay *Cyanocitta cristata*

Cow Bird *Molothrus ater*
Red-winged Blackbird *Agelaius phoeniceus*
Kestrel *Falco sparverius*
Sharp-shinned Hawk *Accipiter striatus velox*
Red-shouldered Hawk *Buteo lineatus*
Red-tailed Hawk *Buteo jamaicensis borealis*
Northern Goshawk *Accipiter gentilis atricapillus*
Tufted Titmouse *Parus bicolor*
Black-capped Chickadee *Parus atricapillus*
White-breasted Nuthatch *Sitta carolinensis*
Red-breasted Nuthatch *Sitta canadensis*
Downy Woodpecker *Picoides pubescens*
Hairy Woodpecker *Picoides villosus*
Pileated Woodpecker *Dryocopus pileatus*
Red-bellied Woodpecker *Melanerpes carolinus*
Yellow-bellied Sapsucker *Sphyrapicus varius*
Flicker *Colaptes auratus*
Orchard Oriole *Icterus spurius*
Baltimore Oriole *Icterus galbula*
(now called Northern Oriole)
Scarlet Tanager *Piranga olivacea*
Dickcissel *Spiza americana*
Pine Grosbeak (winter) *Pinicola enucleator*
Pine Siskin *Carduelis pinus*
Indigo Bunting *Passerina cyanea*
Rufous-sided Towhee *Pipilo erythrophthamus*
Ruby-throated Hummingbird *Archilochus colubris*
Common Pigeon (family *Columbidae*)



Bobwhite *Colinus virginianus*
Cardinal *Richmondena cardinalis*
American Goldfinch *Carduelis tristis*
House Finch *Carpodacus mexicanus*
Purple Finch *Carpodacus purpureus*
Canada Goose *Branta canadensis*
Mallard Duck *Anas platyrhynchos*
Killdeer *Charadrius vociferus*
Ring-necked Pheasant *Phasianus colchicus*
Wild Turkey *Meleagris gallopavo*
Purple Martin *Progne subis*
Yellow-billed Cuckoo *Coccyzus americanus*
Great-crested Flycatcher *Myriarchus crinitus*
Least Flycatcher *Empidonax minimus*
Eastern Phoebe *Sayornis phoebe*
Eastern Kingbird *Tyrannus tyrannus*
Horned Lark (winter, rare) *Eremophila alpestris*
Barn Swallow *Hirundo rustica*
Chimney Swift *Chaetura pelagica*
Tree Swallow *Iridoprocne bicolor*
Rough-winged Swallow *Stelgidopteryx ruficollis*
Blue Gray Gnatcatcher *Polioptila caerulea*
Brown Thrasher *Toxostoma rufum*
Wood Thrush *Hylocichla mustelina*
Northern Shrike (winter) *Lanius excubitor*
Cedar Waxwing *Bombycilla cedrorum*
Warbling Vireo *Vireo gilvus*
Red-eyed Vireo *Vireo elivaceus*

*(*The above inventory was supplied by Mildred Read, an avid birder and resident of Frelinghuysen for over 40 years)*



PART III.

CULTURAL AND VISUAL RESOURCES

FRELINGHUYSEN, THEN AND NOW

Where and what is Frelinghuysen? It is a beautiful New Jersey township, some sixty five miles from New York and an equal distance from Philadelphia. Its twenty four square miles offer a panorama of rolling farms, lakes, clean streams and mountains, with many views of the renowned and spectacular Delaware Water Gap. It astounds visitors whose previous notions of the State are based on their observation of the industrial sprawl of the eastern counties.

Approaching Frelinghuysen today, we enter Warren County as we move south on Route 94 from the direction of Newton, noting on our left the charming Presbyterian church called Yellow Frame, which can be taken as a border marker. It is said that in the original Yellow Frame church the preacher's pulpit was in Sussex County and his congregation in Warren County, in Frelinghuysen Township. The church cemetery is beautifully kept and many of the grave stones date from the 1700's.

In sharp contrast, as we proceed along Route 94 we see on the right a handsome modern school, and a sign proclaiming Frelinghuysen Township School. This elegant sign, erected in 1987 by volunteers, is in fact the only visible evidence that the township exists. No railway or bus station, no highway signs reveal the presence of Frelinghuysen, which by 1988 contained an estimated population of 1800, according to its mayor for 18 years, the Honorable Charles Rydell.

The structure of Frelinghuysen is fairly indescribable and sweetly ramshackle. Besides the six remaining working farms in the township and the increasing number of residences springing up along every side road, Frelinghuysen contains a half dozen sub-villages, which were at various times in the past completely self-sustaining. Some of these have now disappeared entirely while others have shrunk from prosperity to relative insignificance. We encounter one of these communities as we continue along Route 94. It is called Marksboro, and extends for perhaps a quarter of a mile along the highway. We first see a small tavern called the Fireside Inn, then a dozen or two houses, a Presbyterian Church, a general store, and a junk yard tucked back in the woods which is part of a farm machinery concern. That's Marksboro today.

Back in 1775 a Colonel Mark Thompson, who owned land for miles around, built a grist mill powered by the Paulins Kill, the stream which runs parallel to the present highway. He built himself a handsome residence which still stands on the bluff above the mill. As a community developed, the Colonel named it after himself, and by the early 1800's Marksboro contained five or six small houses, a store, and something that was called an academy, but which for lack of patronage was transformed into a combination saloon and hotel.

By 1846 Marksboro had thrived to include its own post-office, two stores, two blacksmiths, a harness maker, a school house, and a Presbyterian Church. Self-contained, self-sustained. The citizens could walk to the stores, the church. The people now drive their cars three or so miles to the post office in Blairstown which serves a large portion of Frelinghuysen. The children ride to school in big yellow buses. And the farmers, who a hundred years ago supported two blacksmiths and a harness maker, today come to Marksboro to buy new or used farm machinery from Cappy Rydell, or find needed parts in his junk yard in the woods.

The story of Marksboro is a good example of the history of Frelinghuysen's interior communities. A mile farther down Route 94 is another - an entity called Paulina, which today is half a dozen houses, a tavern, and an abandoned laundry. Paulina once had its own school, post office, a Presbyterian chapel, a grist mill, and a sash and blind factory. All gone. And the village itself was absorbed into Blairstown in 1881.

A more important example of the decline and fall of Frelinghuysen's mini-communities is the story of Johnsonburg, in the middle of the township. It was the county seat of Sussex County two hundred years ago, and was then known by the more colorful name of Log Gaol (pronounced jail). To avoid confusion, it should be understood that Warren County was part of Sussex County until 1825. Warren County contains Frelinghuysen, which contains Johnsonburg. Clear?

It was called Log Gaol because someone decided that as the county seat of Sussex County it should have a jail and a court house. The village fathers built the jail but not the court house, finding it more convenient (and doubtless more economical) to conduct county affairs in the local taverns. The jail they built was not a very good one. It was made of logs, and the construction itself skimped on some details. It is said that the jail had no lock on the back door. It did have a watchman, who guarded it "from time to time".

The inmates were principally convicted debtors, and the laws of the day kept them in jail until they paid up. If they escaped, the jailers were responsible for the debt. After a few years the village discovered that the money they had been obliged to pay for escaped debtors amounted to some six hundred pounds, which was more than the jail cost in the first place. But even after the village was no longer the County seat, which was moved to Newton in 1762, it was still called Log Gaol. The name was not changed until 1799, when it was rechristened Johnsonburg in honor of its first postmaster, a Mr. Johnson.

Johnsonburg grew and prospered, county seat or not. By 1835 two stage lines converged and crossed at the tavern in the center of the village and by 1881 the village of 215 souls and through-passers supported three blacksmiths, two wheelwrights, tow shoemakers, a tin shop, a grist mill, a cooper, a school house, a post office, three churches, and a milliner who sold bonnets and perfume from Paris, France. In 1911 the Lackawanna Railroad came through and opened a handsome station in Johnsonburg, with imitation marble floors and counters, on the main line from Hoboken to Cleveland, Ohio. The first man to step off a westbound train was a new pastor for the Methodist church.

Today the grand station is gone. Gone, too, is the milk depot from which farmers' milk was loaded to be rushed by rail to the cities. Train service was discontinued in the 1970's. The one-room school house no longer stands, and vanished are the artisans who shod the horses and supplied the village with wagon wheels, pots and pans, shoes and bonnets, barrels and wheat flour. One church remains, along with the post office and the Frelinghuysen Town Hall.

Johnsonburg is diminished, but other small villages have left the scene entirely. A place called Howard is now only the remains of a few old foundations in the woods in which lived the miners who once dug for hematite near Jenny Jump Mountain, on the western border of Frelinghuysen. Southtown is no more, Shiloh is no more. Ebenezer, now one or two houses and a converted church, once had, besides its schoolhouse, a Methodist Church and a large farming community. The farms are gone, the church now is a residence.

A hundred years ago each of the villages in Frelinghuysen had its own school. Each school received $300 a year from the County, and together all the schools served some three hundred children. Each school had one room and one teacher, generally a male teacher. Many of them left the job soon to become doctors, lawyers, businessmen and politicians.

A hundred years age, a diarist described the simple life of those bygone days: "We knew the filed history of every piece of cloth, from the sheep or flax to the finished garment; of every piece of leather from the cow that furnished the hide to the top boots made by the village shoemaker; and of every piece of furniture from the tree in the forest to the finest specimen of work turned out by the local cabinet maker."

In those days ice was cut from ponds and stored in sawdust. Farmer's plows and reapers were pulled by horses. Cows were milked by hand. Houses were heated by woodstoves, the wood cut from woodlots on the farm. Light was furnished by "tallow dips", cotton wicks dipped repeatedly into melted tallow until a candle was formed. The kerosene lamp came later and electricity did not come until 1925.

Life was simpler and cheaper a hundred years ago. The township government, for example, has not changed basically since 1848, when Frelinghuysen was separated from Hardwick Township, but is now more elaborate, and, undoubtedly, more expensive. Then, as now, the governing power was in the hands of an elected committee; three members now, as against five in 1848.

Today's committee elects a mayor; they did without a mayor. They had a poundkeeper; we have a dog warden. They had a tax assessor and a tax collector; so do we. They had no police department, nor do we. But we have a building inspector, a road department, a Planning Board, a Board of Adjustment, a township attorney, a township engineer, and numerous other officials, all part time.

By 1939 the township had a school budget of $8,300. By 1988 it was $800,000. Today, Frelinghuysen children are bused to the North Warren Regional High School, for grades seven through twelve, at a cost per pupil of a little over $7,200.

With the arrival of the gasoline age, the railroads began a long decline, and the federal government helped out by building Interstate Route 80 through the township and the nation to serve the multiplying millions of cars and trucks.

Today Frelinghuysen is still an attractive rural community though it feels more and more the pressure of an expanding metropolitan area. Frelinghuysen is fighting hard to keep its country character. Not too many years ago we boasted that we had "more cows than people". Today although this is no longer true, we are still determined to preserve and enjoy our Jersey heritage.

by Sam Moore
February 3, 1989

(We happily, and with gratitude, include this chapter which was one of the last pieces of writing by the late Sam Moore whose love of Frelinghuysen we share and respect.)

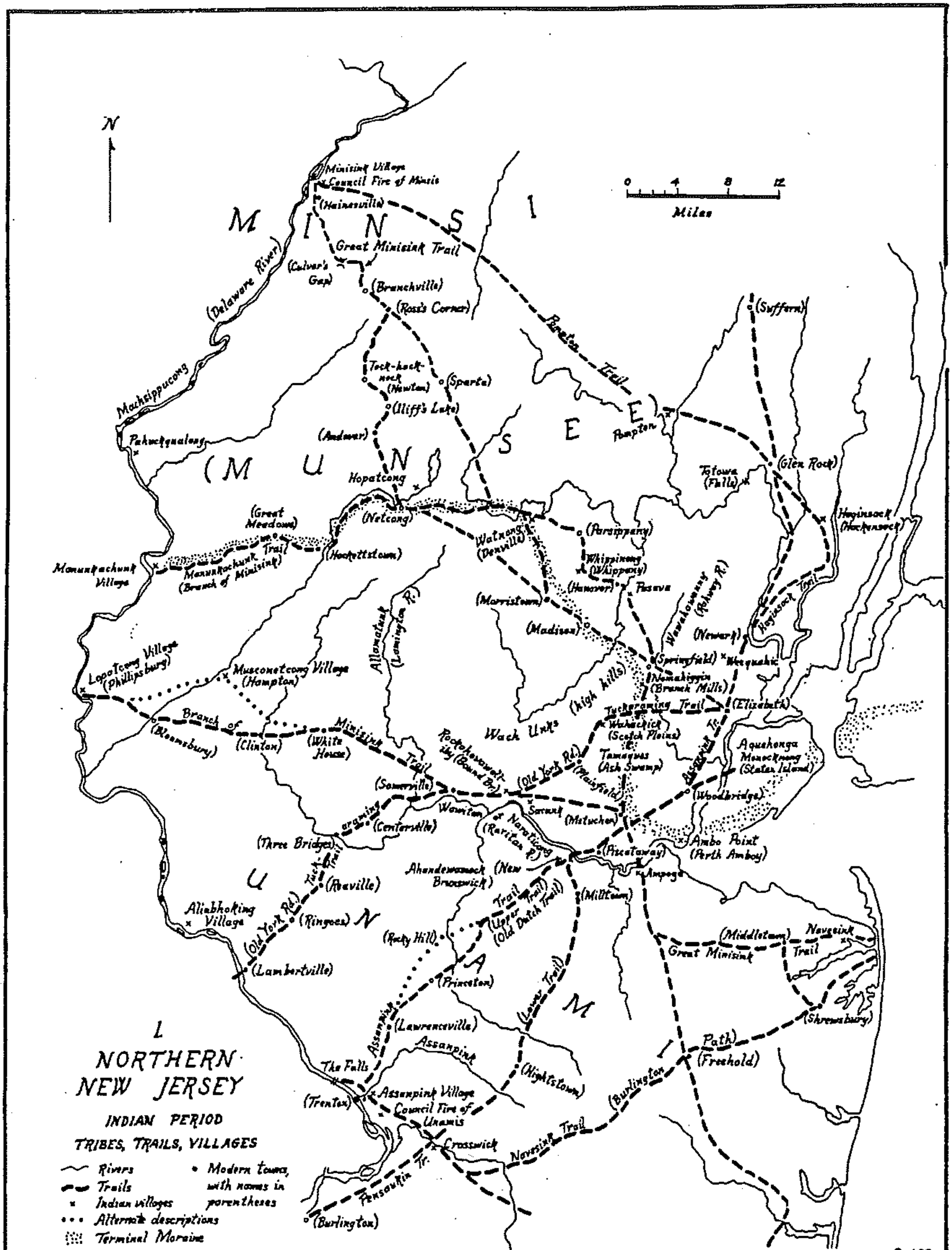


Fig 26 - Map of Northern New Jersey during the Indian Period. (From THE STORY OF NEW JERSEY'S CIVIL BOUNDARIES 1606-1968. John P. Snyder, 1969.)

EARLY HISTORY AND BOUNDARY CHANGES

Archaeologists tell us that the first Indians appeared on the scene in this area about eleven to twelve thousand years ago. Paleo-Indians lived among, and hunted, a rich array of mammals at the end of the Wisconsin glaciation. They were contemporary with mastodons, caribou, elk, dire wolves, large cats, and other exotic mammals that flourished on the rich tundra-like environment.

After the Paleo-Indians, came the Archaic periods (early, middle, late and transitional) from ca. 8000 to 1000 B.C. The Archaic people were hunters and gatherers. The Woodland periods (early, middle and late) began ca. 1000 B.C. and extended into historic time, ending ca. 1600 A.D. These Woodland phases saw the introduction of the bow and arrow, extensive agriculture, smoking, pottery, domesticated animals, and a more settled village life.

There are many archaeological sites in Frelinghuysen that attest to past Indian occupation. These sites are usually located near water (rivers, ponds, springs, and swamps). Many are found in farm fields; and plowing turns up a multitude of artifacts each year. There are also many rock shelters in the township that were once occupied by the Indians, as well as locations where black and gray chert (commonly called flint) was broken out of limestone formations and used to make tools and weapons. Farmers, collectors and amateur archaeologists have surface-collected and excavated a rich and profuse assortment of Indian artifacts - arrow and spear heads, grooved axes, belts, pottery, knives, scrapers, hammer stones, stone mortars for grinding, pestles, atl-atl weights, etc.

In prehistoric times, the area that was later to become Frelinghuysen Township was known to its native inhabitants, the Lenape (which means "common" or "real people") Indians, as Lenapehoking ("land of the Lenape"). It was populated by Munsee Lenapes ("people of the stony country") who spoke a different dialect than their southern brethren, the Unami Lenapes ("people from down the river").

In early colonial days, the future Frelinghuysen was a remote wilderness, located north of New Sweden and west of New Netherlands. Following the English conquest of the Dutch and Swedes in 1664 when New Amsterdam (Manhattan) surrendered, the Duke of York granted proprietorship of the land between the Hudson and the Delaware Rivers to Lord John Berkeley and Sir John Carteret. In 1676, the new colony of Nova-Caesaria (or New Jersey) was divided into East and West Jersey.

On May 17, 1715, Samuel Green, a deputy surveyor, and his two companions were some of the earliest recorded white men to set foot in what was to become Frelinghuysen Township. According to Green's diary, they were surveying a line from what is now Allamuchy to the 'cleft in the hill where the Minisink path goeth through", thought to be near present-day Millbrook. The Lenape's famed Minisink Trail ran from the Atlantic Ocean to the Delaware River. Green and his men ran their line to Pahuckqupath (Johnsonburg) and on to what is now Marksboro. Here they were turned back by the Indians and not allowed to cross the "Pawlings Kill".

The period from ca. 1600 to 1758 witnessed the partial demise and exodus of the Indian population from this area. The Lenapes fell prey to new diseases (e.g. measles and small pox) for which they had no immunity. Untold numbers died during epidemics. They also had no tolerance to alcohol and, as their society degenerated, they sold their land under pressure – and, sometimes, trickery – to the Board of Proprietors which was responsible for buying the land from the Indians.

The Lenapes were also called Delawares. In 1610, Sir Thomas West, 3rd Lord De La Ware, Governor of the Virginia Colony, had the Delaware River and Bay named after him. Thus, the Indians living along the bay and river were referred to as De La Ware's Indians, a name which was soon applied to all Lenapes.

The Lenapes were of Algonquin stock and were politically unfederated. This organizational weakness led to their decimation during raids both from their northern neighbors – the warlike Iroquois Confederacy (Senecas, Mohawks, Cayugas, Onondagas and Oneidas) – and English Colonists. The remnants of a once proud tribe migrated north and westward, and by 1742, the last Indian left Frelinghuysen. However, during the French and Indian Wars (1755-1758), the Lenapes (Delawares) stormed back from the west with a vengeance. Their raids in the upper Delaware Valley caused much destruction, turmoil and death. Following the signing of the treaty of Easton in October 1758, between the Lenapes (Delawares) and the Colony of New Jersey, Indian claims to their land and rights in New Jersey were bought.

In a little over two centuries, Lenapehoking would only be a memory. (fig. 26).

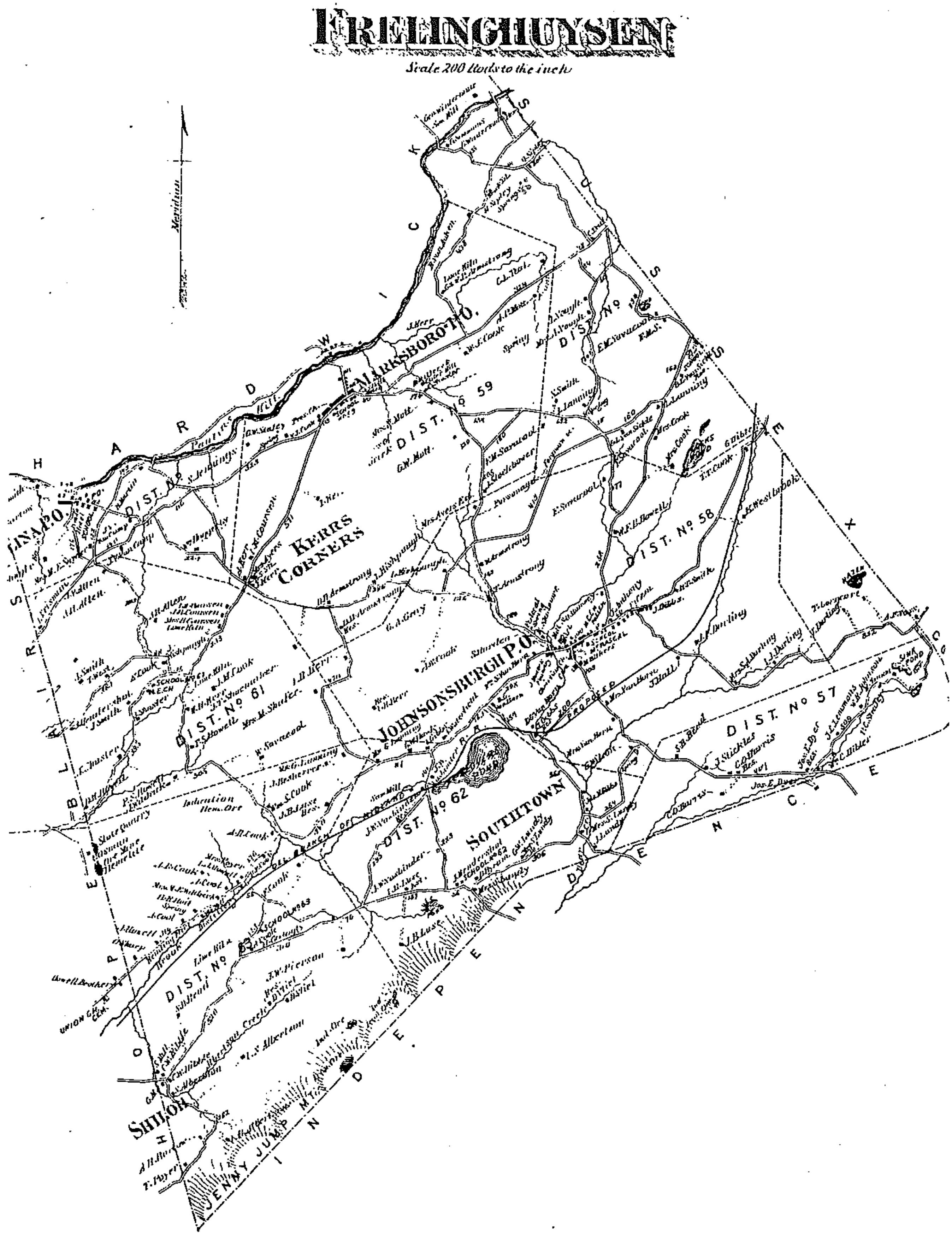


Fig. 27 - Map of Frelinghuysen Township, 1874. (from *Beers County Atlas of Warren,* 1874)

Fig. 28 - Map of Marksboro, 1874

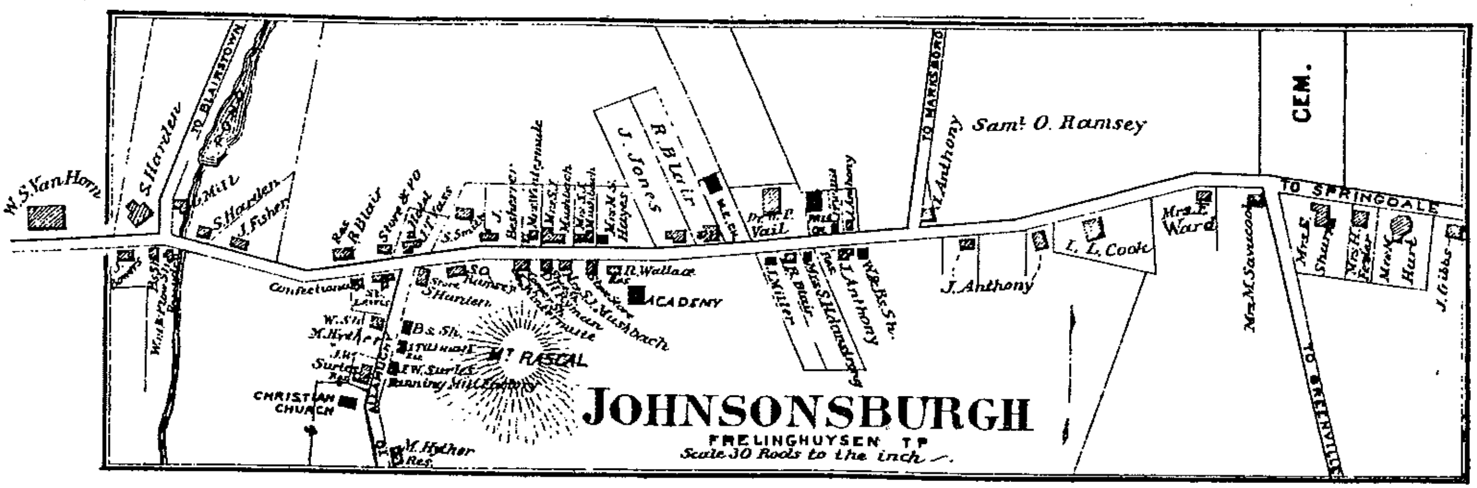


Fig. 29 - Map of Johnsonburg, 1874. (from *Beers Atlas*, 1874)

As the years passed, the area known as West Jersey became part of Morris County (1739) which then contained all of the present Morris, Sussex and Warren Counties, an area of roughly 870,000 acres. Sussex County, which contained Warren County, was created in 1753, and Log Gaol (present-day Johnsonburg) became the County seat. It was not until 1825 that Warren County was separated from Sussex, and Belvidere was designated its new county seat. (fig. 27).

Among the early settlers were English Quakers, Scotch-Irish Presbyterians, Germans, and Dutch. Common names in the area were Green, Armstrong, Pettit, Linn, Kennedy, Van Horn, Hazen, Dyer, Cook, Shaw, and Everitt.

Much of the early history centers around Johnsonburg which, besides being the county seat, was also a major stage coach stop. The town prospered for many years serving as a center for lodging, eating and shopping. Taverns served as centers of business and official affairs. The first court sessions were held at Pettit's Tavern and later moved to Wolverton's Tavern, which stood on the present site of the Johnsonburg Hotel. The mill built by William Armstrong near Federal Springs in 1770 was in operation until 1937 and is still standing. (fig. 28 and fig. 29).

Elsewhere, throughout the township are reminders of an age gone by – lime kilns, windmills, millraces, hedgerows, stone walls, smoke houses, outhouses, spring houses, stone foundations of dwellings, cemeteries, slave and Indian burial sites, and camp sites. There is a stone marker on the Allamuchy-Johnsonburg Road bearing the inscription "2 to LG" (two miles to Log Gaol). Many bridges were built across the Paulinskill in the 1700's. Of the two still being used today, one, the bridge on Hess Road, is believed to be the oldest in Warren County.

Old and colorful names of roads also remain as reminders of our past - Dark Moon Road, Mount Rascal, Henfoot Corners, Shades of Death Road, to name just a few.

No story of Frelinghuysen's history would be complete without mention of two prominent men whose stories are now immortalized in Henry Charlton Beck's *Tales and Towns of Northern New Jersey.* One is the tale of the Old Pig Drover. No one knew where he came from or where he went, but when he came to town and appeared at the tavern to tell stories, the seats were always filled and it "was always the occasion for a great gathering of the story-loving public, for let us remember that this was before the age of the daily papers, when even books were few,..."

The second tale is that of the itinerant preacher from Ohio, Joseph Thomas, who visited New Jersey in 1835 and was in Johnsonburg sometime soon thereafter, preaching his doctrine at the Christian Society. Thomas was known as the White Pilgrim because of his custom of wearing white clothing, including white hat and boots, and riding a white horse. He preached but one sermon in Johnsonburg when he was stricken with small pox and died. His body was at first buried in the Dark Moon burying ground but was later moved to the Christian Church cemetery in town. A monument was erected and is still standing in the very center of the grounds.

Frelinghuysen Township in the 1980's took on a different character – it has changed from a dairy farming community to primarily a bedroom community. Our township is slowly transforming into a suburb as the land is being developed with housing subdivisions. Pettit's Tavern and one-room schoolhouses have long since turned to dust, along with the towns of Howard, Shiloh and Southtown. The log gaol and the railroads are just a memory, but the historic echoes remain. As with many things, the longer they age, the more precious they become.

(See Table X for a listing of Historical and Cultural Resources as they appear on the map, **"Visual & Cultural Resources")**

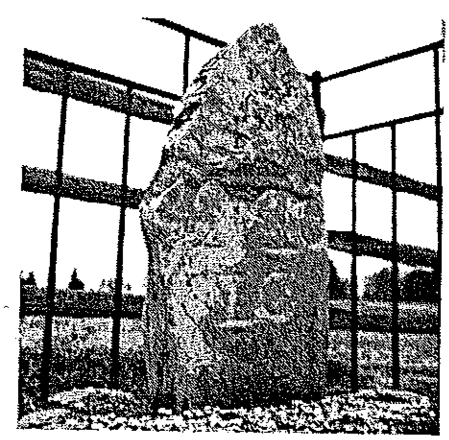
Major sources of Information

Snell's History of Warren and Sussex County.

County Atlas of Warren County, F.W. Beers & Co., 1874.

Bicentennial Booklet of Frelinghuysen Township.

Bulletin of the Archaeological Society of New Jersey, #40, 1986.



Ancient Road marker on the Allamuchy Road.

TABLE X. KEY TO FOLD OUT MAP

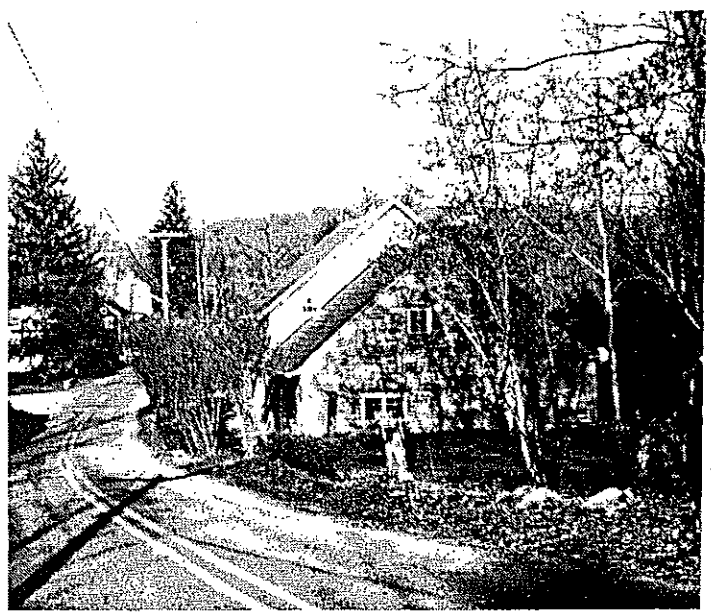
1) Stone Bridge over Paulinskill (late 1700s)
2) g. Wintermute early 1800, res.
2a) Van Auken Ca. 1840
2b) Ca. 1800's
2c) W.J. Cook Ca. 1800
2d) C.L. Teal Ca. 1800
3) Simmons, Ca. 1870
4) Mott, Ca. 1800, res., was tavern
5) site of cider mill & distillery, Ca. 1870
6) site of J.S. Ball Hotel, burned in fire
7) VanHorn and Lanning Store Ca. 1830, res. still standing
8) Col. Mark Thompson house, Ca. 1770, res.
9) stone fortress on Thompson property, still standing
10) stone mill, Thompson Ca. 1750, restored res.
11) Thompson homestead, 1780 Ca., res. (fake stone front)
12) G. Armstrong, Ca. 1850, res.
13) Vough res., Ca. 1850
14) Ryman, blacksmith) res., Ca. 1870
15) Wildrick, Ca. 1870, res.
16) Johnson, Ca. 1870, res.
17-20) homestead still standing Ca. 1870, res.
21) Marksboro Presbyterian Church, 1814.
22-25) homestead standing as of 1850, res.
26) Schoolhouse district #53, Ca. 1840, res.
27) J.P. Lewis, Ca. 1840, res.
28) Van Camp, Ca. 1800 res.
28a) across Van Camp, Creamery Ca. 1900, now a bank)
29) Ebenezer Methodist Episcopal Church, 1859, restored res.
29a) Ebenezer School District #67, res.
30) Coursen-Swinson res., Ca. 1770, res.
31) W.H. Kerr, Ca. 1800, res.
31a) P.S. Howell, Ca. 1800, res.
31b) J. Shuster, Ca. 1800, res.
32) W. Savacool, Ca. 1800, res.
32a) A.R. Cook. Ca. 1850, res.
32b) R.P. Cook, Ca. 1850, res.
33) Poyer, Ca. 1800, res. 33a) L.J. Howell, Ca. 1800, res.
33b) Distillery, Ca. 1850, store and tavern
34) A. Cook, Ca. 1790, res.
35) A.R. Cook, Ca. 1800, res.
35a) Wildrick, Ca. 1790, res.
35b) H.R. Hoit, Ca. 1800, res.
35c) A. Cool, Ca. 1790, res.
35d) J. Howell, Ca. 1800, res.
36) Schoolhouse, Ca. 1900, res
36a) Schoolhouse, Ca. 1800, ruins District #63
36b) lime kiln, standing along road
36c) A. Cook. Ca. 1790, res.
37) D. Vliet, Ca. 1800, res.
38) site of sawmill and homestead, Ca. 1770 ruins remain
39) S. Howell, Ca. 1780, res.
39a) site of gristmill, Ca. 1770
40) S. Albertson, Ca. 1780, res.
40a) I.N. Albertson, Ca. 1790, res.
40b) L.R. Albertson, Ca. 1828, office for Jenny Jump State Park
41) H. Galogy, Ca. 1850, res.
42) site of Southtown, Ca. 1840, marked are ruins of homes and school
43) J.W. Vasbinder, Ca. 1770, res.
43a) ruins of sawmill operated in 1775
44) site of town called Howard Ca. 1790, ruins still found in woods
45) F. Cook, Ca. 1800, res.
45a) J.B. Luse, Ca. 1800, restored
45b) J. Besherrer, Ca. 1800, res.
45c) I. Lanning, Ca. 1790, res.
46) G.W. Hawk, Ca. 1800, res.
46a) I. Gibbs, Ca. 1800, res.
46b) J. Waterfield, Ca. 1800, res.
47) M. Shafer, Ca. 1850, res.
47a) I.R. Kerr, Ca. 1800, res.
47b) I.R. Kerr, Ca. 1800, res.
47c) J.T. Shoemaker, Ca. 1874, res.
48) Locke homestead, Ca. 1874, res.
48a) J. Kerr, Ca. 1800, res.
48b) Ayers homestead, Ca. 1800, res.
48c) I.M. Coursen, Ca. 1800, res.
49) I. Kerr, Ca. 1800, res. Genesis Farm
49a) A. Wildrick, Ca. 1800, res.
50) L. Kishpaugh, Ca. 1800, res.
50a) A.W. Cook, Ca. 1800, res.
50b) R.T. Armstrong, Ca. 1800, res.
50c) W. Armstrong, Ca. 1800, res.
50d) Slockbower homestead, Ca. 1800, res., stone add-
tion from Union Church
51) F.M. Savacool, Ca. 1800, res.
51a) S. Smith, Ca. 1800, res.
51b) L. Lanning, Ca. 1800, res.
51c) Vough homestead, site, Ca. 1820
52) F.M. Savacool, Ca. 1800, res.
52a) schoolhouse Ca. 1900, res.
53) Yellow Frame cemetery and site of original church
54) L. Lanning, Ca. 1800, res.
55) site of Parsonage along Great Road
56) W.B. Howell, Ca. 1820, res.
57) site of Indian Hollow.
57a) ruins of train station Ca. 1910 and Sheffield Creamery Ca. 1911
58) S. Ramsey, Ca. 1800, res.

In Johnsonburg

59) Presbyterian Church, 1850, presently the Town Hall
60) Dr. Vail homestead, 1820, res.
61) Methodist Church, 1850
62,62a,62b) J. Mushbach property, Ca. 1800, res.
63) Wintermute House, Ca. 1800, res.
64) Mission House, episcopal Church, 1751, res.
65) Johnsonburg Hotel, 1870, site of Wolverton's Tavern Ca. 1780
66) Store and Post Office, Ca. 1820
67) R. Blair homestead and Log Gaol farm, Ca. 1750, Log Gaol may have been on this site
68) S. Harden Ca. 1800, res.
69) Gristmill, Ca. 1770
70) R. Skidmore, Ca. 1800, res.
71) Federal Springs, site of 1st schoolhouse in Sussex County, 1760.
72) Pettit's Tavern, here sets the site of the first courts of Sussex County, 1752, foundation of house remains.
73) D.G. VanHorn, Ca. 1800, res.
74) J. Bowers Foundry, Ca. 1850, res.
75) S.Y. Lewis Store, Ca. 1800, res.
76) J. Surles, Ca. 1800 res.
77) Christian Church, Ca. 1846
78) Christian Cemetery, "White Pilgrim" buried in the center.
79) M. Hyther, Ca. 1800, res.
80) J. Tillman, Ca. 1800, res. blacksmith
81) S. Harden Store, Ca. 1820, res. and gas station.
82) Coppershop, Ca. 1800, res.
83) site of Mt. Rascal Schoolhouse.
84) J. Miller, Ca. 1800, res.
85) R. Blair, Ca. 1800, res.
86) S. Armstrong, Ca. 1800, res.
87) J. Anthony, Ca. 1800, res. was blacksmith
88) site of stone schoolhouse, Ca. 1824, now Johnsonburg Park.
89) J. Anthony, Ca. 1800 or earlier, two homesites, res.
90) I.L. Cook, Ca. 1800, res.
91) E. Ward, Ca. 1800, res.
92) M. Savacool, Ca. 1790, res.
93) Methodist Cemetery
94) E. Sharp, Ca. 1800, res.
95) M. Hart, Ca. 1800, res.
96) K. Westbrook, Ca. 1800, res.
97) Dark Moon Cemetery, site of Upper Hardwick church, Ca. 1750
98) Site of Indian Campsite, Ca. 1400
99) J. Hibler, Ca. 1800, res.
100) J.F. Durling, Ca. 1800, res.
101) J. Hall, Ca. 1800, res.
102) S.A. Durling, Ca. 1800, res.
103) I.J. Durling, Ca. 1800, res.
104) J. Durling, Ca. 1800, res.
105) T. Lorgcore, Ca. 1800, res.
106) A. Vass, Ca. 1800, res.
107) M. Minion, Ca. 1800, res.
108) J.E. Dyer homestead, Ca. 1770, res.
109) Historic roadmarker, Ca. 1700, "2M to L.G."
110) C.O. Harris, Ca. 1858, res.
111) Harris, Ca. 1850, res.
112) J. Stickles, Ca. 1800, res.
113) S.H. Read, Ca. 1800, res.
114) G. Wilson, Ca. 1800, res.
115) Dr. Kinney, 1760, res.
116) J. Gibbs, Ca. 1800, res.
117) J. Gibbs, Ca. 1800, res.
118) Ca. 1770, ruins
119) S. Lundy, Ca. 1770, res.
120) S. Lundy, Ca. 1800, res.
121) J. Lundy, Ca. 1800, res.

Glossary

res. = residence, still standing and inhabited
o = indicates a building once stood at this site Ca. 1870
— = drawn in roads of 1800's, still visible
Ca. = approximate date of building, could be older than 1870 (the date of the map from which our map was drawn).



J. Bowers (#74), ca. 1850.

VISUAL RESOURCES

INTRODUCTION

The rich diversity of New Jersey's rural areas is under increasing development pressure. Rural areas near cities are threatened particularly by urban sprawl, which can destroy the beauty of the countryside, ruin the agricultural economy, and disrupt the rural social fabric.

Visual and cultural resources are a major factor in land selection. People move from the city to the country because it is "beautiful" and because rural values are perceived as providing a good atmosphere in which to raise children. Though most of us think of these resources as having intrinsic value, in a very real sense they have real estate value. They are, in fact, a powerful economic factor in real estate appraisal.

Our aim is to show that scenic beauty is a measurable and legally defensible component of public policy and that the impact of development on irreplaceable visual resources is a matter of our political choice. Legislation permitting the protection of scenic and historic resources is already in place on the state level, but local guidelines are needed to both delineate and guide public and private real estate transactions. As of now,

- Historic buildings can be forever removed from the landscape by a simple "demolition permit";
- Public or quasi public intrusions on the landscape (e.g. powerlines, microwave towers, water towers, etc.) can be placed anywhere;
- Subdivision development can cut swaths of woodland for new roads or widen existing roads without concern for historic trees and buildings; and
- There is neither protection of valuable agricultural lands nor forests, nor concern for scenic public open space for recreation and enjoyment.

Therefore, our primary objective is: to prepare a preliminary inventory which we hope will lead to an understanding of the character of our township; and to communicate that character to local residents and political leaders so that a plan to protect that special quality will become the guiding factor in both new development and the revitalization of existing, but often deteriorating, historic elements.

IDENTIFICATION OF VISUAL AND CULTURAL RESOURCES

In Frelinghuysen township, the countryside is an array of colors and forms which represent a rich diversity of open space, woodland, wetlands, ponds, managed and wild fields, clustered farmstead structures, and small communities in harmony with each other and the common landscape.

Until very recently, our township has had a very stable identity. It appears that we have, as yet, not been absorbed into the urbanizing sprawl which surrounds us. The protection and enhancement of our township's identity assumes considerable importance for planning purposes as our citizens, more than likely, will experience a sense of loss if that identity is damaged or destroyed. Unfortunately, the loss will not be obvious until it has occurred.

Every rural community is heir to a unique identity formed, in part, by people and, in part, by geography. Farming communities such as ours are expressions of the cultural traditions, livelihood and ambitions of the people who created them. In rural areas, historic resources are inseparable from their setting. Barns, spring houses, corn cribs, silos, water mills, bridges, fences, old general stores and farmhouses are as much a part of the scenic landscape as narrow country lanes, stone walls and hedgerows, pastures, fields, woods, streams, brooks, ponds, rock ledges and outcrops. These cultural scenic resources together with panoramic vistas of the Delaware Water Gap or the Kittatinny Mountains, and scenic roads such as Route 519, are valued amenities many of us take for granted. Yet they contribute to the quality of life and create the "spirit" or *genius loci* of the township. It is this "spirit" that bonds many of us to this place.

Historic architectural style and its use of local materials, as can be seen in old stone houses and barns and in the craftsmanship of early builders, make up our unique character. Early settlers showed great sensitivity in the siting of buildings, though it was probably for other than strictly visual reasons. Nevertheless, we rarely find an historic farmstead placed imposingly on top of a ridge. The Wilbur Carr farmstead is a good example; although it is located at a high elevation within the township, the buildings sit close to the ground, nestled into the landscape, backed by woods, and surrounded by open fields.

Early settlers also showed sensitivity in the siting of roads and bridges - within the township many of our existing roads have great scenic value with their pleasantly evolving sequence of visual impressions. For the most part, they are in a harmonious relationship with the natural topography and neighborhoods - their locations probably chosen to bypass old trees, streams, rock outcrops, woodland edges, farmfields and farm fences. No doubt most views from our public roads have been produced unintentionally as the old farm lanes and highways were slowly converted to blacktopped automobile and truck conveying roads.

The best of our roads meander through our valleys, fields and woods. One of the great pleasures of country driving is to suddenly come upon a special place unexpectedly...

- The old mill in Marksboro;
- Magnificent old trees on South Street;
- Old stone houses, barns and other farm structures on the Hope-Johnsonburg Road;
- Lime kilns such as the one on Shiloh Road;
- Spectacular views of the Kittatinny Mountains from Silver Lake Road and Lincoln Laurel Road;
- The cathedral-like hush on Henfoot and Hess Roads where large and ancient hemlocks and beeches line the edge of the woods;
- An old cemetery on Dark Moon Road
- The lush, mossy railbed of the Lackawanna cutoff;
- The majestic glimpse of Jenny Jump Mountain from the Allamuchy-Johnsonburg Road;
- The view of the Delaware Water Gap from Jenny Jump Mountain; and
- The many faces of the Paulinskill River, Trout Brook, and Bear Creek.

Township character will be irretrievably altered by major growth and change, as well as minor daily decisions. The loss of essential character, however, may not be noticed until it has occurred and until the impact of our daily decisions is compounded to forever change the very nature of the township in which we live. It is, therefore, important for the community to recognize that change is inevitable, but where and how change should occur can be incorporated in the planning process. It is equally important to identify and protect areas and features where change should not occur at all.

ASSESSING VISUAL AND CULTURAL RESOURCES

Landscapes can be categorized according to types, criteria can be established for evaluating their significance, and maps can be drawn expressing scenic resources in graphic form. Residents can evaluate landscapes, generally by sorting through photographs taken from within or outside the community into categories ranging from "most pleasing" to "least pleasing". Open-ended questionnaires can be answered by them in which they themselves define areas most worthy of preservation.

The sorting of photographs and answering of questionnaires are often set up through random polling methods, but analyzed statistically. Interestingly, such surveys have revealed that what have been commonly regarded as subjective perceptions of landscape beauty are objectively substantiated

In 1986, and again in 1989, the Environmental Commission mailed 500 questionnaires to residents at random. Of those returned to us, more than two thirds considered the following items "most important visually and worthy of protection" -

- Old farms, homesteads and farmland;
- Rural atmosphere;
- Brooks, streams, wetlands;
- Historic and large trees; and
- The historic town centers of Johnsonburg and Marksboro.

Another third objected to the visually negative impact of junk yards, buildings falling down, overhead wires, metal guard rails and wide new roads.

Identifying our scenic and cultural resources will make us more aware of what does not fit in. It will show us unique concerns of the whole community as well as minority concerns.

PROTECTING AND PRESERVING VISUAL AND CULTURAL RESOURCES

Many rural residents have traditionally been skeptical of planning and land-use regulations, viewing these activities more as an infringement on citizen's rights to independent individual land-use decisions than as a democratic process for resolving land-use conflicts and guiding community development over the long term for the benefit of all. Local planning needs to address both the development *and* the conservation of the natural as well as cultural/visual resources.

While the State of New Jersey has passed several laws which would enable local communities to fulfill the above goal, there has been no local initiative to set standards for a "Visual Appearance Plan" element of the Master Plan in Frelinghuysen. Such a plan could provide policy statements and implementation techniques for either improving or maintaining township appearance and serve both developers and local residents. It could inform architects, builders and developers of guidelines for development that are considered important by the residents. It could provide a general education in design to increase public awareness of the issues, focus efforts for improvement, and influence the many small design decisions that collectively affect the character of the township.

Guidelines by which to set policy might include the following:

- Skylines and ridges are an important visual resource and most sensitive to visual intrusion because more people see them and they affect more views;
- Higher topography is more vulnerable to scenic disruption by solid structures; and
- Scenic resources are a potentially important economic resource as they are the primary reason home buyers are attracted to this area. They could provide the basis for a potentially important economic activity, tourism.

The Municipal Land Use Law and its open ended "plan element" policy, however, does not focus on our individual homes, farms and fields. We are responsible as individuals for the composite appearance of the landscape. Its future appearance will be a result of the same private decisions. When we are careful and evaluate our actions in terms of aesthetic effects, we produce a landscape that everyone in Frelinghuysen can respect and enjoy.

Understanding the visual implications of our collective and individual decisions, and using principles that result in a well designed landscape – be it home, road or store – is good business practice. It is a sound investment that results in increased property values and a scenic landscape of which we are proud.

Major sources of information

Preservation League of New York State, Inc. *Farmsteads and Market Towns: A Handbook for Preserving the Cultural Landscape.* 1982.

The Rural Landscape. Newsletter of the American Society of Landscape Architects, Rural Landscape Open Committee, V. 2, No. 1, 1989, and V. 1, No. 2, Fall 1988.

Coalition for Scenic Beauty, Scenic America (undated). *Whatever Happened to America the Beautiful?*

Garnham, Harry Launce, *Maintaining the Spirit of Place: A Process for Preservation of Town Character,* PDA Publishers. 1985.

American Planning Association, *Rural and Small Town Planning,* Wash. D.C. 1979.

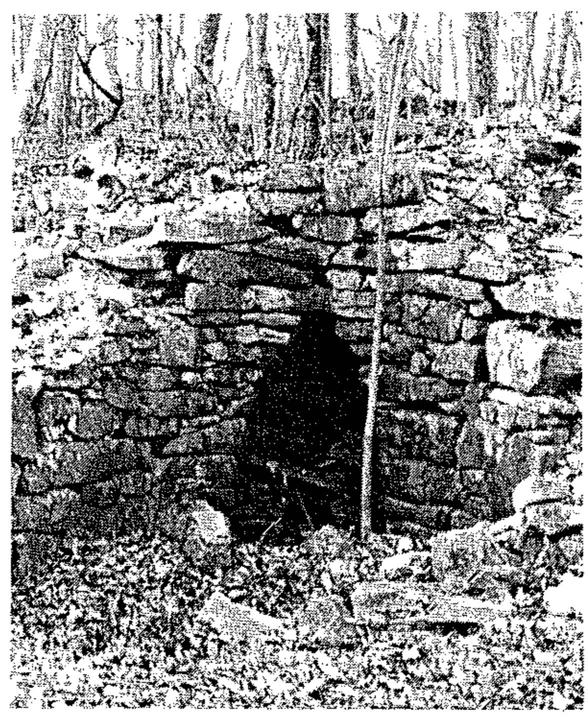
Simonds, John Ornsbee, *Earthscape, a Manual of Environmental Planning,* McGraw-Hill, Inc. 1978.

Leopold, Aldo. *A Sand County Almanac.* Oxford University Press, Inc. 1966.

American Socity of Landscape Architects. *Visual Resource Management,* Latis, V. 1, No.2. 1978.

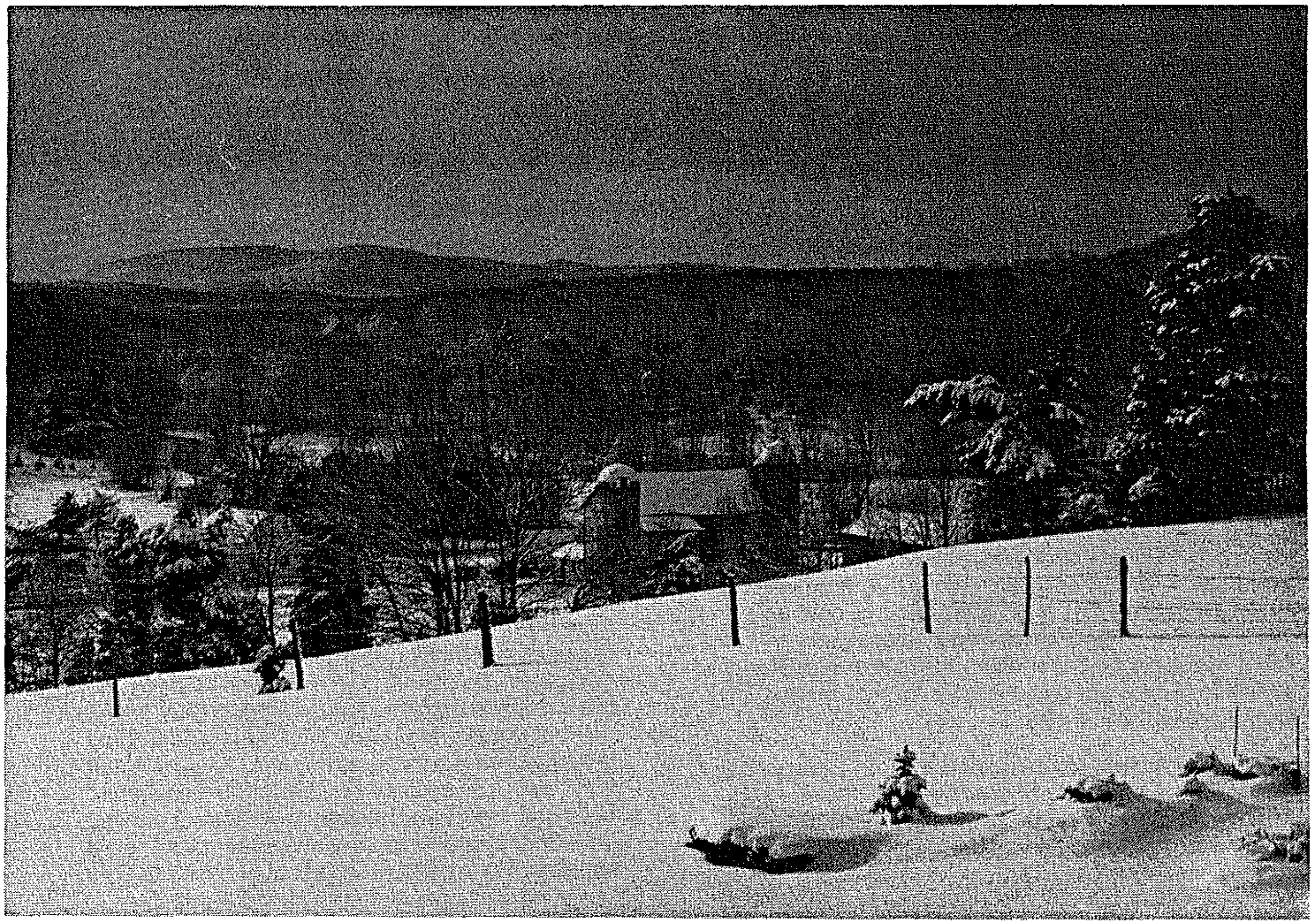
National Trust for Historic Preservation. *Rural Conservation: Information sheet.* 1984.

American Society of Landscape Architects. *Landscape/Land use Planning, Proceedings from Selected Education Sessions of the 1989 ASLA Annual Meeting,* Orlando, Fla., Nov. 1989.



Lime Kiln on Shiloh Road.

OPEN SPACE



According to the State's enabling legislation passed in 1968, our Environmental Commission MUST maintain an inventory or index of all open areas in the township, whether publicly or privately owned. In 1972, further legislation added the following paragraph to the original 1968 law:

> "An environmental commission shall have power to study and make recommendations concerning open space preservation, water resource management, air pollution control, solid waste management, noise control, soil and landscape protection, environmental appearance, marine resources and protection of flora and fauna."

As can be readily seen from the accompanying map "OPEN SPACE", Frelinghuysen Township has considerable privately owned open space. Jenny Jump State Park is the largest publicly owned open space with 967 acres, of which 233.38 are in Frelinghuysen. Wildlife Preserves Inc. is the largest privately owned conservation area with 134 acres. Frelinghuysen Township has no public open space (other than what surrounds the elementary school or the town hall), no conservation policy for setting land aside that should not be developed, and no public playgrounds.

The Warren County Open Space Plan of 1974 states:

> "The rapid and largely unanticipated development experienced throughout New Jersey, and particularly in metropolitan areas, has focused the attention of most people on what is now an obvious error of government and other responsible groups, namely, the failure to conserve open space for future generations and, for that matter, for the present generation."

As the demand for land increases, Warren County runs the risk of losing unusual opportunities for the preservation of open space that will be of immeasurable benefit to present and future generations.

The 1966 Master Plan for Frelinghuysen recommended that land be set aside for public recreation "while the community is in a stage of low density development". Included in the proposal was the purchase of five additional acres adjacent to the township school as well as acreage for a community park. The 1987 Master Plan Reexamination Report did not address open space other than to mention that environmentally sensitive areas be set aside for recreation within a development.

All of Frelinghuysen Township is zoned for development whether residential (AR-2, AR-3, AR-4) or Retail/Industrial/Commercial (VN-1, VN-2; NC, HC, ROM). However, in the Report the township enumerated eleven goals and objectives, six of which were identified in the 1966 Master Plan, and five of which were added in 1987. Among these four deal directly or indirectly with open space. They are:

> To encourage the continuation of agricultural use in the Township;
>
> To encourage permanent open space through conservation, floodplain and wetland protection, and scenic easements;
>
> To encourage the preservation of historic/cultural resources unique to the Township; and
>
> To preserve the rural character of the Township and prevent future traffic circulation problems.

Until now, a sense of openness has prevailed in the township by the dominance of widely separated single family residences and farmland. Until 1987, Frelinghuysen Township had no major subdivision. Only 2 years later, the Planning Board has approved or is in the approval process, of seven additional applications which will add 227 dwellings units* thereby drastically altering the population. This trend will continue, unless the proposed State Plan becomes effective. The need for setting aside land for park and recreation, as well as environmentally sensitive lands of value to the township, is urgent.

The M.L.U.L. defines "open space" (40-55D-5) as

> "open space" means any parcel or area of land or water essentially unimproved and set aside, dedicated, designated or reserved for public or private use or enjoyment or for the use and enjoyment of owners and occupants of land adjoining or neighboring such open space; provided that such areas may be improved with only those buildings, structures, streets and offstreet parking and other improvements that are designed to be incidential to the natural openess of the land.

And "public open space" (40:55D-6) as

> "public open space" means an open space area conveyed or otherwise dedicated to a municipal agency, board of education, State or county agency, or other public body for recreational or conservational uses.

In section 40:55D-28b.(2) the MLUL states that the Master Plan shall at least....but not necessarily be limited to. . . .showing existing and proposed location, extent and

*(includes 64 minor subdivisions 1988–1990)

intensity of development of land to be used in the future for varying types of residential, commercial, industrial, agricultural, recreational, educational (uses).... It lists the various plan elements that may be included; among these are:

> "A recreation plan element, showing a comprehensive system of areas, and public sites for recreation;"
>
> "A conservation plan element, providing for the preservation, conservation, and utilization of natural resources, including, to the extend appropriate, energy, open waters, fisheries, endangered or threatened species, wildlife and other resources, and which systematically analyzes the impact of each other component and element of the master plan on the present and future preservation, conservation and utilization of those resources."

While our zoning ordinance addresses open space in the section dealing with cluster development, it does not require or suggest open space anywhere else.

The Model Subdivision and Site Plan Ordinance compiled by Rutgers University for the N.J. Department of Community Affairs suggests that open space requirements should be flexible and customized to each locality, using national standards as guidelines only since national recommendations concern themselves with developed areas. A rural community's open space should also require that the natural amenities and unique features of a site be retained and incorporated into the open space system for a number of reasons:

> "Natural features add to the attractiveness & harmony of the development, and preservation of fragile areas in their natural state can avoid a number of future problems and potential dangers. Among the areas that should be preserved are flood hazard areas, wetland areas containing specimen trees, steep slopes; existing water courses, ponds, marshes and swamps; and ecologically sensitive areas."

No general standard can specify the amount of open space that should remain undeveloped since it is dependent on local site conditions outlined above. However, since Frelinghuysen has such limited public open space for either undeveloped or developed recreational use, it is hoped that this issue will be addressed during the next Master Plan revision due in 1992.

OPEN SPACE INVENTORY FOR FRELINGHUYSEN TOWNSHIP

1. Jenny Jump State Park, owned and operated by the State of N.J. through the Green Acres program, located in the south western section of the township on State Park Road. Provides camping sites and hiking trails as well as a small tot-lot. Fabulous views of the Delaware Water Gap, the Kittatinny Ridge and Valley, as well as the Great Meadows valley. Many of the springs in the township originate here and the park abounds in a variety of vegetation ecosystems.

2. Wildlife Preserves, Inc., located in the eastern section of the township and surrounded by privately held land and not accessible to the public.

3. Private camps - Presbyterian Camp off Rt. 519, used as an educational summer camp facility, owned by P.C. & C. Managed by the Nature Conservancy. Not open to the public.

NATURAL AREAS OF SPECIAL INTEREST

Frelinghuysen Township is fortunate in that it still has a large variety of habitats which support a high diversity of wildlife and plant species, including:

1. Mud Pond and vicinity: Approximately 565 acres, the Mud Pond area near Johnsonburg may support the greatest number of threatened New Jersey plant species, as compared to any site of comparable size in the state. Lack of disturbance and diversity of habitats make this area a highly significant site, acccording to Robert Cartica of the New Jersey Office of Natural Lands Management (Division of Parks and Forestry, NJDEP). At least 23 rare New Jersey plant species have been documented for the area, making this possibly the most species-rich site in the entire state. Up to 500 native species may be found within the area. Ownership is as follows:

   State of New Jersey-Green Acres Program - 11 acres;

   Wildlife Preserves, Inc. - 134 acres;

   Private ownership - 705 acres (numerous lots)

2. Presbyterian Camp and Conference Center: A detailed inventory is not available of this location at this time. However, a wide variety of habitats are found on the site, ranging from dry upland open meadows, oak/hickory mesic forest, sugar maple/mixed hardwood forest, hemlock ravine, bogs, swamps, and calcareous fen. The site is a registered "Natural Area" with the Nature Conservancy, and is used for environmental education.

Most of the plant species listed in Tables II, III, and IV occur here. In addition, the calcareous fen at Glover's Pond includes wetland species unique to the area, such as Acadian hairstreak (Satyrium acadica), swamp birch (Betula pumila), smooth gooseberry (Ribes hirtellum), Hoary willow (Salix candida), water sedge (Carex aquatilis), spreading globe flower (Trolius laxus), and few-flowered spikerush (Eleocharis pauciflora).

Major sources of Information

Listolein, David and Baker, Carol, *Model Subdivision and Site Plan Ordinance*, prepared for the N.J. Dept. of Community Affairs, by Rutgers University, Center for Urban Policy Research.

Warren County Planning Board. *Open Space Plan-Warren County.* 1974.

N.J. State Planning Commission. *The Preliminary State Devlopment and Revelopment Plan for the State of N.J.* 1988.

N.J. Department of Environmental Protection, *Environmental News*, Jan./Feb. 1986.

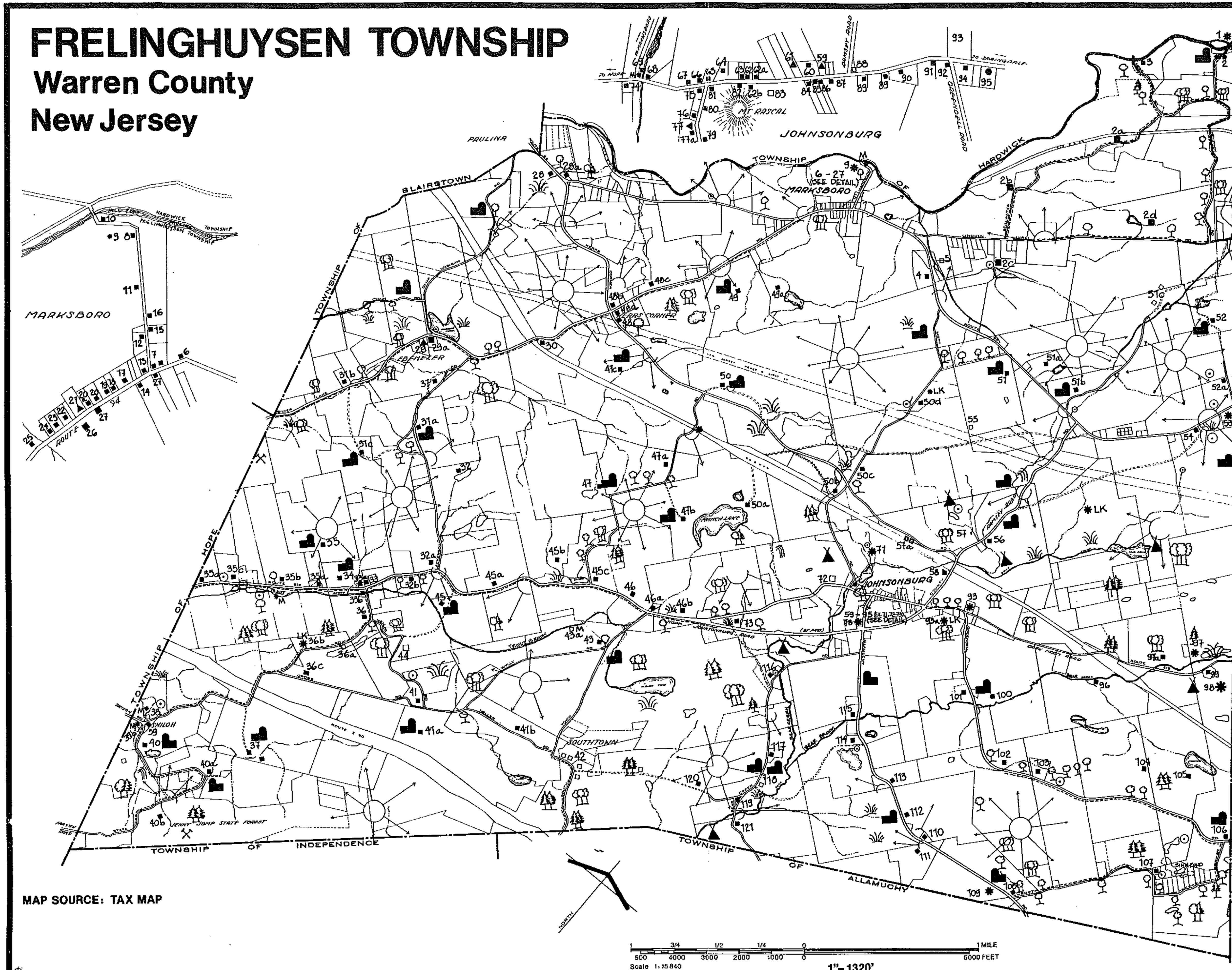
Brown, Christopher N. Brown. *The Community Rivers Concept* American Forests, June 1984.American Forestry Association, Wash. D.C.

Moore, David F. *Securing Parks and Open Space-The Alternatives*, Federation of N.J. Municipalities, Dec. 1987.

Thurow, Charles, Toner, William, and Erley, Duncan. *Performance Controls for Sensitive Lands, a Practical Guide for Local Administrators*, Planning Advisory Service Report, Nos. 307 & 308.

Typical country road, Frelinghuysen.

FRELINGHUYSEN TOWNSHIP
Warren County
New Jersey



VISUAL & CULTURAL RESOURCES

LEGEND

- SCENIC ROADWAY
- EXCEPTIONAL WETLANDS
- QUARRY/MINE
- SPECIMEN TREE
- EXCEPTIONAL WOODLAND
- EXCEPTIONAL WOODLAND
- WATERFALL
- SPRING / DUG WELL
- CHURCH
- HISTORIC BUILDING
- HISTORIC BUILDING RUIN
- HISTORIC LANDMARK; CEMETERY OR AREA
- LK LIME KILN
- M MILL
- VISTA/VIEW
- FARM
- ELEM. SCHOOL
- INDIAN SHELTER / CAMPSITE

ENVIRONMENTAL RESOURCES INVENTORY prepared December 1987 by the ENVIRONMENTAL COMMISSION

APPENDIX A.1-A.4 SOIL LIMITATIONS FOR SPECIFIC LAND USES

(TABLE A.1)

Risk Level	Soil Series	Map Unit	Potential Limiting Soil Factor
Severe	Adrian	Ad	ponding
	Annandale	An D2	steep slopes slow percs
	Bartley	Ba, Bb, Bd	slow percs, perched water table
	Bath	Bf, Bg	steep slopes slow percs
	Carlisle	Ck	floods, wetness
	Chippewa	Cm, Cn	wetness, slow percs
	Edneyville	Ee, EPD	steep slopes large stones
	Fredon	Fr	shallow water table and poor filter
	Halsey	Ha	shallow water table
	Hazen	HfD Hb, HfA, HfB, HfC	steep slopes and poor filter poor filter
	Hero	Hk, Hr	shallow water table and poor filter
	Lyons	Ly, Lz	ponding, slow percs
	Middlebury	Md	flooding, wetness and poor filter
	Nassau	Na, Nb, NF	steep slopes shallow soil profile
	Palmyra	PaB	poor filter
	Venango	Ve, Vn, Vs	slow percs, wetness
	Washington	WaD2, WgD, WkE	steep slopes
	Wassaic	Wm, Wn, WO	steep slopes shallow soil profile
	Wayland	Wp	shallow water table
	Rock Outcrop (Wassaic Complex and Parker Edneyville	RPF, RWF, RWD	steep slope, bedrock
Moderate	Edneyville	EdC	steep slopes and stones
	Washington	WgC	steep slopes
Slight	Edneyville	EdB	
	Washington	WgA	

TABLE A.1 LIMITATIONS TO CONSTRUCTION OF CONVENTIONAL SEPTIC SYSTEMS

(TABLE A.2)

Risk Level	Soil Series	Limiting Factor(s) (one or several may apply)	Map Unit
Severe	Adrian		Ad
	Annandale	wetness, frost	AnD2
	Bath		BfD, BfE
	Edneyville	action, flooding,	Ee, EP
	Carlisle	steep slopes, large	Ck
	Chippewa	stones	Cm, Cn
	Fredon		FrA
	Hazen		HfD
	Hero		Hk, HfE Hr
	Lyons		Ly, Lz
	Middlebury		Md
	Nassau		Na, Nb, NF
	Palmyra		PaB
	Parker		Pb, RPF
	Venango		Vn, Vs
	Wassaic		WnD, WOD
	Washington		WgD, WkD
	Wayland		Wp
Moderate	Annandale	wetness, frost	AnB2
	Bath	action, steep	Bf, Bg
	Bartley	slopes, large	Ba, Bb, Bd
	Hazen	stones, shallow depth	Hb, HfB, HfC
	Wassaic	to bedrock	Wm, WnC, WOB, WOC
	Washington		WaD2, WgC

TABLE A.2 SOIL LIMITATIONS TO CONSTRUCTION OF DWELLINGS ON SLAB FOUNDATIONS

(TABLE A.3)

Risk Level	Soil Series	Limiting Factor(s) (one or several may apply)	Map Unit
Severe	Adrian	steep slopes, large	Ad
	Annandale	stones, frost action	AnD2
	Bath	ponding and	BfD, BfE
	Carlisle	wetness	Ck
	Edneyville		Ee, EP
	Fredon		Fr
	Halsey		Ha
	Hazen		HfD, HfE
	Hero		Hk, Hr
	Lyons		Ly, Lz
	Middlebury		Md,
	Nassau		Na, Nb, NF
	Parker		Pb, RPF
	Venango		Ve, Vn, Vs
	Wassaic		Wm, Wn, WO
	Washington		WaD2, WgD, WkD, WkE
	Wayland		Wp
Moderate	Annandale	steep slopes, large	AnC2
	Bartley	stones, wetness	Ba, Bb, Bd
	Bath		BfC, BgB, BgC
	Edneyville		EdC
	Hazen		HbC, HfC
	Washington		WgB, WgD, WkB, WkC
Slight	Bath	steep slopes, large	BfB
	Hazen	stones, wetness	HbA, HfA, HfB
	Palmyra		PaB

TABLE A.3 SOIL LIMITATIONS TO CONSTRUCTION OF BUILDINGS WITH BASEMENTS

(TABLE A.4)

Suitability	Soil Series	Limiting Soil Factors (one or more may apply)	Map Unit
Favorable	Adrian Carlisle Fredon Halsey Wayland		Ad Ck Fr Ha Wp
Marginal	Bartley Chippewa Hero Venango	slow refill rates	Ba, Bb, Bd Cm, Cn Hr, Hk Ve, Vn, Vs
Unfavorable	Annandale Bath Edneyville Hazen Middlebury Nassau Parker Washington Wassaic	no shallow water table large boulders shallow bedrock	An Bf, Bg Ed, Ee, EP Hb, Hf Md Na, Nb, Nf Pb Wa, Wg, Wk Wm, Wn, WO

TABLE A.4 SUITABILITY OF SOILS FOR THE INSTALLATION OF EXCAVATED PONDS

APPENDIX A.5 PROFESSIONAL CONTACTS FOR INFORMATION ON SOILS, FORESTRY, AND LAND USE

U.S. Department Of Agriculture 1370 Hamilton Street
Somerset, New Jersey 08873 201-246-4110

Contacts:
State Soil Scientist (State soils programs, administration)
State Conservationist (State conservation programs, administration)
State Resource Conservationist (State conseration programs)
State Engineer (Ponds, dam safety)

Warren County Soil Conservation District, Stiger Street
Hackettstown, New Jersey 07840 908-852-2579

Contacts:
District Conservationist (Interpretation of soils and soil capabilities), USDA, (908) 852-5450
District Manager (Soil erosion and sediment control; construction practices)
Erosion Control Specialist (Review and enforcement of sediment control compliance)

Bureau of Forestry Box 999, R.D. 1 Franklin, New Jersey 07416 201-827-6100
Contacts:
Area Forester (Forest/timber stand improvement program; funding for forest management and improvement on private lands; forest and tree ordinances)
District Forester (Forest management; consultation on forest management plans)

Rutgers University, Rutgers Cooperative Extension Service
P.O. Box 231, New Brunswick, New Jersey 08903 908-932-9306

Bureau of Law Enforcement Division of Fish and Game New Jersey
Department of Environmental Protection 609-292-9430
Conservation Officer (Protection of waters from sediment pollution; law enforcement)

APPENDIX B. PLANT INVENTORY AT GENESIS FARMS, TAKEN 1987
BY GENESIS FARMS (140 acres between Rt. 94, Silver Lake Road, and farm boundary, Marksboro)

Oak-hickory forest (wooded tract by Route 94)

Dominant tree species:

Quercus rubra	red oak
Quercus alba	white oak
Quercus velutina	black oak
Carya ovata	shagbark hickory
Fraxinus americana	white ash

Others:

Acer saccharum	sugar maple
Acer rubrum	red maple
Liriodendron tulipifera	tulip-poplar

Cattail marsh

Typha spp.	cattail
Decoden verticillatus	swamp loosestrife
Sagittaria latifolia	arrowhead
Eleocharis spp.	spike rush
Symplocarpus foetidus	skunk cabbage
Rumex verticillatus	water dock
Dryopteris thelypteris	marsh fern
Carex ?	sedge
Asclepias spp.	swamp milkweed
Impatiens capensis	jewelweed
Cypripedium pallida	lady's slipper
Onoclea sensibilis	sensitive fern
Iris versicolor	blue flag
Cirsium muticum	swamp thistle

Red maple swamp

Dominant tree species:

Acer rubrum	red maple

Herbaceous plants:

Onoclea struthiopteris	ostrich fern
Nasturtium officinale	watercress
Tussilago farfara	coltsfoot
Ranunculus septentrionalis	swamp buttercup
Caltha palustris	marsh marigold
Cicuta maculata	cow bane
Arisaema triphyllum	Jack-in-the-pulpit
Erythronium americana	trout lily

Sugar maple-mixed hardwoods

Dominants tree species:

Acer saccharum	sugar maple

Others:

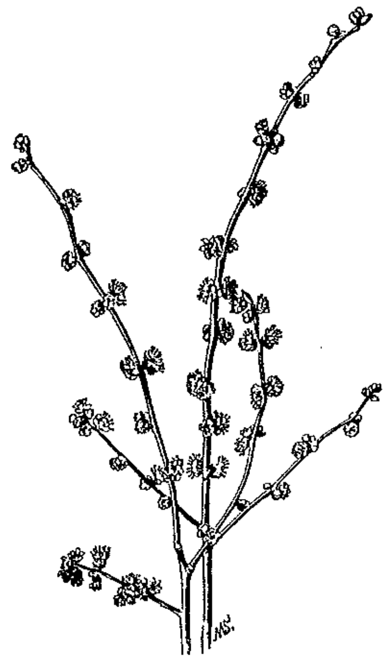
Acer rubrum	red maple
Betula lenta	black birch
Betula lutea	yellow birch
Betual papyrifera	white birch
Tilia americana	basswood
Fagus grandifolia	american beech
Fraxinus americana	white ash
Quercus alba	white oak
Ostrya virginiana	hop hornbeam
Carpinus caroliniana	ironwood
Prunus serotina	black cherry

Shrubs:

Lindera benzoin	spicebush
Viburnum	

Herbaceous plants:

Epigaea repens	trailing arbutus
Polygonatum pubescens	Solomon's seal
Smilacina racemosa	false Solomon's seal
Trientalis borealis	starflower
Hamamelis virginiana	witchhazel
Mitchella repens	partridgeberry
Polypodium vulgare	Common Polypody



SPICEBUSH.—*Lindera Benzoin.*

Pteris aquilina	bracken fern
Oxalis acetosella	wood sorrel
Alliaria officinalis	garlic mustard
Monotropa uniflora	Indian pipe
Maianthemum canadense	Canada mayflower
Chimaphilia maculata	wintergreen
Allium canadensis	wild garlic
Asarum canadense	wild ginger
Polytrichum juniperinum	hair-cap moss
Amelanchier spp.	serviceberry
Cypripedium spp.	lady's slipper
Lycopodium obscurum	ground pine
Hepatica americana	hepatica
Coptis graenlandica	golden thread
Dicentra eximia	bleeding heart
Sanguinaria canadensis	bloodroot
Mitella diphylla	Miterwort
Viola palmata	violet

Open space (fields, streams, roadsides)

Dominant tree species:

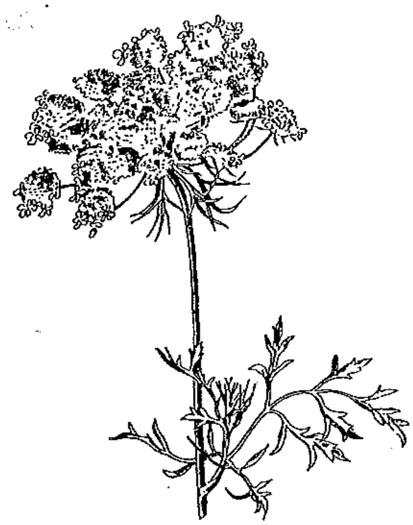
Robinia pseudo-acacia	black locust
Catalpa speciosa	Indian bean
Rhus glabra	smooth sumac
R. typhina	staghorn sumac
Platanus occidentalis	sycamore
Juglans nigra	black walnut
Populus grandidentata	large-toothed aspen
Thuya occidentalis	American arborvitae
Juniperus virgininia	red cedar
Tsuga canadensis	hemlock
Pinus strobus	white pine

Herbaceous plants and shrubs:

Eupatorium perfoliatum	boneset
Plantago major	plantain
Asclepias syriaca	milkweed
Barbarea vulgaris	wintercress
Nepeta cataria (alien)	catnip
Hemerocallis fulva	day lily
Sambucus canadensis	elderberry
Galinsoga	ground ivy
Chenopodium album	lamb's quarters
Menta	mint
Conium maculatum	hemlock
Viola papilionacea	butterfly violet
V. sagittata	Arrow-Leaved violet
Daucus carota	Queen Anne's lace
Fragaria virginiana	wild strawberry
Potentilla canadensis	cinquefoil
Capsella bursapastoris	shepherd's purse
Phytolacca americana	poke weed
Lepidium	pepper grass
Rubus allegheniensis	wild blackberries
Portulaca oleracea	purslane
Thalictrum polygamum	meadow rue
Cichorium intybus	chickory
Trifolium spp.	clover
Symphytum officinale	comfrey
Malva neglecta	mallow
Taraxacum officinale	dandelion
Arctium	burdock
Stellaria media	chickweed
Rumex crispus	sourdock
R. acetosella	sheep sorrel
Vinca minor	myrtle
Ranunculus repens	creeping buttercup
Phlox	
Chrysanthemum leucanthemum	ox-eye daisy
Solidago spp.	goldenrod
Vitis novae-angliae	New England grape
Lonicera spp.	honeysuckle
Achillea millefolium	yarrow
Rosa multiflora	multiflora rose (introduced)
Cirsium arvense	Canada thistle

Rockledges

Polypodium virginianum	rock fern
Umbilicaria spp.	rock tripe
Cladonia cristatella	British soldier
Anemone quinquefolia	windflower
Aquilegia canadensis	columbine
Lycopodium spp.	club moss
Rinodina	custose lichens
Sedum	cushion moss
Polytrichum juniperinum	haircap moss
Potentilla spp.	three-toothed cinquefoil



WILD CARROT—*Daucus Carota.*

Species Description

Staghorn Sumac—*Rhus typhina*
Sometimes this species is called velvet sumac because of the dense velvety hairs that cover the twigs. The leaves are pinnately compound, 16-24 inches long and comprised of 11-31 leaflets. It grows 10 to 20 feet tall from Georgia to Canada. It produces a 4-8" compact cluster of red drupes used by songbirds for food.

Shrub Lespedeza—*Lespedeza bicolor*
This is a small shrub which grows 4-8 feet having woody stems that die back in the winter. The leaves are compound and comprised of 2-3 inch long elliptical leaflets. It has a pink to purple flower 1/2 inch in diameter and produces black seeds that mature in the fall. It is valuable as food and cover, especially for quail and pheasants. The leaves are also browsed by deer.

Autumn Olive—*Elaeagnus umbellata*
This rapidly spreading shrub, introduced from China grows 10-15 feet tall. Its thin, spiny twigs become covered with clusters of red berries that persist into the winter. Valuable for erosion control, it also provides nesting and escape cover for many animals. The fruit is eaten by songbirds, quail, grouse, dove, pheasant, turkey, and rodents. This species will grow out of control if it is not well managed.

White Mulberry—*Morus alba*
This is a small tree that grows 20-40 feet tall. Its leaves, 3-5 inches long, are simple, heart shaped and can be lobed or unlobed. It produces a 1" long multiple of drupes that resemble a raspberry but are white to pink when ripe. The berries ripen in June and are eaten by many songbirds and squirrels.

Bristly Locust—*Robinia fertilis*
This shrub grows 3-10 feet tall with all parts densely covered with reddish-brown bristles. The leaves are 4-8 inches long with 9-15 egg shape leaflets. The flowers are large, pink and in clusters of 3-8 which bloom in June. The fruits are dry, bristly, 1-2 inch long pea-like pods.

White Pine—*Pinus strobus*
This is a fast growing evergreen tree that is common across the eastern U.S. It is the only pine in the east that has five needles to a cluster. The needles are a light bluish green, 2-4 inches long and soft to the touch. The tree produces cones that are eaten by squirrels. More importantly it provides habitat for tree nesting birds.

Norway Spruce—*Picea abies*
This tall growing tree is common but not native to the northeastern U.S. The needles are short, stiff and dark green. The cones produced are 4-7 inches long and are used as food by squirrels, often piled up and used through the winter.

Other Plants Valuable to Wildlife

SPECIES	MATURE HEIGHT	FLOWERS	FRUITS	SUN/ SHADE	WET/DRY	USE IN HABITAT
Trees						
1. American beech	50-100'		Sept-Oct	Lt shd/sun	Moist	Nuts, seeds, acorns and buds; fall-early spring foods for squirrels, game and songbirds. Spring, summer foliage; cover, feeding and reproductive areas for songbirds, tree-dwelling mammals, butterflies and other insects. Leafless branches, cavities; winter roosting for mammals and birds.
Tulip tree	80-150'	May-June	Oct-Feb	Mod shd/sun	Moist	
2. Red oak	50-100'		Sept-Oct	Lt shd/sun	Moist/dry	
3. White oak	40-100'		Sept-Oct	Lt shd/sun	Moist/dry	
4. Red maple	40-100'	Mar/May	July-Dec	Shd/sun	Moist/well drained	
Sugar maple	40-100'			Shd/sun	Moist	
5. White pine	40-100'		Aug-Dec	Sun/lt shd	Dry/moist	Cones and berries; fall, winter, early spring food for red squirrels, songbirds. Boughs; year 'round cover, reproductive areas for songbirds, birds of prey, insects, tree-dwelling mammals.
6. White spruce	40-100'		Aug-Dec	Sun	Dry	
7. Eastern hemlock	50-80'		Aug-Feb	Shd/sun	Moist	
8. Eastern red cedar	30-80'		Sept-May	Sun	Dry/moist	
Small Trees						
9. Winterberry holly	10'	April-May	Oct-Jan	Shd/sun	Wet/moist	Flowers, food for butterflies, other insects. Berries, fruit; fall, winter food for songbirds, small mammals. Spring, summer foliage; cover, food, reproductive areas for songbirds. Leafless branches; winter cover, roosting for songbirds.
Spicebush	10'	March-May	Sept-Nov	Shd/sun	Wet/moist	
10. Flowering dogwood	10-30'	Mar-June	Sept-Oct	Shd/sun	Well-drained/dry	
Serviceberry	10-25'	Mar-April	June-July	Shd/sun	Dry/moist	
11. Hawthorne	10-30'	June	Oct-March	Sun	Dry	
12. Crabapple	15-30'	Mar-May	Sept-Nov	Sun	Moist/Dry	
Sassafras	15-40'	April-June	Aug-Sept	Lt shd/sun	Well-drained/dry	
Shrubs						
13. Autumn olive	10'	May-July	Sept-Dec	Sun	Moist/dry	Flowers, food for butterflies, other insects. Berries; food for songbirds, small mammals. Foliage: cover, reproductive sites for songbirds, mammals, reptiles, amphibians and insects.
Arrowwood viburnum	10'	May-June	Aug-Oct	Shd/sun	Moist/wet	
14. Silky dogwood	6-8'	May-July	Aug-Sept	Sun/lt shd		
15. Flameleaf sumac	4-10'	July-Aug	Aug-Oct	Sun	Dry/moist	
Red osier dogwood	to 10"	May-Aug	July-Oct	sun	Moist/wet	
16. Elderberry	3-13'	June-July	Aug-Sept	Sun/lt shd	Moist/wet	
17. Cotoneasters	2-15'	June-July	Aug-March	Sun	Dry/well-drained	
18. Rhododendron	5-20'	May-July	—	Lt shd/shd	Moist	
Pfitzer juniper	3-12'	—	Aug-March	Sun	Dry Moist	
Tall Oregon grape	4-8'	Feb-May	June-Aug	Sun/lt shd	Dry/Moist	
Amur honeysuckle	6-12'	June-July	Aug-Oct	Sun/lt shd	Dry/Moist	

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General References

1. Ashmun, Candace M. *Municipal Land Use, A decision-makers guide.* The Association of N.J. Environmental Commissions.
2. Booth, Norman K. *Form Evolution: Site Design Considerations for a Residential Community.* Department of Landscape Architecture, The Ohio State University. Columbus, Ohio: 1976.
3. Fraser, Elisabeth A., and Anne F. Morris. *Getting it All Together. The Application of Environmental Information to Land Use Planning.* The Association of N.J. Environmental Commissions and the N.J. Conservation Foundation. 1980.
4. Garnham, Harry Launce. *Maintaining the Spirit of Place.* PDA Publishers Corporation, Mesa Arizona: 1985.
5. Getzels, Judith and Charles Thurow. *Rural and Small Town Planning.* Planners Press, Chicago: 1979.
6. Keller, Edward A. *Environmental Geology.* Charles E. Merrill Publishing Co., Columbus, Ohio: 1979.
7. McHarg, Ian L. *Design With Nature.* Doulbeday & Co., Inc. Garden City, N.Y.: 1971.
8. N.J. Dept. of Community Affairs, Div. of Local Government Services, Local Planning Assistance Unit. *A guide to the Environmental Aspects of the Local Planning Process.* September, 1976.
9. Robischaud, Beryl, and Murray F. Buell. *Vegetation of New Jersey.* Rutgers University Press. New Brunswick, N.J.: 1983
10. Untermann, Richard K. *Principles and Practices of Grading, Drainage and Road Alignment: An Ecological Approach.* Reston Publishing Co., Inc. Reston, Va.: 1978
11. Simonds, John Ormsbee. Earthscape. *A Manual of Environmental Planning.* McGraw-Hill Book Co., New York: 1978.
12. Steiner, Frederick. *Ecological Planning for Farmlands Preservation.* American Planning Association. Chicago: 1981