The Waters of Dennis

A Water Resources Inventory Made with Thematic Maps on a Municipal Geographic Information System

This project was undertaken by the Dennis Township Environmental Commission in 1997-98 with grant no. ES97-018 from N.J. Department of Environmental Protection, Office of EnvironmentalServices, and matching funds from Dennis Township.

It is dedicted to the children of Dennis Township, with the hope that their lives may flow sweetly as the waters of their home town and that those waters will always be there for them and their children's children, pure, cool, clean, abundant, safe , reliable, benificent.

And to the memory of the 10,000 children who die every day on our planet from drinking polluted water...

Members of the Environmental Commission

Catherine Fine, Chair
Robin Goldy, Secretary
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Jim Seibert (zoning board)
Peter Smith
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I.

Once the whole is divided, the parts need names.
There are already enough names.
One must know when to stop.
Knowing when to stop averts trouble.
— Lao Tsu in Tao Te Ching

The waters of Dennis Township go by many names: Dennis Creek, Savage's Run, Pickle Pond, Roaring Ditch, Great Cedar Swamp, Lake Nummy, Tarkiln Brook, Cranberry Bogs, Sand Wash, Old Robin's Branch, Delaware Bay, Ludlam's Thorofare, Townsend's Sound. No matter what they are called — and whether natural or manmade — the water courses and water bodies, along with their allied marshes and swamps and the vegetation these give rise to, are the chief geographical feature and clothe Dennis Township in its fundamental physical character as a place, as well as providing the unique flavor of the township's human community, its heritage and traditions.

It may be said with no exaggeration that we are born, live and die with the waters of Dennis in our blood.

It may also be said in truth that for beauty and healthiness our waters rank among the finest in the State of New Jersey — although, of course, not pristine.

Every resident of Dennis Township lives within an easy walk of one or another surface water feature. The slow, cedar water creeks meandering muddily through riparian forest, then breaking into the monochrome green marshes, pockmarked with the brown huts of marsh rabbits, under a milky summer sky, form an archetype of all streams that we carry with us in our mind's eye wherever we may roam.

Despite the watery abundance of our creeks and swamps, however, perhaps our more immediate connection is to the ground water we drink and bathe in and use to water our gardens and flush our toilets. If we stop to think, we will realize that the water we see on the land's surface and the water that comes out of our faucets from the ground is the same water. Water is the great link in nature; surface waters and ground waters are connected as surely as rivers are connected to the sea.

An ecologically healthy community fuses the human order with nature's ways. But forces of growth and change render this a challenging task insofar as water is concerned.

One major transformation of the century now ending is that water — once the common resource belonging to all and the matrix within which natural resources were exploited (fish, timber, etc.), has become a commodity in and of itself. Most householders and businesses in New Jersey pay for water purveyed by public utilities or by private companies.

The selling of water has a long history in New Jersey. In the late 1800s, Joseph Wharton purchased 100,000 acres of Jersey Pinelands with the idea of connecting ponds and reservoirs with a system of canals and selling the water to the city of Philadelphia for municipal use. Wharton was thwarted when the New Jersey State Legislature passed a statute prohibiting the out-of-state sale of New Jersey water.

Currently, our neighboring townships, such as Woodbine, Middle Township and Sea Isle City, have undergone water commoditization in part or in whole.

Dennis Township has resisted the trend of turning water into a commodity for sale in the name of keeping our rural ambience and will one day, rather sooner than later, very likely remain the sole Cape May County municipality lacking township water and sewer infrastructure — and not sending out sewer and water bills.

Recently, this township consensus not to put water in the marketplace was made explicit in the Dennis Township Master Plan and has become one of the chief ways of containing population growth and ensuring that wastes remain in harmony with the natural carrying capacity of the land. Treating water as a common natural resource is far more than a local quirk — more even than a local consensus: It is the expression of a community value that distinguishes Dennis Township from other communities.

We are not in the water selling business.

But we should make no mistake about it: not treating our waters as a commodity with a price tag brings with it special community responsibilities to make sure our ground and surface waters are used wisely and remain up to the highest standards of environmental quality.

This responsibility is made more complex by several factors, starting with the simple fact that water does not respect political boundaries. Several branches of Dennis Creek have their head waters in Woodbine Borough. West Creek forms the boundary of the township, half in Cumberland County. We share The Great Cedar

Swamp with Upper Township and the Timber and Beaver Swamp with Middle Township. The back bay that meets our easternmost tidal marshes ends on the westernmost portion of Sea Isle City.

On a regional level, the aquifers we draw our drinking water from extend under the entire Pinelands-Central Jersey region. And the waters of our tidal creeks begin their journey as far away as the Delaware Water Gap and the headwaters of the Schuylkill River. Just as all waters are linked to a global water system, water also connects us to our human neighbors near and far. The surface waters of Dennis are part of the much larger Delaware Estuary. The ground waters are part of the Pinelands Cohansey-Kirkwood formations. The Cohansey is the upper aquifer, essentially a water table source overlying the deeper Kirkwood, a contained aquifer.

Another complicating social feature of water must be mentioned at the outset. In earlier times, the economy of Dennis Township relied heavily on waterborne and water-embedded activities: cutting or mining the cedar swamps; building ships; hydro-powered paper and saw mills; fishing or farming salt hay on the marshes and cranberries in the bogs. Daily contact of humans and surficial waters gave residents an intimate working knowledge of the waters of Dennis.

Today, economic change and technological advances have distanced the modern community from nature in general and water in particular. The waters of Dennis, though still near, have been thrown into the background of our daily existence. Viewed in the context of the township's consensus to keep water as a common reource, this alienation from water creates the serious need for the community and municipality to undertake public education measures and establish new forms of civic vigilance.

That is one good reason for the existence of the Dennis Township Environmental Commission.

Most of us still enjoy our creeks and ponds in the form of recreation; some of us still make our living directly from those waters, particularly with regard to fishing. What we do in our every -day domestic activities — from building a house and asphalting a driveway to fertilizing a lawn or garden, washing clothes, cutting down or planting a tree or changing the oil in a car — all have a direct impact on our waters.

The township's routine municipal functions, too, such as storm water drainage, road construction and maintenance and waste

disposal also have effects on the waters. For although we have come far as the thinking species homo sapiens, we still in many cases use water courses much as our earliest proto-human ancestors did, letting flowing waters carry off our wastes: Out of sight, out of mind. Having never put a pricetag on the waters of Dennis, we always run the risk of having residents treat them as worthless.

Finally, maintaining the waters of Dennis is made difficult by the inevitable pressures on a township that has chosen to uphold its rural way of life in a state that symbolizes suburbanization; has the highest population density in the nation; practically invented sprawl development and has typical zoning codes, in many ways antithetical to maintaining a healthy mixed-use human society centered within a healthy surrounding natural landscape.

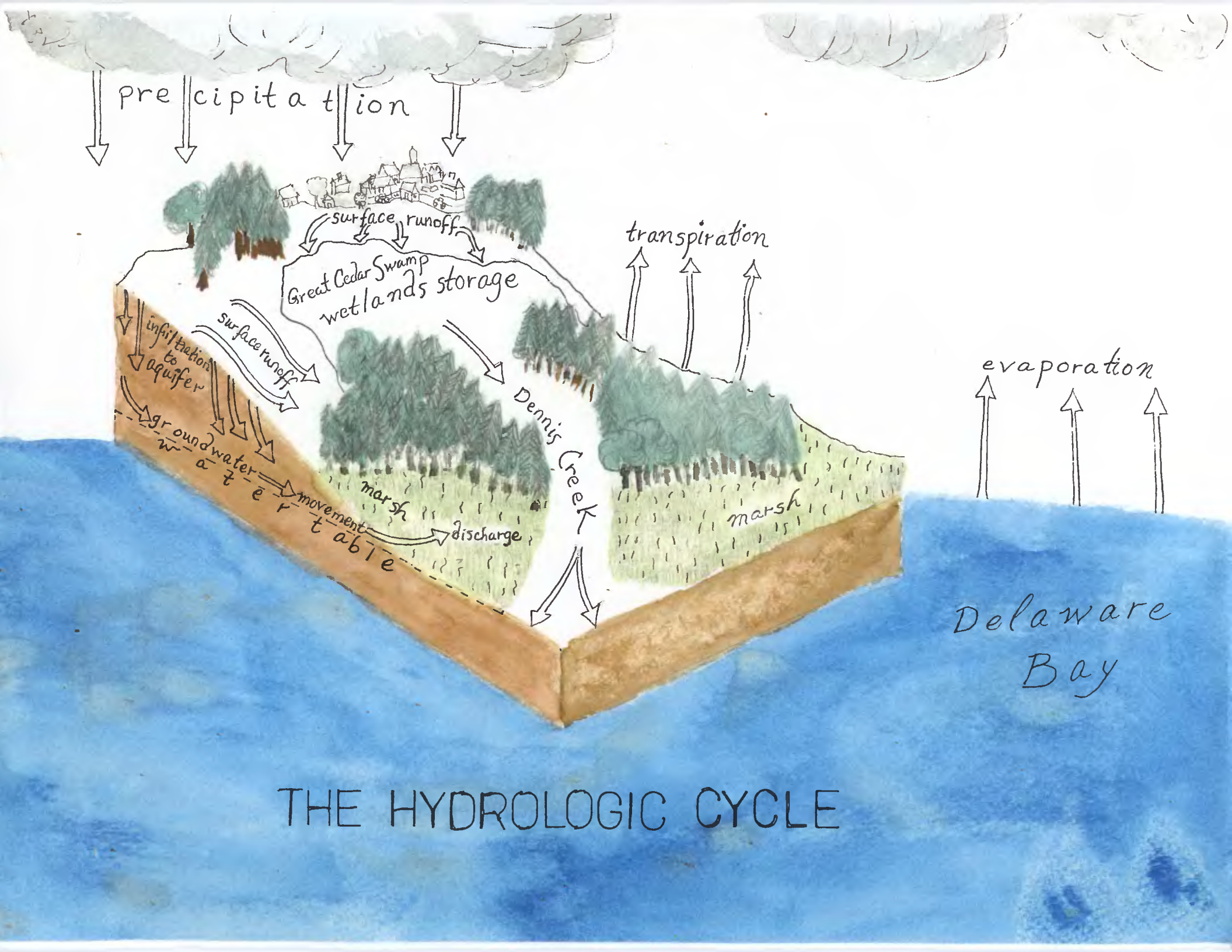
The waters of Dennis may be free, but they are finite. New streets, new subdivisions, new commercial enterprises and their parking lots create bare landscapes that prevent rain waters from penetrating the ground to recharge aquifers. Rain then runs off, carrying away soil, as well as the residues of a thousand products like oil on the roads and pet feces, collectively known as nonpoint source pollution. New residences, new schools, new golf courses and swimming pools — and the summer tourism industry — all pump new levels of water from our ground resources, clashing with our ambition to sustain ruralism for future generations.

More than ever before, we need to increase awareness of the priceless value our waters represent as a life support system. We must pursue water protection policies now — ahead of the growth curve — not waiting to react to already skunked waters, as has happened in other parts of New Jersey — and in neighboring parts of Cape May County.

Let us take a solemn vow among us, that we will never again take a ticket and wait in line at the DEP, asking the state to clean up a mess we could have prevented through reason and foresight.

In order to set those preventive measures, we need to understand Dennis waters' capacity as cleansing agents and to learn how to manage development in the township, lest we awake one day to find our hydro budget in default— and our waters fouled or dried up.

From our proximity and dependence come the need to know about our waters — where they are, where they come from, where they go. And how each of us as citizens, and all of us a community



THE HYDROLOGIC CYCLE

with a vital stake in our waters' health and well being, can help to maintain the waters of Dennis and the life that depends upon them — including our own lives and those of future generations.

That is the goal, of which this project is one small step.

II.

The streams all flow into the sea
But the sea they never fill,
Though the streams are flowing still
— Ecclesiastes, 1:7

Let us first look briefly at our hydrography, or what might be called our geographical setting with reference to surface waters.

Dennis Township straddles the Cape May peninsula, its land mass entirely on the Atlantic Coastal Plain. This plain formed over several hundred million years by the constant deposition of sands, muds and clays, eroded from the Appalachian Mountains and carried down to the sea by the Delaware River system. The Atlantic Coastal Plain extends past Cape May peninsula to the edge of the continental shelf, 75 miles out to sea.

The amount of sedimentary material deposited over the course of ages in the Delaware Estuary — the transition zone between fresh water river and salt water sea — is truly Guinessian, filling a 200-mile basin with sediments 45,000 feet thick — more than seven miles!

Indeed, the weight of these sediments eventually grew so great that the continental shelf began sinking. And as water bound up in Ice Age glaciers was released by melting, the ocean level rose swiftly, covering the plain to form the shape of the coastline we see today.

The melting of the great Laurentide Ice Sheet at the end of the Holocene epoch — the last ice age, about 10,000 years ago — also sent the last big pulse of water, gravel and glacial morraine into the rivers bound for the sea. The stoney gravels that stout Dennis sand miners dig up hereabouts to sell elsewhere is a product of that final deposition of sediment. Since then, the geologic commotion has settled down considerably and the streams took on their directions and drainage patterns we know today.

The coastal plain is characterized in Dennis Township by flat terrain, dipping ever so gently down to sea level at the Delaware Bay and Atlantic Ocean from a high point of 50 feet above sea level in Belleplain. Numerous tidal creeks cut the plain here, surrounded by

coastal tidal marshes fringed by fresh water wetlands. Most of the chief creeks of Dennis flow west into the Delaware Bay, but some smaller tidal creeks flow eastward into Ludlam's Sound and thence into the Atlantic Ocean. A divide in their direction of flow — like a mini continental divide — is locatedsomewhere in the Great Cedar Swamp, where waters forming the Dennis Creek system flow west to the bay, while waters forming the Cedar Creek-Tuckahoe River system flow north and east into Great Egg Harbor.

Each of our creeks flowing toward the Delaware Bay or toward the ocean creates a mini-estuary unto itself, draining fresh water from the wetlands to the bay and receiving brackish waters and sediments from the bay. In addition, flood tides frequently fan out over a large plain that can cover the 4-7 km. of marshes between the bay and State Highway 47.

In almost all cases, the line between fresh water and brackish water in our tidal streams occurs at low dams built during colonial times to create mill ponds for energy to drive small industrial operations. The names of these manmade ponds memorialize those mills, none still in operation: Johnson's Mill Pond, Ludlam's Mill Pond, Pickle Factory Pond, etc. The dams filled lowlands with fresh water after the original cedar swamps covering them were cut. Today, they provide a necklace of translucent pools for fishing, swimming, canoeing and watching birds. The one exception is Lake Nummy, dug in Belleplain by the Civilian Conservation Corps in the 1930s. It lays like a diadem in the midst of verdant, not virgin, pine plantations planted at the same time.

Just as the ponds, or impoundments, above the damns are artificial, humans continue to shape the landscape today by creating a new set of smaller ponds, as a result of sand mining, the chief resource extraction activity in the township. These recently- made, shallow water bodies, however, are fundamentally different from the former mill ponds in that they are unrelated to any creeks and receive their waters as infill from the water table.

Waters also form, in large part, the political boundaries of Dennis Township. West Creek forms our western boundary with Maurice River Township, Cumberland County, while Sluice Creek forms part of our southern border with Middle Township. Part of the eastern boundary of the township lies in the Great Cedar Swamp. Part of the southern boundary with Middle Township is in the

Beaver Swamp (now called the Timber and Beaver Swamp Wildlife Management Area).

Without question, the Great Cedar Swamp is the crown jewel of our township's surface waters, as well as the largest open or green space in Dennis Township — and the closest thing we have approaching true wilderness in all Cape May County. It is formed by an intricate mosaic of habitats, some 15-18 miles in length and covering approximately 8,000-10,000 acres.

The hydro system of the Great Cedar Swamp begins in the coastal marshes of the Delaware Bay, proceeds eastward in the drainage of Dennis Creek toward fresh water. There, cedar-covered wetlands are contiguous with deciduous hardwood forests and mixed deciduous-coniferous wetlands and open fresh water marshes and ponds. Ponding can be either permanent or seasonal in the heart of the swamp.

The procession of water reverses order on the northeast, or ocean-flowing, side of the divide, where Cedar Creek's drainage goes from fresh water swamplands to tidal and saline marshes, as it moves toward the Tuckahoe River, into Great Egg Harbor, and finally to the mighty mother Atlantic.

The vast white cedar swamp water system — and the wonderful diversity of wildlife and vegetation it supports — have almost miraculously survived largely unspoiled to the purlieus of the 21st Century, earlier because of the sheer difficulty and lack of appeal of developing the miasmic and infested swamp, when compared to the uplands.

The swamp and much of its contiguous drainage area eventually began to come under the usual development pressures. Then in 1989, the federal government created the Cape May National Wildlife Refuge, 7,800 acres of it incorporated at the time of writing.

The drainage, shape and flow of this water system has determined the township's basic types of habitats — and, in turn, determined human land use patterns. Those habitat types are four in number: 1) the coastal saline marshes; 2) the fresh water bogs, swamps and forested wetlands; 3) the transition zones, seasonally flooded or ponded; and 4) the uplands, where most human settlements are located, along with agricultural and extractive activities.

III.

You can never enter the same river twice
— Hindu proverb

The study of water — how water moves and is stored through the earth's atmosphere, at the earth's surface and below it — is known as hydrology, and the dynamics of water's movements are described by the hydrologic cycle. The domain of hydrology embraces the full life history of water on earth. And we must treat of it briefly, to put our water resources maps to follow in their proper context.

Hydrology used to be the province of civil engineers and professional scientists, but today farmers, sand miners, geologists, developers, surveyors, environmentalists, attorneys and municipal officials, among many others, all have reason to understand the principles and processes involved in moving water. Fortunately, hydrology is becoming more and more comprehensible to the layman, as it is presented in less mathematical ways.

In its most elemental form, the cycle through which water moves follows the course of a random drop of water on its long and liquid journey. In this section, we follow one such random drop — Randy, as we may call him. An accompanying chart provides a visual display of Randy's big adventure (see chart: The Hydrologic Cycle).

Randy the water drop begins his travels as a dot of water vapor living in a big, swiftmoving cumulus cloud. One fine spring day, Randy's cloud throws its shadow over Dennis Township. The cloud bursts and Randy hurtles, along with billions of his sibling drops, toward the ground. He has become, temporarily, Randy the raindrop.

He may land on a plant, and be absorbed for the plant's production of chlorophyl and oxygen, later released back to the atmosphere in the process called transpiration. Depending on weather, including relative humidity, Randy could join a humble puddle or a proud pond and, evaporating, rejoin the ranks of the atmospheric vapors, cutting short his travels.

Or, stunned by impact, Randy may simply lay there on the ground. Eventually, his own weight and highly social chemical personality — water mixes with practically every other type of molecule — would have him join the soil as moisture, dwelling in the pores of the earth. In this scenario, he would begin to percolate down into the ground under the force of gravity, taking up progressivly

deeper residence in the water table as new drops pile up on top of him. Eventually, after a great deal of time passed, Randy might seep down far enough to infiltrate an aquifer and make his home there, until beckoned back to the surface by a well pump.

But let's say that the ground is hardened by previous lack of rain; Randy and his tribe cannot penetrate. Or that the soil already holds quite enough moisture and can't accept any new tenants. Or that Randy lands on a rock surface — can't get down through stone. Or that Randy has the misfortune to land on an asphalt road, impervious to the downward infiltration process.

Then Randy closes ranks with the other rain drops and together they begin to run swiftly across the ground surface. They have become runoff and the direction they take is the quickest way downhill. Since the ups and downs of the land surface are known as the topography, we may say that runoff water follows the slope of the topography. Ground water, too, by the way, mimes the shape of the surface topography, for similar gravitational reasons.

As runoff, Randy might soon wind up shooting down a storm drain and out an outfall pipe, into a stream. Let's hope he has not picked up any pollution on his way, or the stream will be Randily befouled. Or he might simply run across bare ground, downhill, directly into a stream or pond. Geology, slope, vegetation and impervious surface, whether natural or manmade, all influence the quantity of surface runoff. Whatsoever his speed and compass direction, once Randy reaches a creek or river, he becomes part of the channel flow, and is on his way toward the most exciting career a wee water drop can pursue — as a drop in the ocean.

Let's say Randy in his rain drop phase comes to earth as part of such intense precipitation that the runoff fills the creeks to brimming and they overflow. Randy becomes part of a flood. Whenever a stream channel is overtaxed, causing waters to cover lands outside the normal channel, the stream is said to have reached flood stage. Randy and his brethren spread out over a flood plain, creating a temporary ponding. Flatter areas with sluggish brooks like Dennis Township tend to flood more frequently than rough terrain with steeper gradients. On the other hand, rocky terrain tends to absorb water less and to flood more frequently than soft, absorbent, sandy soils like ours. Generally speaking, we tend to have more frequent, but less severe, floods, of rather short duration. Given the broad

marshes that surround our creeks, most of us are scarcely aware of the usual local flood — unless, of course, it reaches a road.

The same is not true of communities that have let impervious surface run riot, where flooding is a major problem. A rule of thumb: The more paved surfaces, the more frequent the flooding, as concrete and asphalt, as we make them today, are impervious to rain. And when Randy gotta go, he gotta go somewhere.

If Randy the runoff drop or Randy the flood plain drop reaches a comparatively low area, like a pond, wetland, or the Great Cedar Swamp, he will take up residence there. Cedar swamps and mixed cedar-red maple swamps in Dennis Township are generally flooded for about four months of the year. This varies according to the amount and timing of rain and particular location.

But let's return to the earlier possibility, that Randy enters the ground and starts a downward journey through the pores of the soil. That is to say, he becomes a ground water drop, residing at first in the uppermost limit of ground water, known as the water table. In any one place, the water table rises with increased precipitation and declines in response to seasonally dry weather or drought, or excessive pumping by humans. As a ground water drop, Randy may meet one of several fates.

If, for example, he seeps down into an absorbent layer of sand, which has an impervious layer of clay below it, his downward movement will be halted at what is called a perched water table.

As ground water, Randy could also take on a new and promising role, to wit, adding his wet little self to all the other ground water accumulated below the surface of the earth, which replenishes, or recharges, the aquifers. In most cases, the downward movement through soils of billions of Randys is the principle mechanism for recharging ground water, a process known as vertical infiltration.

What are Randy's chances of this?

On average, we receive 44 inches of rain per year in Dennis Township. Of this, 24 inches are lost to the air by transpiration and evaporation. Of the remaining 20 inches, about three inches run off overland to the nearest downhill water body, leaving some 17 inches to soak into the ground.

Still a third possibility for our drop Randy has to do with the formation of an hydraulic head, which is the pressure of new ground water weighing down upon older ground water. Water, like all

fluids, moves from high pressure areas to lower pressure areas. As more precipitation presses down upon ground water, Randy may be diverted from his vertical path and instead start following the topography, beneath the surface, until he reaches a low pressure area. There he is squirted back out to the surface; this is called discharge.

Under natural conditions, discharge zones are either at the head waters of a creek or in fresh water wetlands. The majority of fresh water wetlands in New Jersey are, in fact, discharge zones. Dennis Township, with its gentle slope from Belleplain to the Delaware Bay, has plenty of them. Water which returns to the surface because of pressure from below is called Artesian, after the first such well drilled in Artois, France, in the year 1126. Artesian wells do not require a pump, but merely a hole into the pressurized water below, which will flow freely to the area of lower pressure at the surface. In just the same way, Professor Claude Epstein, the Stockton State College hydrologist, speaks of "Artesian discharge" made by "Artesian pressure."

Disturbed lands, logically, by disrupting the topography, can affect the discharge of waters. Excessive pumping, too, by disrupting the pressure gradient, can also affect discharge. Cape May peninsula is all too familiar with this effect, since salt water has intruded into excessively pumped aquifers in its southern portions. Dennis Township is by no means immune to salt water intrusion, which could take place as a result of the excessive pumping of ground water by our southerly neighbors, like Middle Township, with its big development dreams, or by a climate-related change in the natural salt gradient of the Delaware Bay, or a combination of both.

But whether Randy the water drop meets sodium chloride underground or not, his journey is coming to an end. Either he remains underground as a recharge drop or he returns to the earth as a discharge drop. From the latter, he may join the coursing freshets and go down to the big sea and the big salt. Or he may stay, betimes, in one of our fine wetlands, until evaporation finally takes him back to his home in the sky.

The travelogue of a random drop of water highlights the interconnections between surface water and ground water. Randy began as a rain drop, joined the surface waters, seeped into the ground waters, and was finally discharged back to the surface

streams or ponds. In water's neverending journey, it can move from surface to ground and back to surface again.

The inventory of the waters of Dennis concentrates on the surface waters. It should never be forgotten, however, how those same surface waters reach the surface — often from below ground.

A chart showing a geologic cross section with the aquifers underlying the township puts this point in an image.

IV.

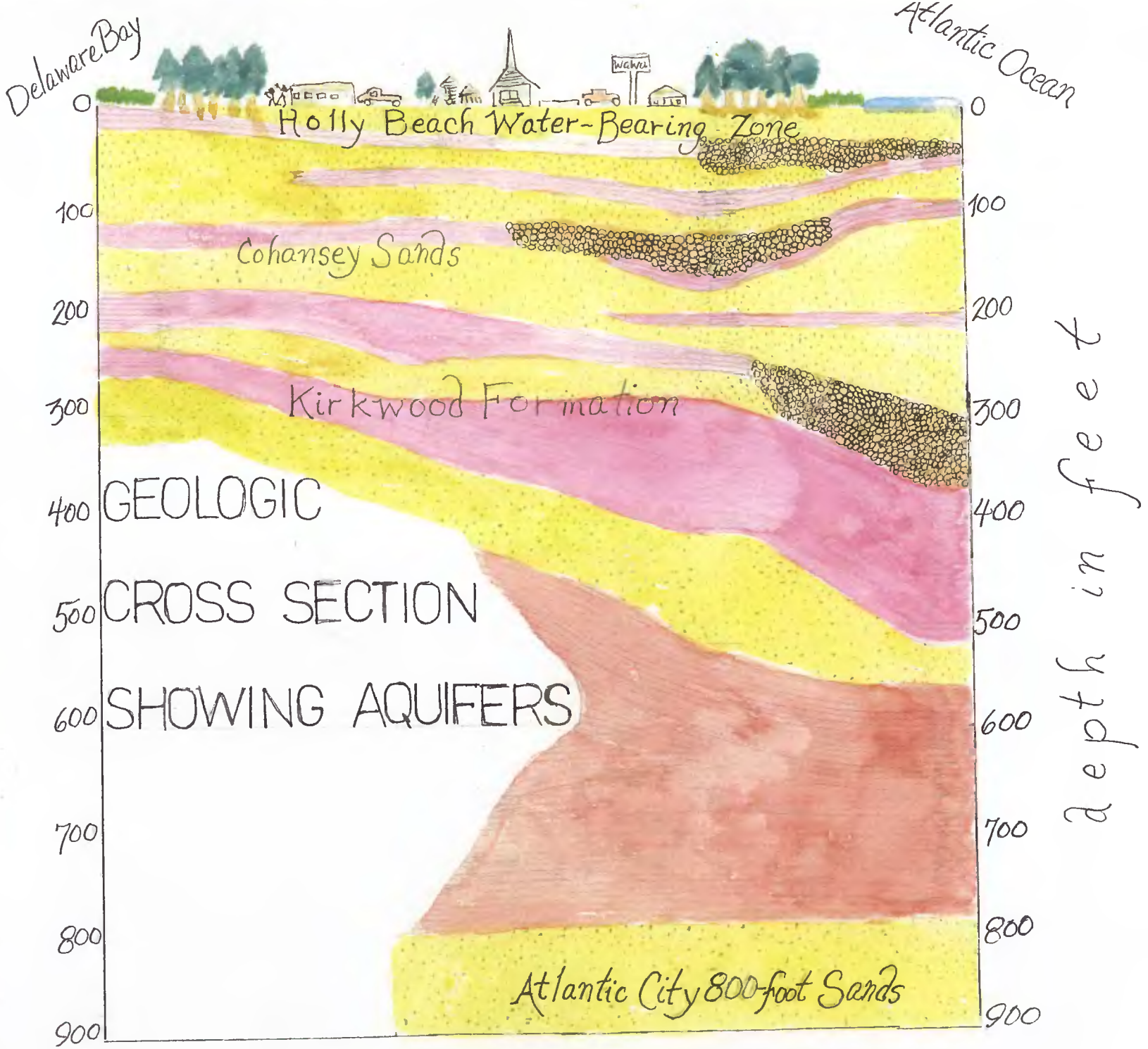
GIS is a map that makes a map.
— Anonymous

In April 1996, Dennis Township Committee suffered a presentation on geographic information systems (GIS), a 30-year-old technology, which began as a computer tool for landscape architects and city planners, then military trackers and navigators, before developing and spreading rapidly worldwide as a mapping, planning, tracking, distributional and analytical information technology. Today, with tens of thousands of systems operating in the public and private sectors, widely available desktop software and an international strike force of GIS Internet users, GIS is poised to become the third standard computer application, after word processing and spread sheets.

GIS connects geography (location) to information (data). The geography is in the form of map coordinates, i.e., a longitude and latitude stored as a series of numbers, which a computer can process. Digital GIS data is warehoused and can be displayed in many forms — maps, tables, charts, graphs, satellite images, etc. Commonly, GIS displays information visually as choropleth or thematic maps. An example of a thematic map would be a map showing the vegetative cover in Dennis Township.

The "theme": vegetation.

A GIS database could have a data set of trees and another data set, for example, of bushes. Tell the computer to display both themes together and you have your new thematic map: vegetative cover of Dennis Township. The old maps have made the new map, just as Anonymous promised above.


Delaware Bay
Atlantic Ocean
0
100
200
300
400
500
600
700
800
900
Holly Beach Water-Bearing Zone
Cohansey Sands
Kirkwood Formation
GEOLOGIC
CROSS SECTION
SHOWING AQUIFERS
Atlantic City 800-foot Sands
depth in feet
sand
clay
gravel

At the time of the GIS presentation, Township Committee was asked to consider how much of the information that the municipality deals with on a daily or longer basis has to do with particular locations. Property taxes? Yes. Zoning? Yes. Planning board? Yes. Road maintenance and garbage pickup? Yes. Fire and emergency service? yes. It was suggested that 70-80 percent is a reasonable, probably conservative, estimate. The power of GIS is in the connectivity it provides between information and the locations the information applies to.

Once data is captured in a database, it can be manipulated and analyzed by the GIS, according to the user's requirements, commands and queries. Once solutions to particular problems or queries are found, they can be output as new maps, reports or statistical graphs. Or they may merely be stored as new data sets for future use in cartography applications.

Typically, a GIS project produces a thematic map or set of maps, with explanatory keys and a technical record. The accurate visual representation of spatially referenced information proves a key tool for decisionmakers, who are able, often for the first time, to literally "see" information, patterns and trends.

Therefore, Township Committee's approval was sought and won, for the Dennis Township Environmental Commission to establish a municipal geographic information system with a functional — if young and inexperienced— database and to carry out a benchmark project, an inventory in maps of the water resources of Dennis Township — i.e., the waters of Dennis.

Specifically, the goal of the water resources inventory is to identify areas having to do with water and water protection, for use, 1) in reviewing the township Master Plan, when it is next revised in 2000 and the zoning ordinance thereafter; 2) educating residents and school students about water and water issues, and 3) familiarizing municipal officials with GIS interactions and informing them of important or critical water-related issues.

In fall 1996, a grant application was made to the New Jersey Department of Environmental Protection (DEP) to obtain the ARC-VIEW 3.0 software DEP offers to public and nonprofit agencies.

ARC-VIEW is not a fully functional GIS, capable of originating data sets and analyzing with map geometry, but rather for viewing the results of cartography and analysis done on more sophisticated systems. Because of this limitation, DEP suggests datasharing

partnerships for smaller GIS units, such as the one we have established.

Dennis Township Municipal GIS forged several such datasharing partnerships, in addition to our primary relationship with DEP itself. They are with, 1) Cape May County Health Department; 2) Public Service Electric & Gas, which is undertaking, partially in Dennis Township, a Delaware Bay Estuary Enhancement Project, returning tidal flow to formerly diked saline marshes; 3) The New Jersey Nature Conservancy; 4) U.S. Department of Interior, Fish and Wildlife Service, which is building the Cape May National Wildlife Refuge, for which Dennis Township is a host community; and 5) Dennis Township Economic Development Council, for whom the municipal GIS undertook to make an eco-tourism map. An evaluation of the datasharing partnerships is included in the self-critique section below.

DEP used to provide free training in ARC-VIEW, but, regretfully, no longer does so. But the system operator and writer of this report had a little theoretical and lab training in GIS; a little algebra and trigonometry; a little statistics; a little geology; a lot of physical geography and a fundamental knowledge of both cartography and the landscape-land use-land cover of his own home town.

DEP Office of Environmental Services formally approved the grant in June 1997. The ARC-VIEW software was received thereafter.

The grant project consisted of several phases:

1) Constructing a municipal GIS with a functional database.
2) Carrying out the water resources inventory.
3) Making the thematic map set.
4) Writing this narrative report.
5) Public outreach and comments.
6) Evaluation & recommendations.
7) Implementation agenda.

In the first phase, the township's hardware was updated to cope with the ARC-VIEW 3.0 software and mapmaking on an inkjet printer, and the software was installed.

It took about three months to debug and become rudimentarily familiar with the software. ARC-VIEW is not as user-friendly as, say, an Apple computer; requests for training fell on deaf ears at DEP.

In summer 1997, we began in earnest to build our database, on a foundation of digital data in ARC-VIEW format on a CD-ROM we had to purchase from the DEP. Data capture and enhancement has gone on since then and continues, as we find a need for, and learn of, new GIS "coverages" or "data sets" or themed map "layers," as they are (all) sometimes called. There is an awful lot of GIS data out there. Good data, bad data and just plain expensive data. One could spend entire days on the Internet and entire weeks on the telephone, tracking down new sources and new data sets. The game for the poor, little voluntary muni GIS group like ours is to capture only what we can use and to get it for free. This can be done, but sometimes requires the sassy pluck of a Luke Skywalker trying to beat the Evil Empire and the patience of Job tested by God. Dennis Township Municipal GIS has become adept at begging, borrowing and thieving new coverages. Like pack rats, we bear them back to our work station at town hall and greedily store them on our one-gigabyte hard drive.

We have also cooked up original recipes (map coverages), specific to our own needs, in the map makes map mode.

A simple example of a digital data set we created in-house is a "shapefile" of Dennis Township. This map displays the boundary line around the township — a basic necessity and first step, as anyone can comprehend, in making any kind of map of the township. The DEP's CD-ROM contained a map of the entire state of New Jersey, showing all the municipal boundary lines. We "clipped" the boundary lines of Dennis Township from the statewide municipal map and stored it in our database for future cartographic use under the file name "Dennis.shp" (Dennis shapefile). Every map made during the benchmark project required that we first display the Dennis shapefile; so it was obviously very useful to have the GIS make this map.

Although building a GIS database is absolutely an openended and neverending process, ruled only by the sybarite's proverb "the more the merrier," by early winter 1998 we started to review and evaluate the database we had built so far, in preparation for mapmaking. This included the making of evaluation tools, such as a metadata document to go with each data set and a data dictionary listing the entire contents of our archive. Examples of these appear in Appendices 1 and 2. The full read-only text is available in hard copy, in a document called "Dennis Township GIS Directory" or on

the GIS, where each coverage has its complementary read-only document file.

We also entered into discussions with half a dozen agencies, concerning what our inventory maps should show and could show (there is, sadly for the cartographer, a great deal of difference). A fruitful meeting was held with Prof. Richard Scott, chair of the Department of Geography and Anthropology, Rowan College of New Jersey, our GIS guru, and another with Dr. Yuri Gorkhovich, Ph.D., head of the GIS lab at New York City DEP, Division of Water Quality and Conservation, who has acted as our conceptual and technical mentor. At the December 1997 Environmental Commission meeting, discussion centered on what aspects of water resources commissioners wanted to see portrayed in thematic maps. We incorporated those suggestions.

Prior to entering the mapmaking phase of the project, we had to evaluate our database in terms of the accuracy of scale and projection. There is some error in all geographic information. Further error is also introduced at every step of the cartographic process. One's objective should not be to eliminate error, but to minimize and manage it.

All maps depict earth features and distances in much smaller size than the true features and distances the maps attempt to represent. This is elementally obvious. A map is really a model — a model drawn to scale. The scale is the ratio between the map distance and the actual ground distance, written as a fraction. Thus, the scale 1:24,000 means that one inch on the map represents 24,000 inches on the ground, or 2,000 feet.

The scale of 1:24,000, used by DEP, also became our standard. Our maps bear a scale bar when relevant.

Projection is what mapmakers use when they try to make the actual curved surface of the globe flat as a map, with parallels of latitude and meridians of longitude. All flat maps distort to some degree; the salient point is to have all your maps distort the same way and amount.

Here, too, we chose the easy way out, following the DEP's lead in making all our maps in the projection known as state plane coordinates.

Plane coordinates are not, in truth, a real projection, but rather a grid of straight lines intersecting at perfect right angles, superimposed on a true projection, such as Merkatur's transverse

projection or Lambert conformal conic projection. Plane coordinates were developed by straight military minds for ocean and aerial navigation purposes. Later, individual states set up their own state plane coordinate systems, using aerial photography. State plane coordinates are quite useful in GIS, especially inasmuch as computers have a difficult time dealing with curved lines, but are quite happy dealing with straight lines.

The state plane grid is scaled in thousands of feet. However, no one wants to see numbers like 537,988 on maps. No one outside cartographic squares would have any notion what such numbers might mean. So we decided to transform our state plane coordinates into decimal degrees of latitude and longitude. Then we made a new map of Dennis Township showing the location in traditional degrees. This is displayed in map 1, the location finder; of course, it applies to all other maps of Dennis Township, though the legends indicate that our municipal GIS "thinks" in state plane coordinates and our maps are printed using the same.

Shortly after New Year 1998, we commenced mapmaking. The water resources inventory proved a challenging benchmark. However, a GIS must be put through actual paces, both to drag the system operator up the learning curve and to begin to establish practical GIS relationships with other municipal agencies and decisionmakers.

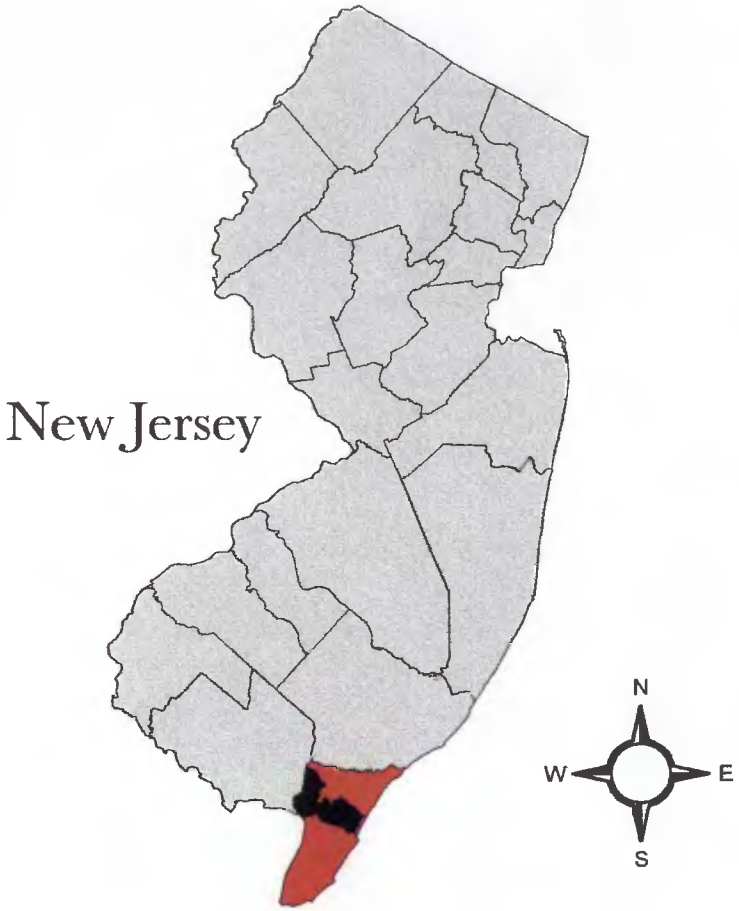
Perhaps the greatest limitation of our GIS proved to be the inkjet printer output device, which limits our hard copy maps to an 8 1/2-by-11-inch format. Such a miniature format often necessitated weeks of cartography, eliminating visual clutter and displaying the map theme clearly, accurately and forcefully. The visual display of information in such small space also calls on the constant aesthetic judgments of the mapmaker, looking for a bolder color contrast here, a thinner line there, or titles that strike the viewer in the face or, perhaps, fade a few shades more subtly into the background. It meant learning when enough information is enough, and when too much is too much.

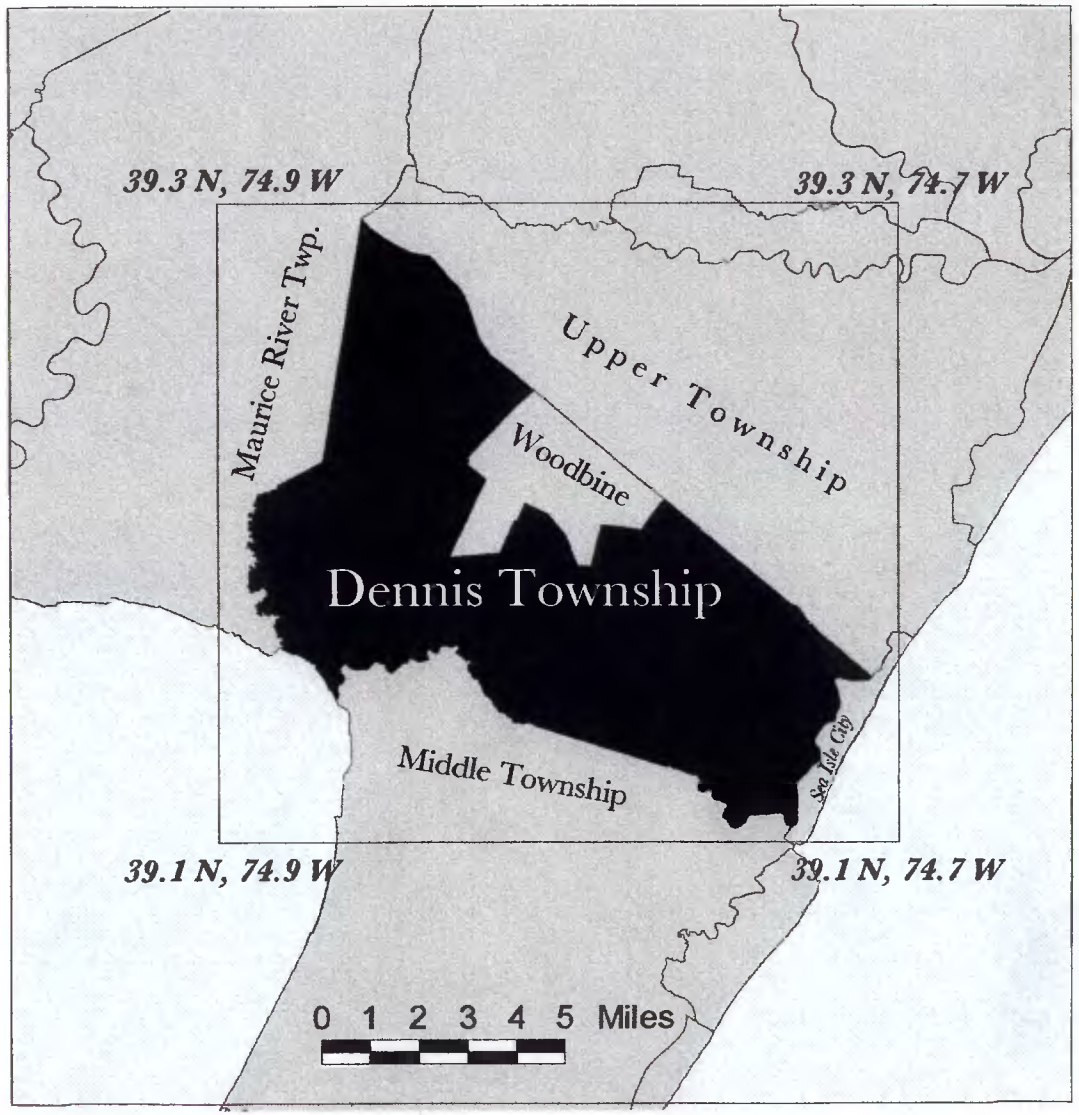
After all, the whole idea of thematic mapping is to be able to grasp information visually.

Mostly, it meant looking again and again at our maps, until they represented the best we could possibly do with a particular theme. These were stored for reference and future endeavors as a new project archive in a special folder called N.J. Data/projects.

The set of maps that follows are the themes we chose to represent the waters of Dennis. They are maps of local surface water and surface water management features, allied physical features and water-related concepts. The maps come with the briefest of explanatory text, but some include specific, theme-related recommendations. The maps are informational and educational, and may not, as of now, be used for surveying or where accuracy is the critical determinant of decisions in law or regulatory procedures. The GIS and our experience with it is simply too new to jump into processes where legitimacy depends on accuracy. For example, the township's global positioning system we used in ground truthing the headwaters of streams is only accurate within 100 meters — obviously inadequate for surveying purposes.

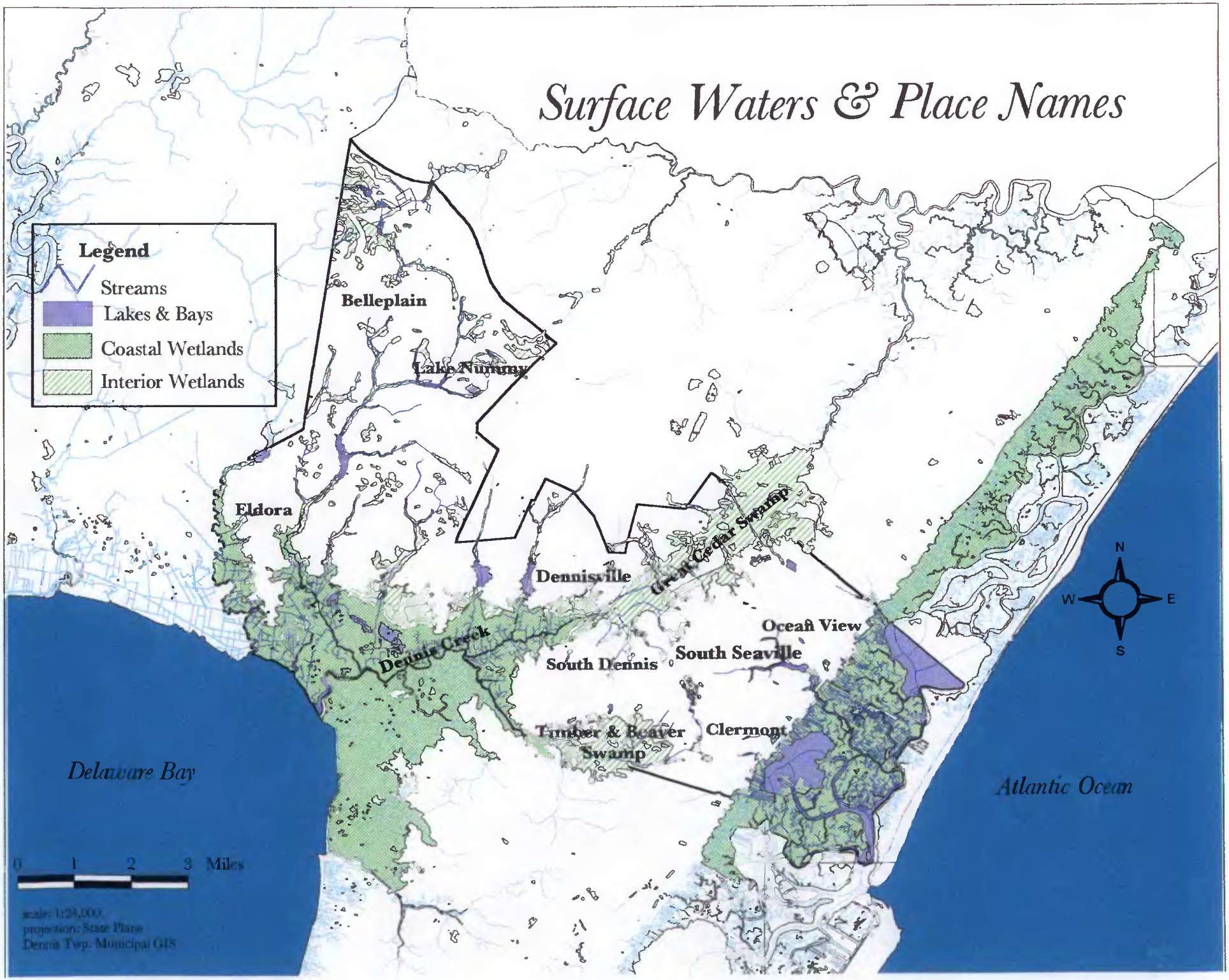
Location of Dennis Township





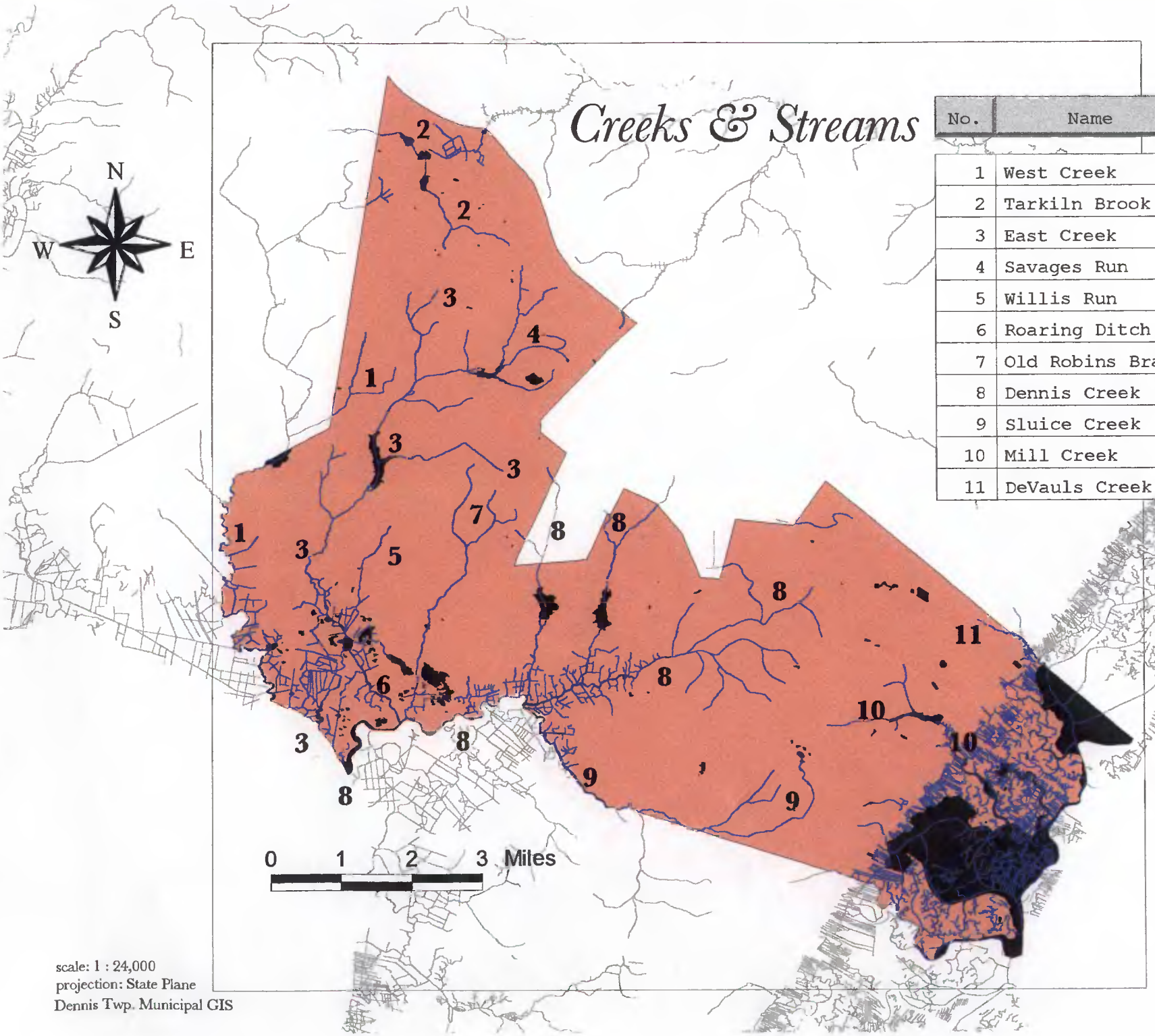
projections: State Plane
Dennis Twp. Municipal GIS

The Location Finder shows Dennis Township's geographic location in relation to the State of New Jersey, Cape May County and neighboring townships, as well as the township's geographic coordinates.


Surface Waters & Place Names
Legend
Streams
Lakes & Bays
Coastal Wetlands
Interior Wetlands
Belleplain
Lake Nummy
Eldora
Dennisville
Great Cedar Swamp
Dennis Creek
South Dennis
Ocean View
South Seaville
Timber & Beaver Swamp
Clermont
Delaware Bay
Atlantic Ocean
N
W
E
S
0 1 2 3 Miles
scale: 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

Surface Waters, showing streams, lakes, bays, coastal and interior wetlands features, along with place names as common reference points.

Creeks & Streams



No.	Name	Length/feet
1	West Creek	38398
2	Tarkiln Brook	28494
3	East Creek	74174
4	Savages Run	34104
5	Willis Run	9641
6	Roaring Ditch	13459
7	Old Robins Branch	23993
8	Dennis Creek	111063
9	Sluice Creek	40063
10	Mill Creek	9224
11	DeVauls Creek	6974

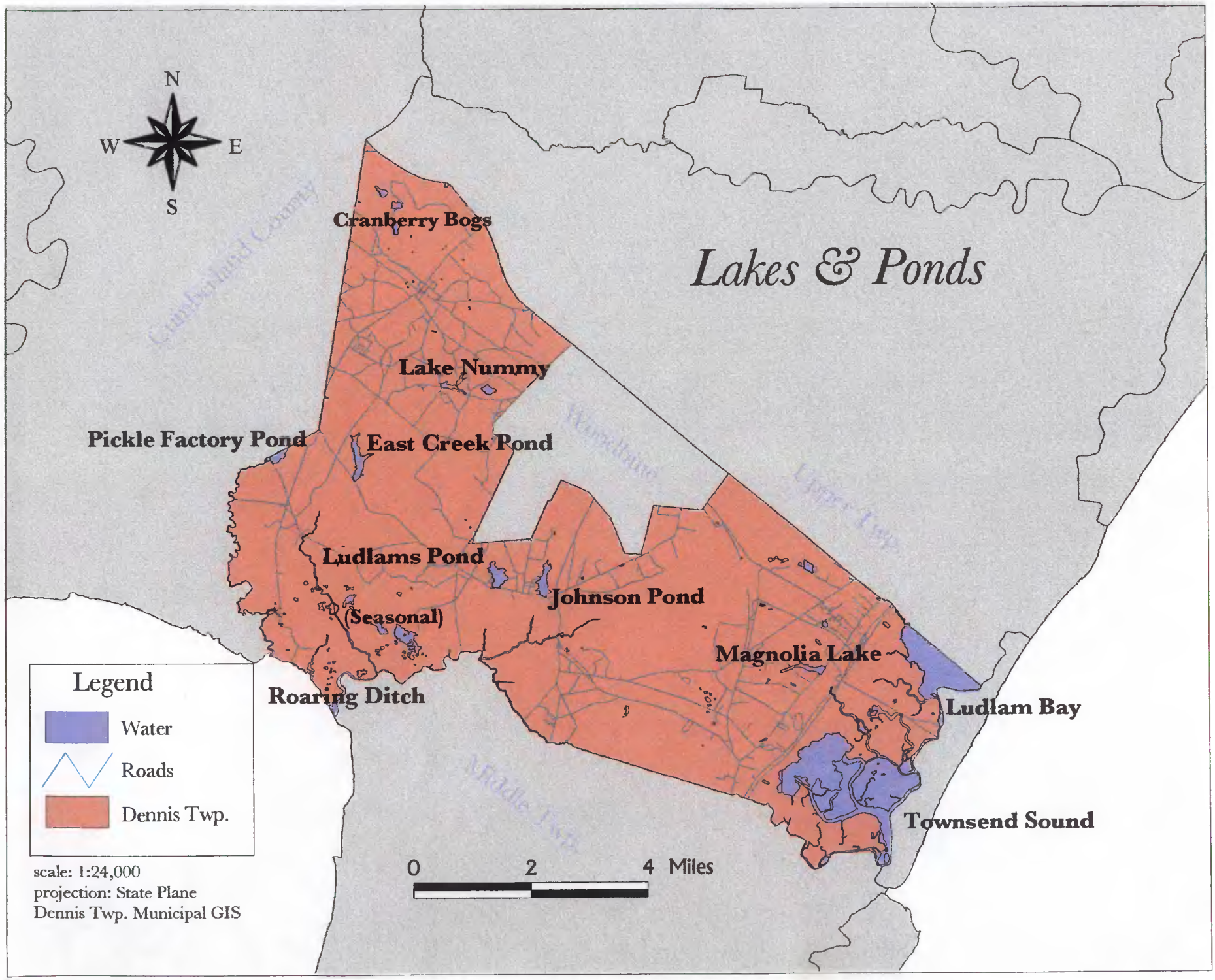
scale: 1 : 24,000
projection: State Plane
Dennis Twp. Municipal GIS

Creeks and Streams, keyed to a table of the main named creeks and their approximate lengths. The lengths were derived by adding lengths appearing in the attribute table of streams accompanying the state's coverage, which appear by tributary.

RECOMMENDATION

1. The township should set up a long term volunteer stream monitoring program, as many municipalities and regions have done throughout the nation in order to protect water quality. The monitoring program should pay special attention to the headwaters of our streams and the tidal waters below the dams. Monitoring sites and schedules should be chosen, water testing kit (s) obtained and all data recorded on the municipal GIS. Currently, there is no stream water quality monitoring taking place in Dennis Township.

2. The township should undertake to assess and improve, where necessary, the condition of the headwaters and riparian buffer areas of all streams. Such improvements could take the form of widening riparian buffers and/or reforesting headwater areas.

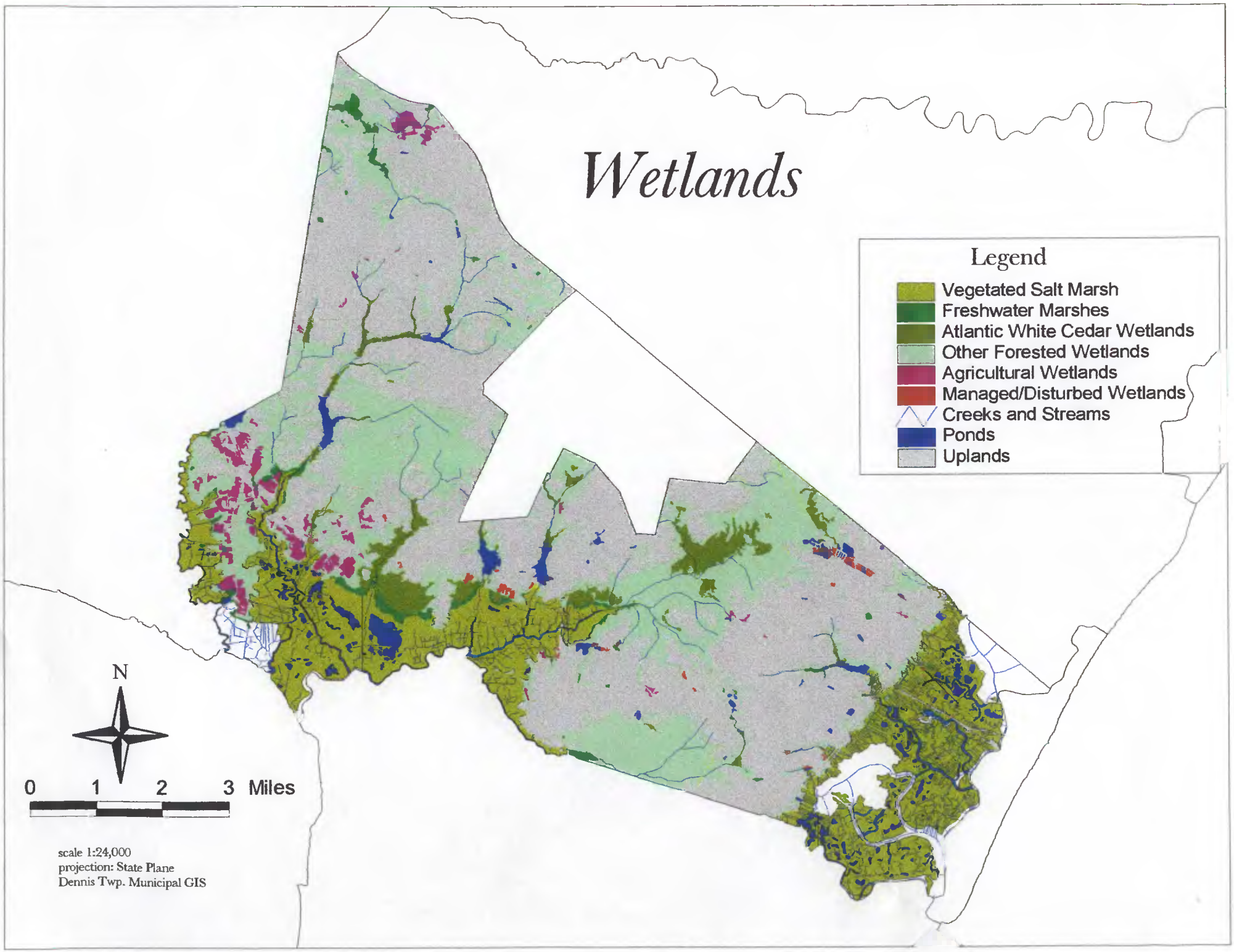

N
W
E
S
Lakes & Ponds
Cranberry Bogs
Lake Nummy
Pickle Factory Pond
East Creek Pond
Ludlams Pond
(Seasonal)
Johnson Pond
Magnolia Lake
Roaring Ditch
Ludlam Bay
Townsend Sound
Legend
Water
Roads
Dennis Twp.
0
2
4 Miles
scale: 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

Lakes and Ponds, including back bays and set against a road network.

RECOMMENDATIONS

1. Include the six principal impoundments in a volunteer water monitoring scheme, with particular reference to contamination by mercury, nutrients and other air and water deposited pollutants. The overall purpose of monitoring the ponds and lakes is to maintain healthy recreational fish stocks.

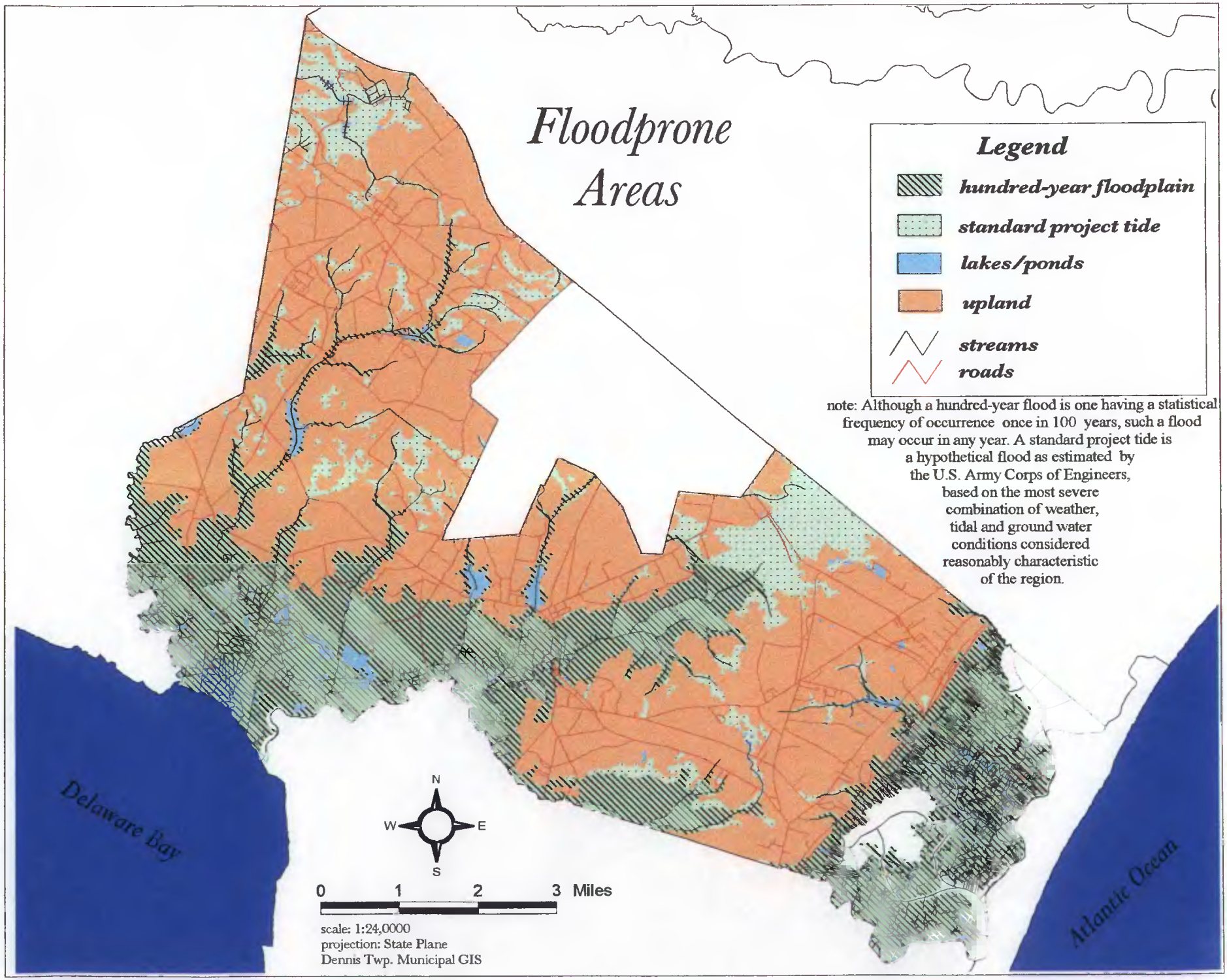
2. We need additional geographic information on the ponds and lakes, including detailed surveys, which should be published as anglers' maps, and bathymetry (depth and depth changes by season). Again, the main purpose is to encourage recreational fishing by maintaining healthy fish stocks.


Wetlands
Legend
Vegetated Salt Marsh
Freshwater Marshes
Atlantic White Cedar Wetlands
Other Forested Wetlands
Agricultural Wetlands
Managed/Disturbed Wetlands
Creeks and Streams
Ponds
Uplands
N
0 1 2 3 Miles
scale 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

Wetlands, showing the diversity of wetland habitats and locational relation to creeks and ponds.

RECOMMENDATION

The township should build consensus for a no-net-loss of wetlands ordinance. A first step in that direction would be to add orthoquad data to the GIS system, based on aerial photography, providing an accurate measurement, comparison and basis for analysis of wetlands conversion. As of now, all we really have to go on is a crude zoning map based on older map datums and the say so of development applicants and the state.

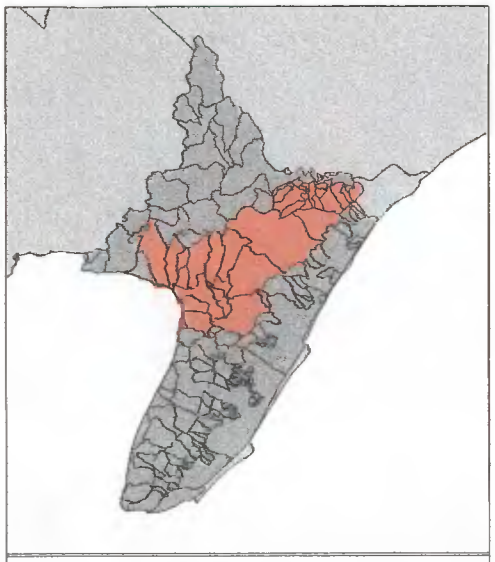

Floodprone Areas
Legend
hundred-year floodplain
standard project tide
lakes/ponds
upland
streams
roads
note: Although a hundred-year flood is one having a statistical frequency of occurrence once in 100 years, such a flood may occur in any year. A standard project tide is a hypothetical flood as estimated by the U.S. Army Corps of Engineers, based on the most severe combination of weather, tidal and ground water conditions considered reasonably characteristic of the region.
Delaware Bay
Atlantic Ocean
N
W
E
S
0 1 2 3 Miles
scale: 1:24,0000
projection: State Plane
Dennis Twp. Municipal GIS

Floodprone Areas, set against a road network.

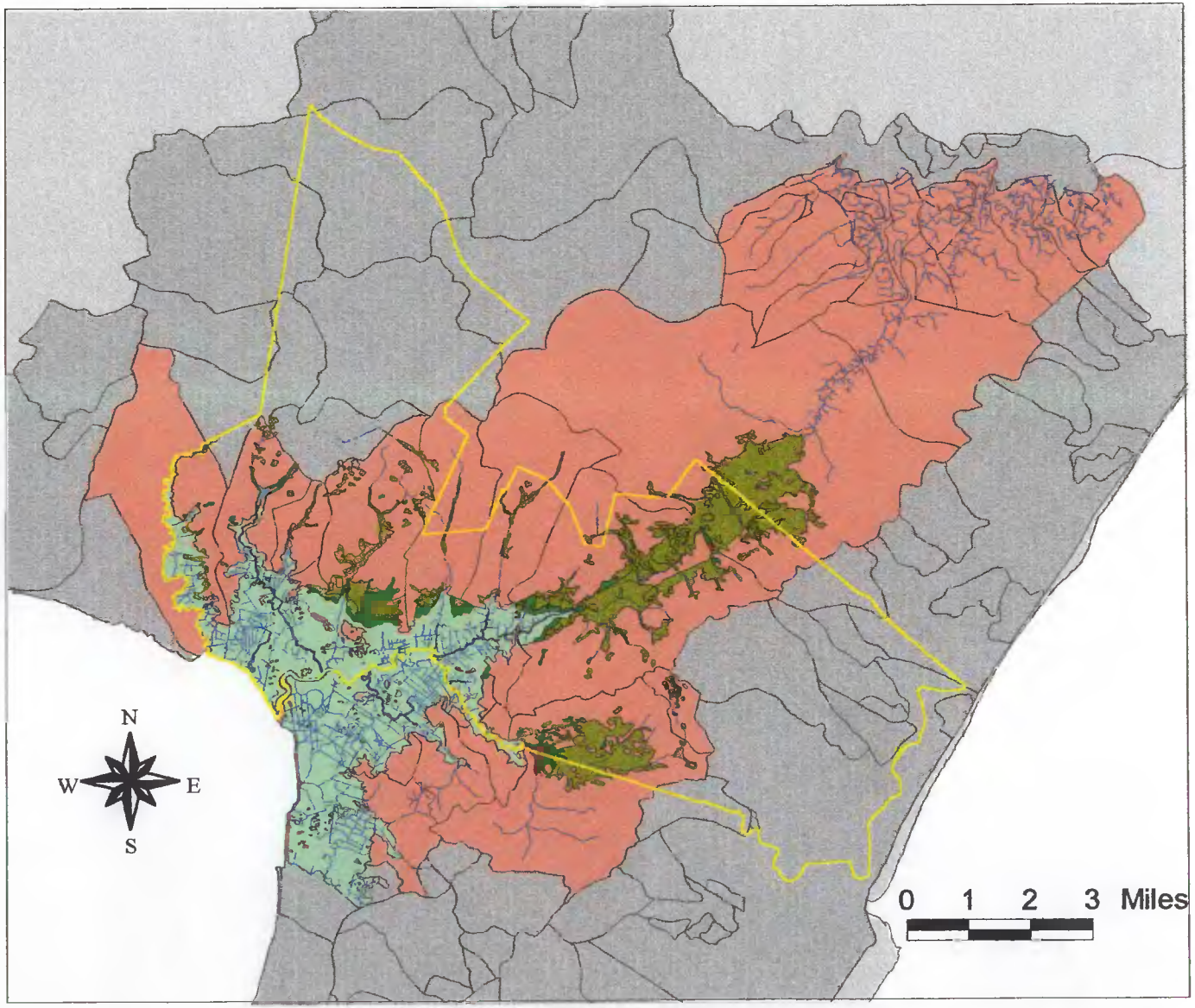
RECOMMENDATION

Review flood-related sections of Dennis Township Master Plan and revise to ensure zoning compliance, from an emergency management and flood insurance perspective. The goal is to see and know the flood plain and to not put houses and people in harm's way.

The Dennis Creek-Great Cedar Swamp Watershed



View of Cape May County's Drainage Basins



Legend

- Dennis Township
- Tributaries

Wetland Types

- saline marshes
- wooded wetlands
- brush dominant and bog wetlands
- nontidal marshes
- Dennis Creek/Cedar Swamp Micro-basin
- Cape May County Basins
- New Jersey

scale 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

The Dennis Creek-Great Cedar Swamp Watershed, showing the drainage area of the Great Cedar Swamp in relationship to Dennis Township, including Dennis Creek and its tributaries and an inset map of Cape May County's micro-basins

RECOMMENDATION

The obvious conclusion from looking at this map is that although we are at the heart of the Great Cedar Swamp, we share the watershed with Upper Township, Woodbine Borough, Middle Township and Maurice River Township, Cumberland County.

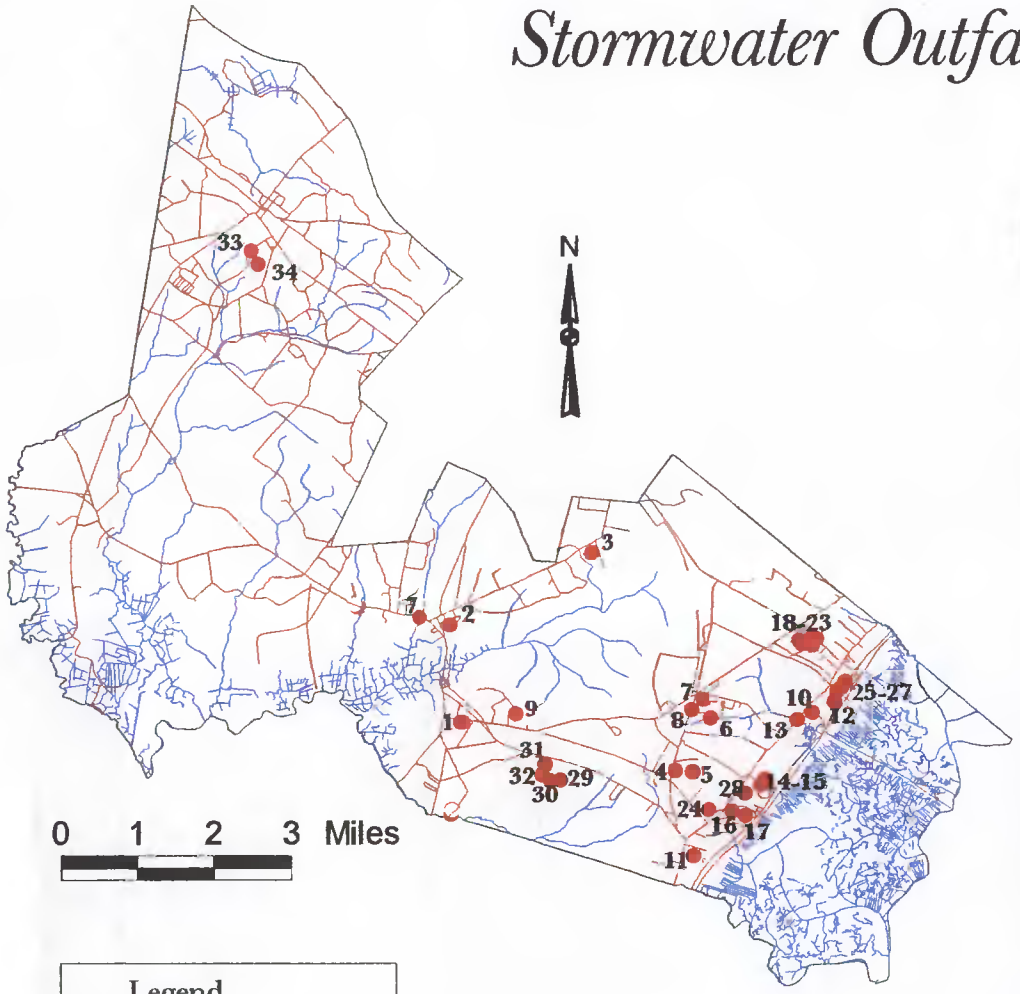
The core area of the Great Cedar Swamp is preserved in the Cape May National Wildlife Refuge. However, this will in no way prevent ground water and runoff pollution from flowing into the swamp.

Therefore, the township should take the lead role in forming a watershed association of municipal, state, federal, ngo and private interest stakeholders.

The purpose: community involvement and public education; baseline data, including water table and hydrologic model; investigating current nonpoint source pollution and reducing it; studying impervious cover impacts on the watershed as a whole and developing an impervious cover budget, if called for, with development of alternatives to ensure adequate ground water recharge; coordinating watershed development practices, including R-10-type buffer zoning; building watershed-wide consensus for no-net-loss-of tree coverage agreement to reduce runoff.

The Great Cedar Swamp Watershed is so valuable we should be thinking of its condition out 50-100 years. We should start that process now.

Stormwater Outfall Locations



scale 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

K e y

No.	Outfall	Location
1	Dennis Creek	N. side of intersection of Hoffman Rd. and School House Rd.
2	Dennis Creek	So. of Gatzmer Ave. 500' N. of Hill Avenue
3	Dennis Creek	300' SW of Doe Dr. and 800' SE of Rt. #585
4	Ludlam Thorofare	200' SW of Timithy Lane
5	Ludlam Thorofare	140'S. of Elizabeth Lane
6	Ludlam Thorofare	So. end of Siskan Lane
7	Ludlam Thorofare	300' So. of Seaville Rd. across from Old Goshen Rd
8	Ludlam Thorofare	200' E. of the Cul-de-sac at end of Lurlong Lane
9	Ludlam Thorofare	20' SW of Sea Isle Blvd. and 700' So. of Rt. #9
10	Ludlam Thorofare	20' SW of Sea Isle Blvd. and 650' So. of Rt. #9
11	Ludlam Thorofare	75' SE of Cul-de-sac on Clermont Dr.
12	Ludlam Thorofare	200' SE of Ocean View Drive
13	Ludlam Thorofare	No. side of Rt. #9 Apx. 1200' So. of Sea Isle Blvd
14	Ludlam Thorofare	30' W. of Cedar Dr. at NW bend
15	Ludlam Thorofare	30' So. of SW bend of Cedar Drive
16	Ludlam Thorofare	260' NE of Barbers Lane at the NE bend
17	Ludlam Thorofare	200' NE of Meadow Creek Dr at the NE bend
18	Ludlam Thorofare	200' N. of Baywyn Dr. S. apx 100' SW of Woodbine Oceanview Rd
19	Ludlam Thorofare	200' S of Baywyn Dr. S. apx. 100' SW of Woodbine Oceanview Rd
20	Ludlam Thorofare	200' No. of Cul-de-sac at Baywyn Dr.
21	Ludlam Thorofare	200' S. of Cul-de-sac at Baywn Dr.
22	Ludlam Thorofare	200' S. of Baywyn Dr. 100' E. of Woodbine Oceanview Rd
23	Ludlam Thorofare	200' N. of Baywyn Dr. and 100' E. of Woodbine Oceanview Rd
24	Ludlam Thorofare	270' SW from the end of Lake Vista Dr. cul-de-sac
25	Ludlam Thorofare	175' S. of Fairway Court S. cul-de-sac
26	Ludlam Thorofare	305' E. of Fairway Court Drive
27	Ludlam Thorofare	240' E. of Fairway Court North
28	Ludlam Thorofare	275' SE of Ravenwood Dr. E. between B253.02/L16.07
29	Sluice Creek	SW of Beaver Dr. between Lots 9.05 and 9.06
30	Sluice Creek	200' S. of Beaver Dr. between Lots 9.08 and 9.09
31	Sluice Creek	200' W. of Beaver Dr. between Lots 9.11 and 9.12
32	Sluice Creek	700' NW of Beaver Dr. apx. 1200' from NJ Rt. #83
33	Savages Run	50' SW of Holly Lane Cul-de-sac
34	Savages Run	50' N. of Evergreen Dr. Apx. 1500' from Woodbine Ave

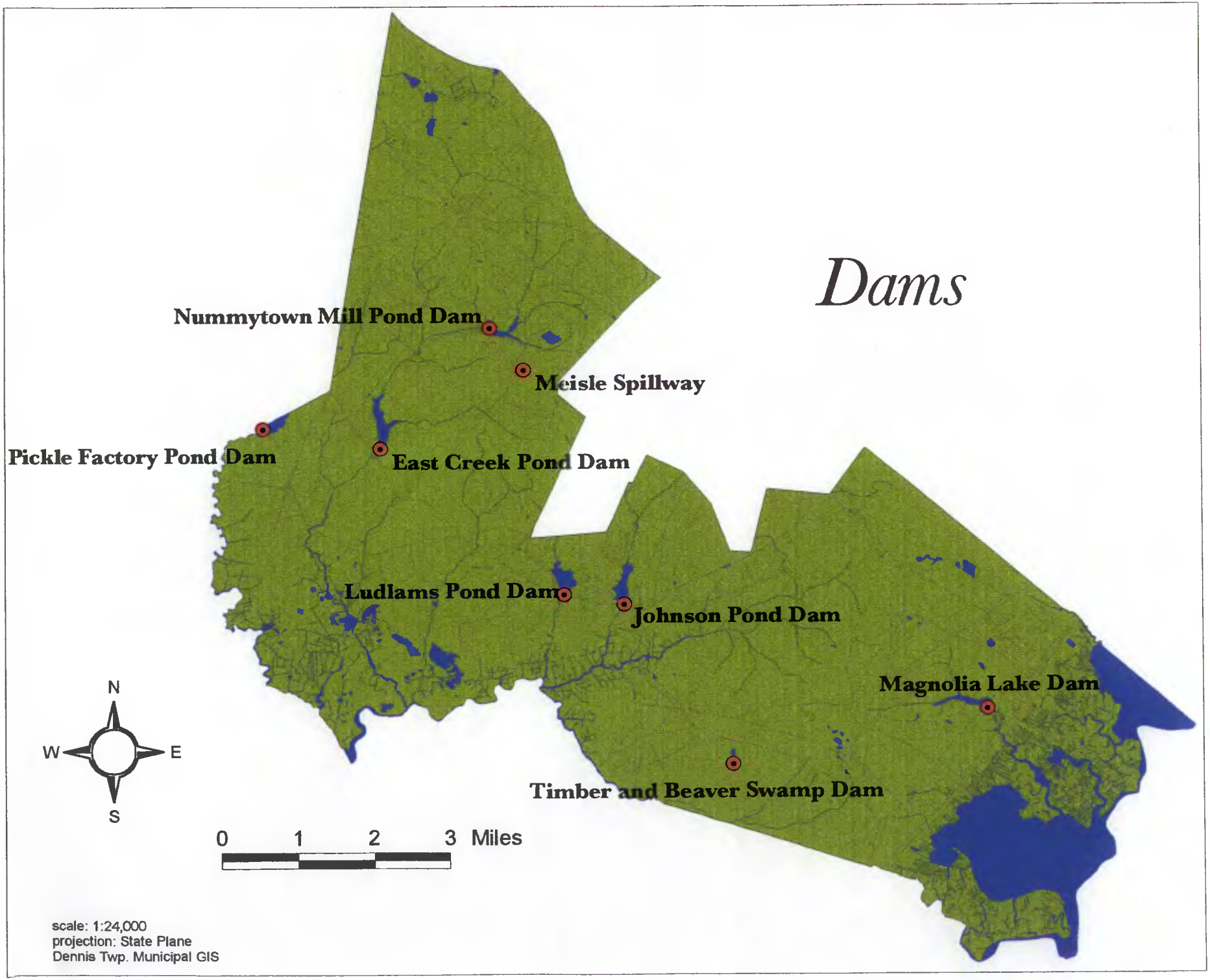
Stormwater Outfall Locations, showing those stormwater management features in Dennis Township currently on file with the state, with a key identifying locations of outfalls.

RECOMMENDATIONS

1. Coordinate with township engineer to put state-mandated updates of stormwater management on the municipal GIS system.

2. Monitor condition of outfalls and integrate outfall monitoring into the volunteer water monitoring program called for above.

3. Paint storm drains to alert residents and prevent nonpoint source pollution.

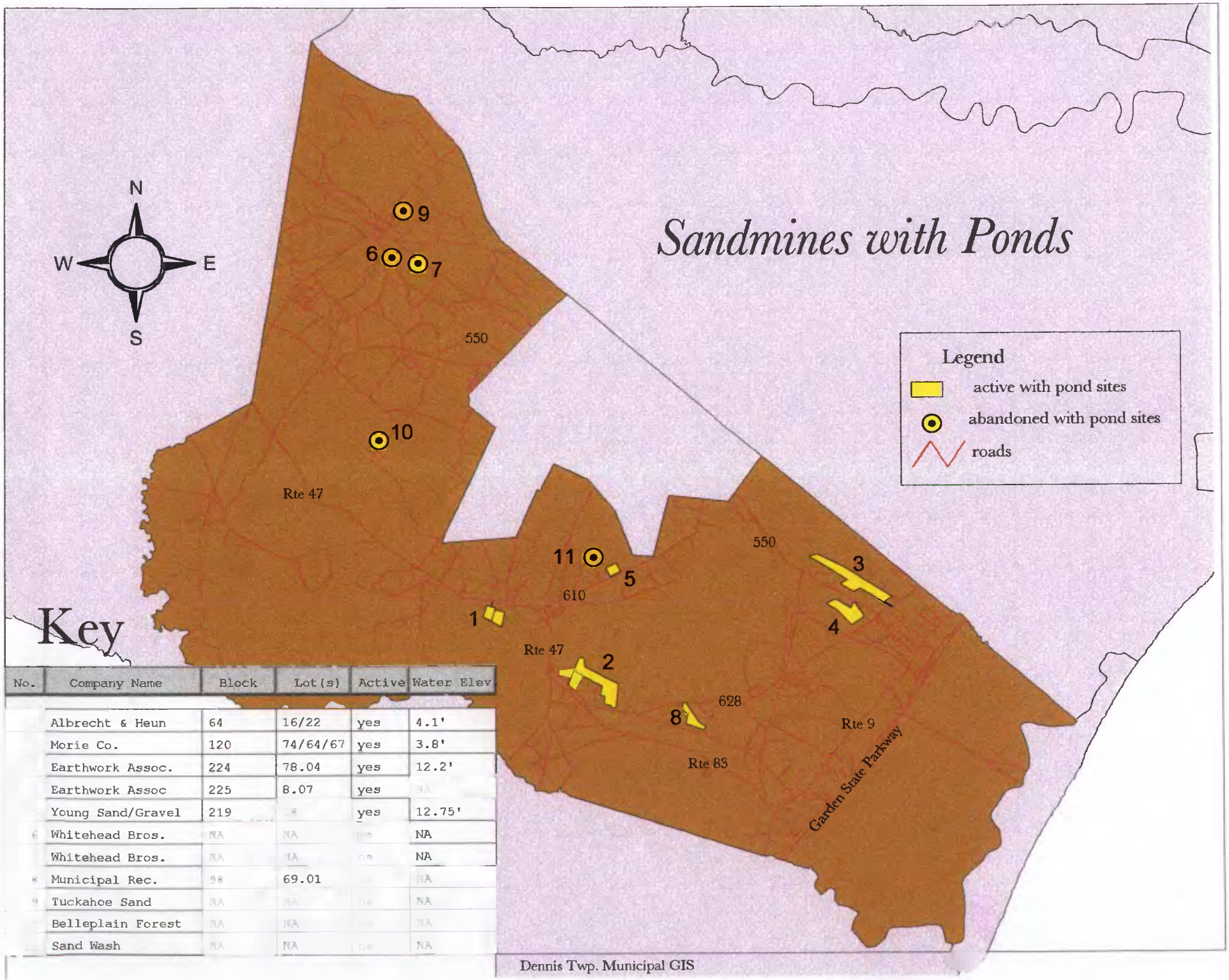

Dams
Nummytown Mill Pond Dam
Meisle Spillway
Pickle Factory Pond Dam
East Creek Pond Dam
Ludlams Pond Dam
Johnson Pond Dam
Magnolia Lake Dam
Timber and Beaver Swamp Dam
N
W
E
S
0 1 2 3 Miles
scale: 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

Dams, showing location of artificial dams in Dennis Township.

RECOMMENDATIONS

1. Install eel ladders at dams to provide access for elvers to impoundments. Study potential of aquaculture development for eels.

2. Monitor treated-wood dams for arsenic and chromium release; develop plan to replace with plastic lumber or other more environmentally friendly materials.



No.	Company Name	Block	Lot(s)	Active	Water Elev
1	Albrecht & Heun	64	16/22	yes	4.1'
2	Morie Co.	120	74/64/67	yes	3.8'
3	Earthwork Assoc.	224	78.04	yes	12.2'
4	Earthwork Assoc	225	8.07	yes	NA
5	Young Sand/Gravel	219	8	yes	12.75'
6	Whitehead Bros.	NA	NA	no	NA
7	Whitehead Bros.	NA	NA	no	NA
8	Municipal Rec.	98	69.01	no	NA
9	Tuckahoe Sand	NA	NA	no	NA
10	Belleplain Forest	NA	NA	no	NA
11	Sand Wash	NA	NA	no	NA

Sandmines with Ponds, showing active and abandoned sandpit sites set against a road network, with an accompanying key documenting names of mines with lot and block numbers and water elevations, when available.

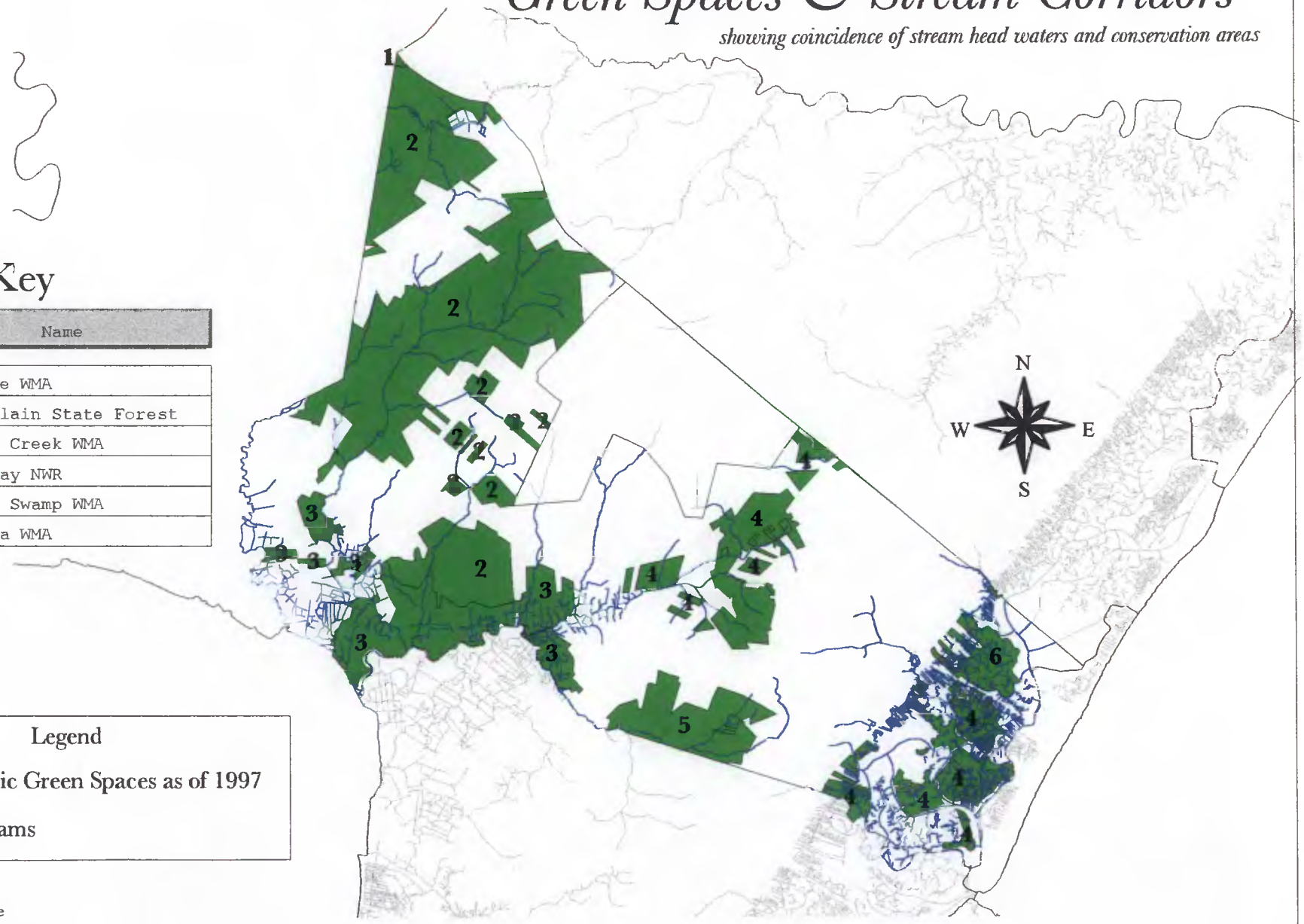
RECOMMENDATIONS

1. Upgrade available information and enter new data on municipal GIS. Upgrade should include current water elevations of all ponds, baseline water tests and aerial photographs of ponds linked to municipal GIS.

2. Work with owner/operators to develop best management and reclamation practices for active and abandoned sandpit sites, including safety factors.

Green Spaces & Stream Corridors

showing coincidence of stream head waters and conservation areas



Key

No.	Name
1	Peaslee WMA
2	Belleplain State Forest
3	Dennis Creek WMA
4	Cape May NWR
5	Beaver Swamp WMA
6	Marmora WMA

Legend

Public Green Spaces as of 1997

Streams

scale: 1:24,000
projection: State Plane
Dennis Twp. Municipal GIS

Green Space and Stream Corridors, showing the coincidence of stream head waters and publicly owned conservation areas.

RECOMMENDATIONS

1. Ground truth stream headwaters, adding accurate geographic coordinates, baseline water testing as part of volunteer monitoring and photographic images linked to municipal GIS.

2. Evaluate stream headwaters for condition and protection needs, including potential for collaboration with Belleplain State Forest land acquisition program and grants available.

VI.

To make a wise decision, consider seven generations past
and seven generations future.
— Cherokee proverb

The water resources inventory was conceived both for its own value as a municipal planning tool and as a benchmark project for the new Dennis Township Municipal GIS. All new systems require standard, easily duplicated tests, to measure performance under typical conditions of use. In this case, however, the benchmark project went well beyond standard testing. The water resources inventory itself created a per se planning tool, as well as the methodology and experience of a GIS project for future work. It was also the beginning of a grafting process, in which the GIS's functionality begins to become known and incorporated into the community corpus.

It was felt that this was indispensible, if GIS is to have any true impact in municipal affairs.

Since the concept of our benchmark project was to learn through pragmatic effort, in order to establish procedures for efficacy and success in future GIS projects, some points of self evaluation are in order:

1) Installing, learning and using ARC-VIEW software may sound like a cake walk; it wasn't. The system operator came to the project with the experience of two undergraduate, semester-long GIS courses : Introduction to GIS and Advanced GIS, both taken at Rowan College of New Jersey. Both of these well-designed and expertly taught courses were based around theoretical lectures and practical lab projects, using a raster-based GIS software package, OSU-MAP (Ohio State University).

A raster GIS stores data for cells, or pixels, organized sequentially by rows and columns. The maps it makes are drawn as a result of the computer reading values for the cells. All that cell-based data lends itself rather well to "map algebra", or scientific/ mathematical analysis, since each cell possesses a numerical value. But raster-based maps tend to look more like a collection of colored rectangles than what the average person would call a map.

ARC-VIEW, on the contrary, is a vector GIS, where the computer stores points, lines and polygons.

These are some of the customary cartographic elements people recognize in maps.

Switching from raster-based to vector-based GIS required no great mental leap, but some time and patience. That transition period could have been abbreviated by ARC-VIEW-specific training. However, none was available, either close by or at a reasonable cost. The DEP, which dispenses ARC-VIEW software with the idea of forming municipal-state partnerships to decentralize environmental monitoring and planning, should be aware that this whole effort is going to fail, unless the state provides ARC-VIEW training and database management training for local GIS system operators.

Municipal GIS operations cannot be left to paid consultants; municipalities cannot afford it. Training cannot be left to goodwilled volunteerism. If municipal GIS is to become an inherent part of the future, DEP must make sure that it is available to the public sector. It should be organized by DEP through an annual training grant to community and state colleges, where legitimate GIS system operators should be given tuition credits. In addition, DEP/Environmental Services grants should allow for municipal and NGO systems operators to obtain training under the terms of the grant.

While it is never too early for GIS training, it is also never too late. If Dennis Township only glimpses some of the splendid benefits of having GIS capability, it should support resources for GIS training. It will be repaid one hundredfold in terms of what the GIS can do for the township.

This point can hardly be overemphasized. Just as real estate's value is in location, GIS's value is in training, training, training.

2) Although it must be said that ARC-VIEW is really a marvelous invention, capable of making cartographers out of those who can barely draw a straight line with a ruler, it does have some developmental problems that are hard to bear.

Neither the documentation nor online help for ARC-VIEW prevented huge amounts of fumble time in our project. In addition, the program itself turned out to be monumentally glitchy. Sometimes one command decided not to work; sometimes another. Sometimes it froze and crashed. Other times it told you errors were made, but

wouldn't tell you what they were. Still other times it told you what the errors were in technical jargon incomprehensible to Bill Gates. The worst was when the work of whole hours — sometimes whole afternoons or evenings — vanished from the computer, leaving a tormented human operator feeling rather lost and lonely in the spanned archives of computer cartography.

It was only as the project was nearing conclusion that we learned that ARC-VIEW's producer ESRI (Environmental Systems Research Institute), recognizing the program's lapses, has put out a "patch kit" on the Internet to cope with the software's difficulties.

ARC-VIEW is not really meant for analyzing or originating new GIS coverages, but rather, as its name implies, for viewing the cartographic products made on systems with much more power — specifically the parent software, ARC-INFO.

This awareness only dawned on the system operator, when he started to conception the of maps he wanted to make for the water resources inventory.

Dennis Township's newest water resource, for example, are the ponds that form when open pit sandmining operations breach the water table. With half a dozen mining operations active in the township, it would be useful to know something about these new water bodies: where they are, how large, how deep, proximity to residential neighborhoods, etc.

Checking the CD-ROM data we purchased from DEP, it was found that, 1) active sand mines were marked with points, and 2) the data was out of date.

That left us with the puzzle, how to draw a new map of sand mines with ponds on our ARC-VIEW system?

Eventually, the problem was partly solved by studying individual mining property site plans filed with the township, recording them in a new table using lot and block numbers, then displaying the new table data.

The map shows which sand mine sites are active and have ponds, which is o.k. : But one would have preferred a map actually showing the ponds as polygons. This is possible using ARC-VIEW — and about $10,000 worth of digitizing, global positioning and plotting equipment.

The bottom line here is just this: not to oversell the abilities of either this particular municipal GIS (or those of the system operator). This is a magnificent tool for thematic mapmaking and

bringing the visual display of information to decisionmaking. It has many "higher" features our GIS group need to explore further.

But it cannot do everything a fully functional GIS with a professional staff team can do.

Not yet anyway.

3) In the beginning, the volunteer system operator tried to undertake too much. The lesson was soon learned that a volunteer intern not only helped move the project forward, but created an unexpected synergy. Fortunately, the first intern — a Stockton State College student with a minor in GIS — proved very adept at computers and versatile navigating WINDOWS and working with ARC-VIEW. So that, while she did more and more of the technical operations — primarily data capture and database management — the system operator was free to become project manager and concentrate on mapmaking.

That division of labor became a key element in the success of the project and a lesson to be drawn for future projects: a duet performs GIS better than a solo.

Why is this so?

Perhaps one person does not commonly possess both the technical and conceptual skills to bring it off. Or have the time to do both well. As soon as the system operator was largely liberated from the technical endeavor, the conceptual, cartographic and social (municipal) aspects of the project advanced much more rapidly.

Another aspect is the synergy created by two persons laboring in the same benchmark experiment. A more general way of expressing this is that technologically-based projects are better done by teams. First, the constant evaluation and review necessary of steps in complex sets of procedures loans itself to a system of checks and balances. Second, even though one mind is a terrible thing to waste, ideas spring forth more readily from a crowded house.

Indeed, it may be stated for future reference that municipal GIS projects should not normally be undertaken by an individual, but should always entail a team effort for optimum results. This may not always be the volunteer system operator-intern relationship. For example, a GIS consultant could be engaged under contract to work with GIS project volunteers. A local or regional users' group could be formed to collaborate on GIS projects. There are many possible variations to this theme.

4) The weakest link in the NJ/DEP's program to develop GIS for bottom feeders is the idea of datasharing partnerships. As encouraged to do, we made datasharing agreements with four agencies in addition to DEP: Cape May County Health Department, which is supposed to provide the county with GIS services; U.S. Department of the Interior, Fish and Wildlife Service, currently both acquiring and managing lands in Dennis Township for the Cape May National Wildlife Refuge, Great Cedar Swamp Division, but with its cartographic lab in Massachusetts; Public Service Electric & Gas (PSE&G), the utility company also currently acquiring, managing and monitoring wetlands in Dennis Township for its Delaware Estuary Enhancement Program; and the Nature Conservancy, currently active in a number of bay side land transfers and open space management as part of the Delaware Bay Biosphere Reserve.

Of these partners, only one came through with any data whatsoever; none have shown any more interest in acquiring our data. The one was Cape May County Health, which coughed up a digitized township tax map after 75-100 telephone messages went unanswered and an intern was dispatched to physically wait at the GIS operator's office door, no exaggeration.

The Nature Conservancy, which had announced a $1-million-plus new Bayshore Headquarters in the Eldora section of the township, turned out not to have any data to share — nor any GIS capability. However, this partnership may actually prove useful — at least to the Conservancy — in the long term, as we have offered them to share our entire system, rather than see them set up a second stand alone system here.

The failure of the datasharing partnership with PSE&G was particularly unhappy, because Dennis Township is one of their estuary enhancment program's host communities and because they have contracted with the Remote Sensing Laboratory at Rutgers University, a public institution, to provide the project data.

The company's cartographer led us on a good, swift chase; when finally reached by telephone after several months, he was curt in declaring that since he knew everything and we didn't know anything, there was no point in speaking further.

Such partnerships are rather wasteful in terms of time management.

5) What is the immediate future of GIS in Dennis Township? Like a shark in the water, we either move forward or die. The experience of having built a small municipal GIS system has amply demonstrated the many uses a robusted GIS could be put to in future — master planning, environmental management, real time property, tax and zoning information, emergency management, school bus routing, ecotourism-related mapping, public access, etc.

To keep the momentum going, however, we need to ask the immediate questions, What do we do next? and Who does it?

What: As the water resources inventory went along, we learned, by their absence, at least some of the coverages it would be quite useful to have on our system that we do not currently have, and some of the techniques we do not currently make sufficient use of.

First, the municipal GIS needs to have a zoning coverage. That would give us the capability to look at properties listed on the tax map and see them in terms of the zoning map, as well as vice verse. This can be accomplished in ARC-VIEW by adding a table of zoning data by individual properties (lot and block), then joining it to the tabular database files that go with the tax map coverage.

It is a large data entry project, nothing more.

At the same time, our tax map database files contain lot and block numbers, but not property owner information, street addresses, zipcodes, valuations or taxes. They could be added in similar fashion.

It should be noted that all of the above information is public knowledge under current laws; there would be absolutely no question as to privacy rights.

Second, current and future landuse management and landuse planning needs require that we have an accurate and detailed open or green space inventory of the township. This does not exist currently. What we have on the GIS is a coverage of publicly-owned open space (federal and state) as of 1997. It does not include municipal lands, farmlands, campgrounds, golf courses, privately owned forested lands, privately owned undevelopable lands (e.g., freshwater wetlands or CAFRA lands), sand and gravel pits, etc.

To have a true and clear picture, we need a set of thematic maps similar to those we have made for the water resources. This would especially help in locating critical habitats and green spaces, in revising the Master Plan, in fostering economic development, in

bringing consistency between the municipal Master Plan and the State Plan for Development and Redevelopment, in tracking and controlling impervious coverage and in any number of tasks that face municipal officials.

Third, the township is currently undertaking a tree management plan under a tiny grant from the state Division of Forestry. The township will subsequently apply for state funding to implement the plan. The tree management plan will require thematic maps and other graphics. Does it make any sense to not create these maps on our municipal GIS? No.

Fourth, as the state inches toward watershed-based environmental management, we should respond with an upgraded endeavor directed toward the Great Cedar Swamp watershed or drainage area. More than half the land mass of the township falls within the Great Cedar Swamp drainage; more than half the swamp's surface waters are located within the township. But the Great Cedar Swamp Watershed also includes parts of Woodbine Borough, Upper Townshilp and Middle Township.

We should make a large map or set of thematics showing an overview of key features of the Great Cedar Swamp Drainage (roads, floodplains, municipal boundaries, streams, recharge-discharge areas, stormsewer outfalls/stormwater management, etc. The Dennis Township Municipal GIS should become GIS provider to other watershed stakeholders. And we should use the municipal GIS, in this case, to start organizing the watershed's united management.

Fifth, ortho quads. These are essentially aerial photos with georeferencing locational data. They are commonly used as underlayment or base maps together with other digital coverages. Maps on top of photographs illuminate any number of geographic details, including wetlands delineations, vegetative coverage and the accuracy of digitized data. The state of New Jersey completed a new flyover in 1996; digitized ARC-INFO COVERAGES are apparently obtainable.

We should obtain ortho quads for the township and learn more about using them.

Sixth, we need to use this water resources inventory itself as a planning and management tool. That will require more outreach and more skill with ARC-VIEW, particularly , a) In "querying" the GIS database for answers to landuse problems; b) In manipulating

tabular data for display purposes; 3) in capturing more water resources data, for example, the DEP's data on mercury in our lakes and ponds; and 4) extending the analytical powers of AARC-VIEW through consideration of software analysis extensions and digitial elevation capability.

The real problem is Who? Who should do all this? It cannot be done by one person on a part-time volunteer basis. It might could be done by a volunteer system operator and interns. One general recommendation would be that if we are to take this thecnology's potential seriously, we should begin to think about and organize a GIS aspect for our township students' computer education and training. It should be possible, for example, to allow high school/technical school students from the township to take a course for credit in GIS at our municipal GIS site. And we should demonstrate GIS and GIS mapmaking to our elementary students, perhaps whetting their appetitite for geography studies by letting them do a local mapping project.

Students should definitely be integrated into the volunteer water monitoring program recommended earlier.

The author's own sense says that the question Who? is acutally more urgent in the short term than What?

We will probably need to do one or several more limited, granted GIS projects while attempting to widen the GIS circle, before getting the technology on anything like an ongoing basis in Dennis Township.

The input of this report's readers on this and other questions is much desired.

VII.

We would like to acknowledge the following for their help in bringing this project to fruition: The Association of New Jersey Environmental Commissions (ANJEC) for unfailing support, advice and encouragement; Prof. Richard Scott, chairman of the Department of Geography and Anthropology, Rowan College of N.J., for inspiring interest in GIS, for GIS instruction and wise project counsel; Dr. Yuri Gorkhovich, Ph.D., GIS Lab, New York City Department of Environmental Protection, Division of Water Quality and Conservation, for his generosity in helping design the inventory and database, helping us evaluate our data and his critique

of the maps, as well as his expert technical help, no matter what the problem; Albert Knoll, Dennis Township municipal clerk, for help with hardware and software; Dennis Township Engineer Jim Holmes, for help with floodprone areas map; Marla Chassels, environmental commission intern and later consultant, for her dedication in building our database and her knowledge of ARC-VIEW cartography; Patrick Hickey, environmental commission intern, for his loyal assistance making maps in winter 1998 ; Mayor Jim Pickering for his support of the municipal GIS concept; Kevin Thomas, Cape May County Health Department, for tax map; Dave McPartland of NJDEP for microbasins and wastewater discharge coverages; Eric Stiles, NJ Division of Fish, Game and Wildlife, for the open space coverage and last-minute technical assistance.

Lastly, gratitude to ESRI founder and GIS guru Jack Dangermond, without whose numerous contributions GIS would be understood by maybe a hundred people, instead of tens of thousands. It was largely Dangermond's vision that has driven the whole revolution in digital cartography, especially the migration to the desktop computer that has given activist amateurs like ourselves the tools to plan for a better world with GIS maps.

Appendix 1

NJdata directory structure.

Directory of available data and documentation for compiled GIS data for New Jersey.

All data and documentation can be found in the folders under c:\NJdata.

Folders are organized as:

Capemay - data for the Cape May County

Cumber - data for the Cumberland County

Dennis - data for the Dennis township area

Projects - arcview projects created using data contained in NJdata folders

Sjmarsh - habitat delineations for the following quads in Cape May and Cumberland Counties: Avalon, Ben Davis Point, Cape May, Cedarville, Fortescue, Heislerville, Port Norris, Rio Grande, Sea Isle City, Stone Harbor, Wildwood, and Woodbine.

State - data for the state of New Jersey

README - this file

Within each folder you will find arcinfo coverage and corresponding documentation file with extension ".doc"

To add documentation of a new coverage:
- use file c:\NJdata\template
- fill out the form as completely as possible
- save as [coverage_name].doc in Rich Text Format (RTF)
- insert information in the following listing, alphabetized by coverage address

NJdata library contents:

Capemay:

capco Boundary of Cape May County

capflood Flood-prone areas in Cape May County

capfww Delineations and classifications of Freshwater wetlands in Cape May County

capgeol Geology for Cape May County

caplake Hydrography polygon coverage for Cape May County

caplu Land use/land cover for Cape May County

capmun Municipal boundaries for Cape May County

capsoil Soil coverage for Cape May County

capstrm Hydrography line (network) coverage for Cape May County

* *

Cumber:

cumco Boundary of Cumberland County

cumflood Flood-prone areas in Cumberland County

cumfww Delineations and classifications of Freshwater wetlands in Cumberland County

cumgeol Geology for Cumberland County

cumlkns Hydrography polygon coverage for northern and southern Cumberland County

cumlu Land use/land cover for Cumberland County

cummun Municipal boundaries for Cumberland County

cumstrm Hydrography line (network) coverage for Cumberland County

* *

Dennis:
cmbasins.shp Drainage delineations for Cape May County, in shapefile format.

coordinates.shp 4 Coordinates (NW,NE,SW,SE) for Dennis Twp. in decimal degrees, in shapefile format.

den_twp Municipal boundary of Dennis Township.

dandams. shp Point locations of artificial dams within Dennis Twp.

denlakes Hydrography polygon coverage for Dennis Twp.

denmarsh1 Habitat delineations for regions of Woodbine quad that intersect Dennis Twp.

denmarsh2 Habitat delineations for regions of Sea Isle City quad that intersect Dennis Twp.

denmarsh3 Habitat delineations for regions of Heislerville quad that intersect Dennis Twp.

denmarsh4 Habitat delineations for regions of Avalon quad that intersect Dennis Twp.

dennames Point coverage of place names and features found on USGS 7.5' topoquad series within Dennis Twp.

dennis_lu.shp Land use/land cover for Dennis Twp. in shapefile format.

denop.shp An updated version showing federal and state lands within Dennis Twp. as of 1997, in shapefile format.

denopen Federal & state public open space & recreation areas within Dennis Twp as of 1991.

denroads Line coverage of roads within Dennis Twp.

densand.shp Active sandmines within Dennis Twp.,in shapefile format

denstorm.shp Sormwater outfalls & basins within Dennis Twp, in shapefile format

denstrm Hydrography line (network) coverage for Dennis Twp.

dentax Tax map coverage of Dennis Twp.

sandparcels.shp Parcels from tax map containing active sand mines within Dennis Twp., in shapefile format

soil21 Soil coverage of NW Woodbine, NJ quaterquad

soil22 Soil coverage of NE Woodbine, NJ quaterquad

soil23 Soil coverage of SW Woodbine, NJ quaterquad

soil24 Soil coverage of SE Woodbine, NJ quaterquad

* *

Sjmarsh:

Avalon Habitat delineation, Avalon quad

Bendavis Habitat delineation, Ben Davis Point quad

Capemay Habitat delineation, Cape May quad

Cedarvil Habitat delineation, Cedarville quad

Frtescue Habitat delineation, Fortescue quad

Heislerv Habitat delineation, Heislerville quad

Portnor Habitat delineation, Port Norris quad

Riogrand Habitat delineation, Rio Grande quad

Seaisle Habitat delineation, Sea Isle quad

Stonehar Habitat delineation, Stone Harbor quad

Wildwood Habitat delineation, Wildwood quad

Woodbine Habitat delineation, Woodbine quad

* *

State:

airmon95 Continuous air monitoring site locations

cedar Statewide delineations of wetlands containing Atlantic White Cedar.

climmun	Minimum, Maximum, Mean Annual daily temperatures and Mean Annual Precipitation by municipality
condis	Congressional district boundaries for the State of New Jersey.
dams	Dams in NJ
geonames	Point coverage of place names and features found on USGS 7.5' topoquad series
hemlock	Statewide delineations of hemlock stands
histpurv	Water Purveyor Service Areas, Based on Data Published in the 1970's
hot	Head of tide points for watercourses of the state
huc14	Basins for New Jersey coded to 14 digit Hydrologic Unit Codes (HUC)
iron	Location of mines & pits
legdis	Boundaries denoting New Jersey legislative districts
open91	Statewide coverage of federal & state public open space & recreation areas
pineland	Map the legislative boundary of the Pinelands Area (Post-Certification)
qq91	Statewide grid of 1991 quarterquad boundaries
quads91	Statewide grid of 1991 quadrangle boundaries
resrvoir	Existing and proposed water supply reservoirs
sandgrav	Location of mines & pits
state	Outline of the state of New Jersey
stco	County boundaries of the state of New Jersey
stmun	Municipal boundaries of the State of New Jersey
swl	Statewide coverage of solid waste landfills
wsma	Water Supply Management Areas