Water Resources / Water & Wastewater Facilities

The Water Resources and Water & Wastewater Facilities elements of the Mashpee Comprehensive Plan provide a coordinated review and analysis of Mashpee's fresh water resources, including groundwater and surface water bodies, existing and potential threats to those resources and the steps necessary to protect them, needs for future water supply and wastewater treatment facilities and the actions we must undertake to meet those needs. While wetlands and estuarine waters are necessarily dealt with to some extent, they are more fully discussed in the Wetlands / Wildlife & Plant Habitat and Coastal Resources elements of the Plan respectively.

The recommended goals, objectives, policies and actions contained in this plan are intended to be consistent with the provisions of the County's Regional Policy Plan and the relevant goals, policies and performance standards of that Plan are adopted directly as they apply to Developments of Regional Impact. However, they are primarily based on local interests, concerns, public input and planning efforts that have been undertaken over the last twelve years.

The primary issues addressed include:

- protection of groundwater resources within the recharge areas of current or proposed public water supply wells, including those of the Mashpee Water District, the Cotuit Fire District and the Town of Falmouth;
- protection of water quality in private and community drinking water wells;
- protection of the ecological integrity of wetlands and surface water bodies;
- projection of future water supply needs;
- provision of a safe and cost-effective means of water supply to all residents of the town;
- provision of appropriate cost-effective means of wastewater treatment and disposal throughout the town in order to protect the quality of our water supply and surface water bodies.

Community Goals & Objectives

The Planning Board has adopted a set of recommended Goals and Objectives regarding Water Resources and Water & Wastewater Facilities. They were based on Goals and policies adopted in 1986 by the Committee on Mashpee's Goals and Priorities, the 1992 public opinion survey undertaken by the Town at the start of work on this Comprehensive Plan, public input receives at a 1992 "Issues Forum" on the topic and on the Goals and Policies contained in Section 2.1 of the County's 1991 Regional Policy Plan, with which this Plan is intended to be consistent.

After a series of meetings regarding draft goals and objectives with the Mashpee Water District Commissioners, Mashpee Board of Health and Mashpee Sewer Commission and public meetings to solicit comments from the general public, Goals and Objectives were adopted by vote of the Local Planning Committee (Planning Board) regarding Water Resources on May 3, 1995 and regarding Water & Wastewater Facilities on January 17, 1996.

In addition to these Goals and Objectives, this plan recommends adoption, by reference, of the Water Resources Goals contained in the County's 1996 Regional Policy Plan, which was adopted after the completion of work on, and approval of, these Goals and Objectives, as they relate to review and approval of Developments of Regional Impact.

WATER RESOURCES

GOAL #1. TO PROTECT AND IMPROVE THE QUALITY OF MASHPEE'S GROUND WATER TO ENSURE AN ADEQUATE AND SUSTAINABLE SUPPLY OF SAFE, HIGH QUALITY DRINKING WATER.

GOAL #2. TO PRESERVE AND IMPROVE THE ECOLOGICAL INTEGRITY OF MASHPEE'S GROUNDWATER, WETLANDS AND SURFACE WATER BODIES.

Objectives

A. To ensure that any new development or expansion projects will not have an adverse effect on our groundwater, wetlands or surface water bodies.

B. To reduce any negative impacts of existing development on our groundwater or surface water bodies, including wetlands.

C. To ensure that water withdrawals are managed in a way to minimize or prevent any adverse effects on surface water resources, wetlands, existing wells or the safe yield of the aquifer.

D. To ensure that the cleanup of all existing and future groundwater or surface water contamination sites in Mashpee is expedited.

E. To ensure that public facilities and activities will have no significant adverse effect on groundwater, wetlands or surface water bodies.

F. To ensure that adequate and current data is available regarding the condition of Mashpee's groundwater, wetlands and surface water resources.

G. To ensure that land use activities in public water supply recharge areas will not result in predicted nitrate nitrogen loading in excess of 5 mg/l, so as to ensure that the federal and Massachusetts nitrate standard of 10 mg/l for drinking water can be consistently met at the wellhead, and that such land use activities will not prevent any other existing federal or Massachusetts drinking water standards from being met.

H. To ensure that existing and projected nitrogen and phosphorous loading in the recharge areas of our water bodies does not exceed a level that could damage the health or integrity of their ecosystems.

I. To ensure that our residents and visitors are well educated regarding the potential water quality impacts of development, of household products and activities and of typical recreational activities.

WATER & WASTEWATER FACILITIES

GOAL #1. TO PROVIDE A COST-EFFECTIVE AND SAFE MEANS OF WATER SUPPLY TO ALL RESIDENTS OF THE TOWN.

GOAL #2. TO PROTECT THE PUBLIC HEALTH AND THE QUALITY OF MASHPEE'S WATER RESOURCES AND ENVIRONMENT THROUGH THE DEVELOPMENT AND MAINTENANCE OF APPROPRIATE AND COST-EFFECTIVE FACILITIES FOR WASTEWATER TREATMENT AND DISPOSAL.

Objectives

A. To extend public water supply facilities to all areas of the Town with existing small lot development, high levels of commercial development or known drinking water quality problems, and to other areas of the Town as appropriate based on public health, fire protection needs and cost-effectiveness.

B. To ensure adequate public water supply and wastewater treatment and disposal facilities to support the Town's economic development efforts.

C. Where public supply facilities are not warranted, to maintain appropriate means of monitoring and ensuring the safety of private wells.
D. To locate and develop adequate public well sites to meet projected water supply demands.
E. To minimize any need for expensive water treatment through proper well location and protection of well recharge areas.
F. To reduce water supply demands and costs through the development of water conservation programs and incentives.
G. To develop appropriate public sewage collection and treatment facilities in areas where the intensity of existing or proposed development or other factors make adequate protection of groundwater or surface water resources through other means either infeasible or less cost-effective.
H. To ensure that all developments provide the highest feasible level of wastewater treatment.
I. To ensure that wastewater treatment facilities proposed for private developments are coordinated with public wastewater facilities plans or incorporated instead into municipal systems where appropriate.
J. To develop and maintain the highest quality practices and facilities for septage pumping, haulage, disposal and treatment and for disposal of sludge or solids from wastewater treatment facilities.
K. To develop and maintain appropriate water quality monitoring programs for all public water supply and wastewater treatment and disposal facilities.
L. To encourage the highest feasible quality maintenance and operations of all public and private water supply and wastewater treatment and disposal facilities.

Inventory of Water Resources

Public, Community and Private Water Supply

Since its creation in 1987, the **Mashpee Water District** has grown rapidly, to the point that the majority of residences and businesses in the Town are now connected to their system. As of May 1, 1997 there were 5150 services vs. a total of approximately 7750 residences and non-residential structures. That represented an increase of 735 services since January 1, 1996 or a 12.5% annual rate of growth. On an average day in 1996, the District distributed 829,594 gallons of water, while their maximum day demand during the peak summer season was for 1,717,260 gallons. This growth in demand has been illustrative of the growth in the Distict's supply network, which now reaches most parts of the Town. The District's current distribution system is illustrated on Map 4-1.

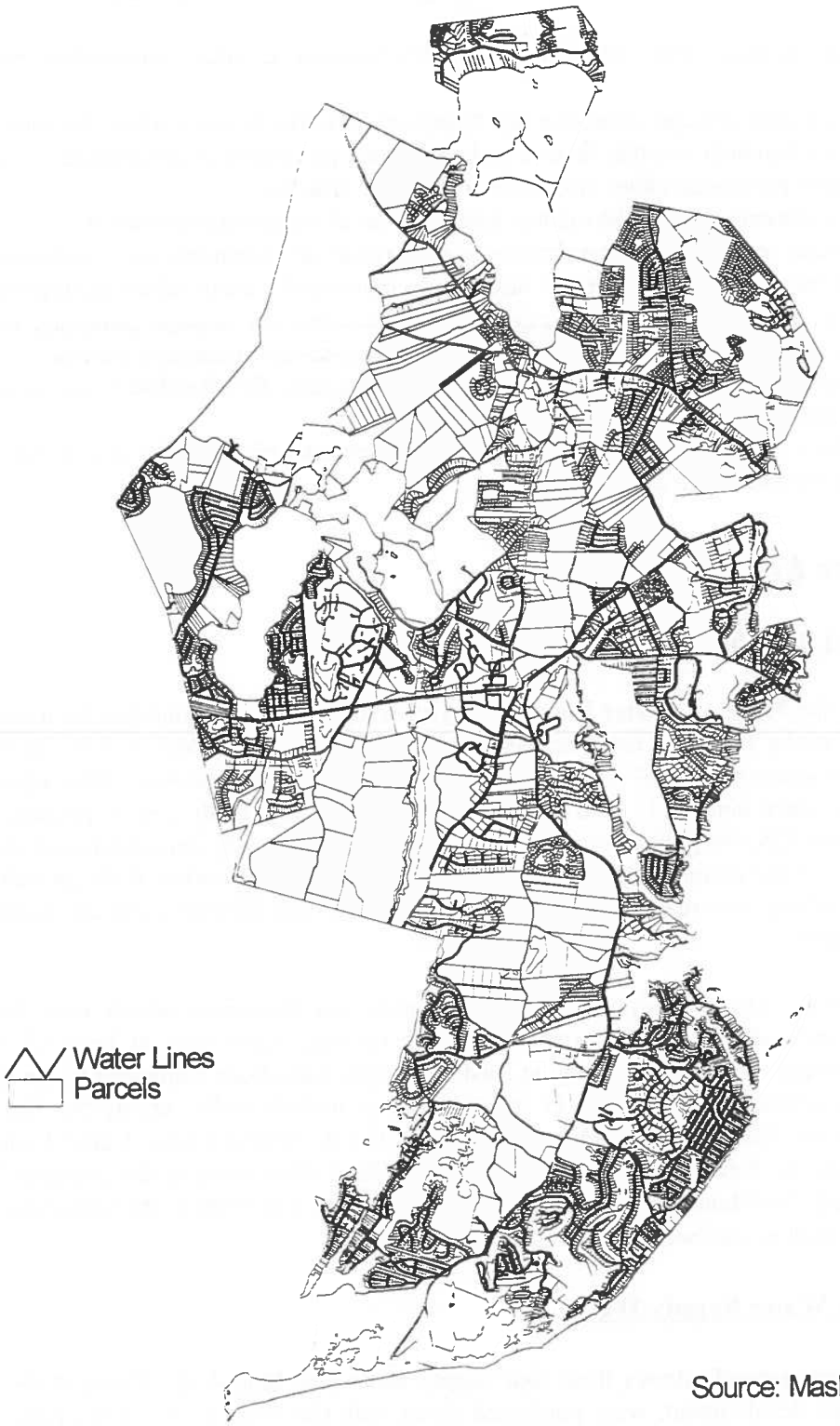
With the growth of the Water District's system, many residences and businesses which were formerly served by individual private wells or by **"community" wells** (private wells with at least 15 service connections used by year-round residents or serving at least 25 people) have been connected to the system. However, a number of community wells remain in service. Those include wells serving the Sea Oaks, Stratford Ponds, Sea Mist and Beechwood Point condominiums, the Riverbend Motel, Camp Farley, the Lakeside Estates trailer park, the Summerfield Park and Shellback Place office condos, the Quashnet Valley Country Club clubhouse and The Flume restaurant. At the time this Plan was written, the remainder of the Town was served by individual private wells.

Public and Community Water Supply Wells

The Mashpee Water District currently draws from four supply wells (see Map 4-4). Three of the wells, located in the New Seabury development, were purchased along with the other assets of the High Wood Water Company. Two of those, located off **Rock Landing Road** near New Seabury's Tennis Center and ballfield, are used year-round and are permitted for a combined maximum daily withdrawal of two million

Mashpee Water District Distribution System

Map 4-1



Source: Mashpee Water District

gallons. The third, located off **Wading Place Road** in the vicinity of New Seabury's former equestrian facilities, is used only during the summer as a backup supply. It is permitted for 125 gallons per minute or 180,000 gallons per day under the Water Management Act but is currently only allowed 40,000 gallons per day by the DEP Division of Water Supply.

The fourth well currently in use, known as the **T-4** well, is located on Town land off Sampson's Mill Road adjacent to Willowbend. The well, which is permitted for a maximum daily withdrawal of 720,000 gallons during the summer and 475,000 gallons during the rest of the year, was originally developed by Willowbend by agreement with the Town and later sold to the Town, which transferred ownership to the Water District upon its establishment.

As of April, 1997, the Water District reported that its current total daily supply available was 2,700,000 gallons per day.

Over the years the Town, and later the Water District, have conducted hydrogeologic investigations to locate additional high-productivity wells. In 1986, the Town funded a well investigation program which reviewed 14 potential sites on Town and private lands and included the installation of more than a dozen test wells. A number of the wells were recommended for further testing and development. Those included the T-4 well which has since come on line, two wells on state and private land in the "P-1" area west of the Quashnet River, one well on private land in the "P-11" area north of the Steeplechase subdivision near Otis A.N.G.B., the T-5 well on Town conservation land off Noisy Hole Road and the T-8 well on Town land at the north end of Santuit Pond.

The Water District has acquired the 62.3 acre **Merganser Realty Trust** property in the "P-1" area for development of an additional well (now known as the "Turner Road" well) and has proposed a 720 gallon-per-minute (1 million gallons per day) well on Town Conservation land adjacent to the **"Holland Mills"** subdivision. Town Meeting has granted an easement for the well and preliminary approval was granted by the Division of Water Supply, but a variety of concerns about the impact of the well on surrounding rare species habitat in the South Mashpee Pine Barrens and Atlantic white cedar swamps have led to the requirement that the Water District prepare a full Environmental Impact Report under the Massachusetts Environmental Policy Act (MEPA) and that the project be reviewed as a Development of Regional Impact (DRI) by the Cape Cod Commission. As a result, the well has also not yet obtained a withdrawal permit under the state's Water Management Act.

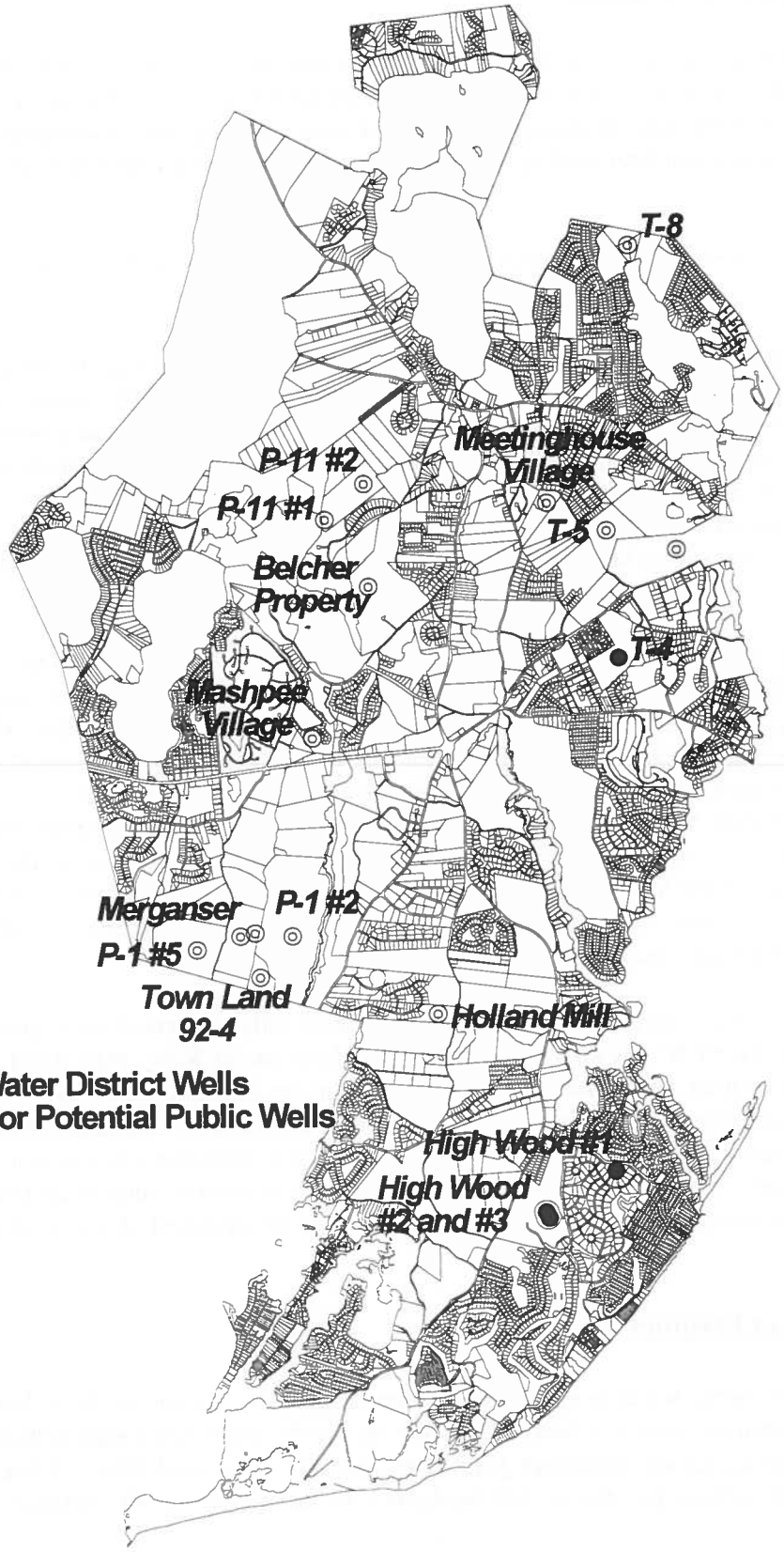
Other potential well sites which have had preliminary testing done which indicated some promise for public supply purposes include the **"T-5"** site on Town conservation land east of Noisy Hole Road, the **"T-8"** site on Town land north of Santuit Pond and the **"P-1 #5"** site on private land just west of the Merganser property. Drawdown tests done by the Town in 1985 were very favorable for a one million gallon per day well at T-8, and fairly favorable for the T-5 site, which lies in close proximity to a major Water District main in Noisy Hole Road. It may be appropriate to protect these as reserve sites to accommodate future demand in excess of that projected by the Water District or in case development of one or more of the other wells is not feasible.

Wastewater Treatment Facilities

Mashpee currently has no public sewer or wastewater treatment facilities, except for those that service Town facilities. All are conventional septic systems except for the newly-constructed **high school**'s sequencing batch reactor (SBR)-type wastewater treatment plant with a tertiary rapid sand filter. While the plant was designed to treat 18,000 gallons per day at full occupancy of the school (1180 students) it is currently

Public Wells

Map 4-4



● Existing Water District Wells
◎ Proposed or Potential Public Wells

receiving an average of 1125 gallons per day (April, 1997) and a peak day flow of 5500 gallons with an enrollment of 377 students as of June, 1997. Total nitrogen was 8.6 milligrams per litre (mg/l) in the plant's effluent when tested in April, 1997.

There are currently three private sewer systems and wastewater treatment plants in operation in Mashpee (see Map 4-5). The largest serves the **Willowbend** golf course condominium development with an RBC (rotating biological contactor) treatment plant having a design capacity of 113,000 gallons per day to accommodate an eventual total of 280 residences, the golf course clubhouse and the development's other recreational facilities. With approximately 60 residences built, peak month average daily flow to the plant was 9623 gallons per day in August 1996, with a maximum day flow of 25,920 gallons. February, 1997 average daily flow was only 2134 gallons per day with a peak day flow of 6480 gallons. These flows have, at times, been insufficient to keep the plant operational and are illustrative of the problems of providing treatment facilities for seasonal housing.

The **Mashpee Commons** commercial center is served by an 80,000 gallon-per-day RBC treatment plant with a denitrifying filter. Average daily flow was 15,403 gallons in July and 14,857 gallons in August, 1996, with a peak day flow in August of 22,066 gallons. February, 1997 flow averaged 9192 gallons per day, with a peak day flow of 12,238 gallons. The capacity of the plant is designed to accommodate a significant amount of expansion of the Mashpee Commons project, but will have to be further expanded to accommodate all that the developers have proposed at buildout of the project. After reconstruction and expansion in early 1996, the plant has achieved excellent nitrogen removal rates, with total nitrogen at 5.4 mg/l in July and 2.8 mg/l in August, 1996.

The most recently completed private wastewater treatment plant is a 40,000 gallon-per-day plant serving the 170-unit **Stratford Ponds** Condominium. The plant uses a Tetra process with a Denite filter that is said to achieve excellent nitrogen removal. Having only become operational in April, 1997 however, there is not yet sufficient data on flows or nitrogen removal efficiency.

C. **Talanian** Realty Co., Inc. has recently filed plans to develop a retail / restaurant complex on the property currently occupied by Dick & Ellie's Flea Market and associated businesses. The project is proposed to be served by a 17,100 gallons-per-day private wastewater treatment plant.

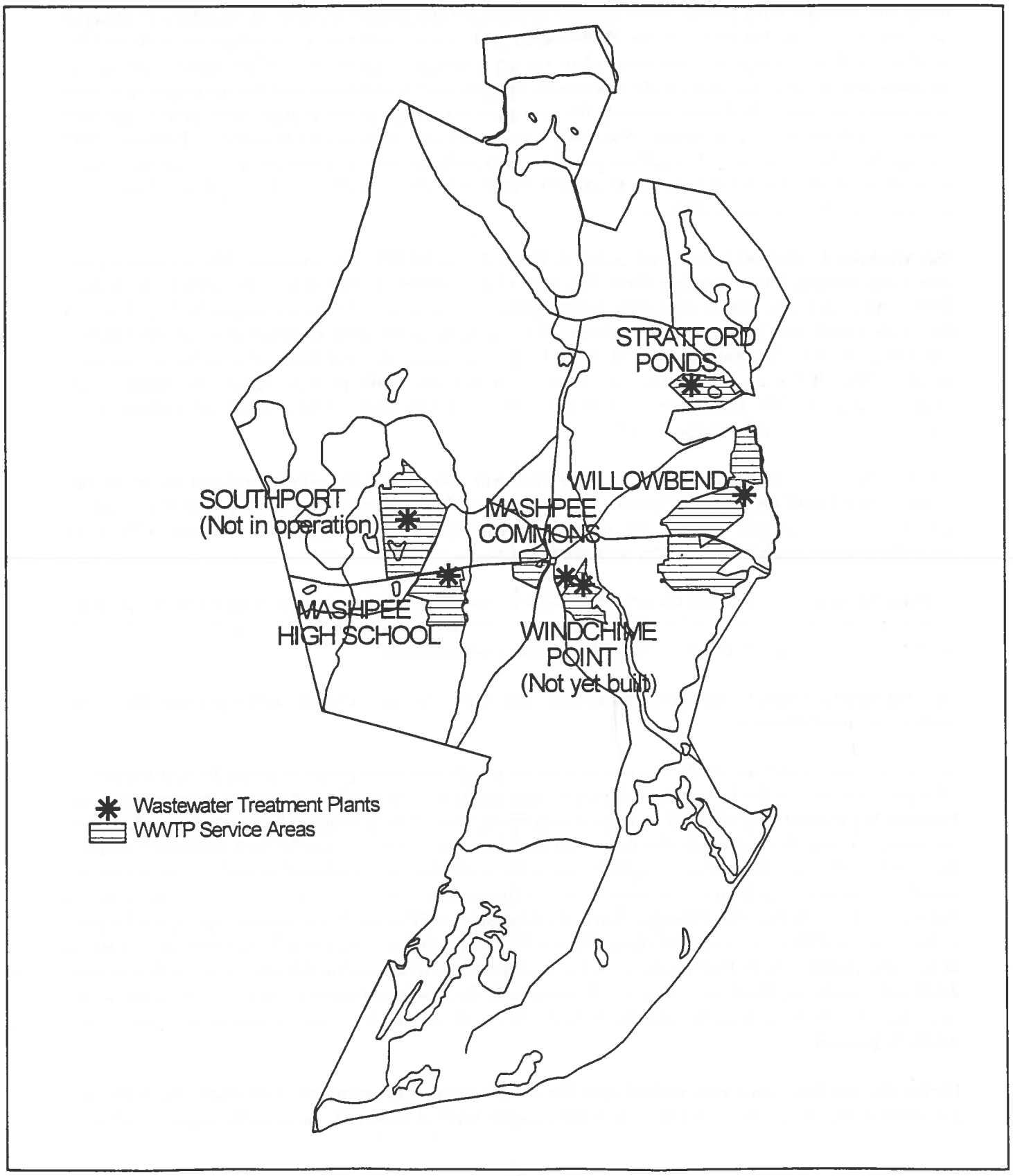
The **Southport** planned retirement community will have its own 172,000 gallon-per-day RBC-type wastewater treatment plant.

At one time during the late 1980s, there were a dozen private treatment plants proposed for construction in Mashpee. Because of the large potential expense and duplication of facilities that might have resulted, the Planning Department developed the concept of combining most of those plants at four locations under Town ownership. Using the same funds that the private developers would have spent for their individual systems, the Town would have been able to expand wastewater collection and treatment systems to other existing densely-developed neighborhoods at little or no additional cost due to economies of scale. The proposal resulted in the creation of the **Mashpee Sewer Commission**, MEPA and Town Meeting approval of a plant at the Town landfill to serve east Mashpee (funded by four developers, including Willowbend and Stratford Ponds) and preliminary hydrogeologic work for a system to serve the central business area (funded by nine developers, including Mashpee Commons, Talanian and the Mashpee Industrial Park). Unfortunately, the recession of 1990-92 caused the demise of many of the developments involved and both projects were unable to proceed.

During the last few years, new technologies for on-site wastewater treatment have been developed and permitted in Massachusetts which provide a much higher level of treatment, particularly regarding nitrogen

Wastewater Facilities

Map 4-5



removal, than conventional septic systems. These are being increasingly used in Mashpee for commercial projects and for residences that are subject to the Town's wetlands bylaw. The latter restricts new residences within the Conservation Commission's jurisdictional area (200 feet from rivers, 100 feet from other wetlands) to wastewater flows of 330 gallons per acre unless the residence is served by a denitrifying wastewater treatment system. To date, approximately 20 such systems have been installed in Mashpee, including a 5950 gallon-per-day FAST system for the **99 restaurant** and a 3400 gallon-per-day Bioclere system for the new **Cook's seafood restaurant**. In addition, as part of a Development Agreement signed with the Cape Cod Commission, the owners of 13 lots in the **Mashpee Industrial Park** have agreed to the use of recirculating sand filter systems on any lots generating daily wastewater in excess of 2000 gallons.

All other parts of the town are served by conventional Title 5 septic systems or older cesspools. Because 55% of Mashpee's housing stock has been built since the inception of the Title 5 standards in 1978 and because many of the older homes are summer cottages used only seasonally, old cesspools, while fairly numerous, do not account for a large portion of annual wastewater flow in the town.

Lakes and Ponds

Mashpee is blessed with an abundance of freshwater lakes and ponds. They range from the 729 acre **Mashpee-Wakeby Pond** to 0.1 acre **Fresh Pond** (largely filled by development of the New Seabury golf course and barely rating the term "pond"). Depending on what definitions you use, there are approximately 23 fresh water ponds in the Town covering 1455 acres. The largest are Mashpee-Wakeby Pond, **John's Pond** (317 acres), **Santuit Pond** (172 acres), **Ashumet Pond** (203 acres, of which 152 acres are in Mashpee), **Great Flat Pond** (37 acres, tidal slightly brackish water) and **Moody Pond** (18 acres). The first four are our major recreational freshwater ponds. Both boating and swimming are popular, while recreational fishing is highly productive.

All of our large inland ponds, as well as the smaller ponds, lie in the kettle hole depressions that were left to us by the glaciers of the Ice Age. Giant blocks of ice were buried in outwash sediments and later melted, leaving large kettle holes. The kettle hole nature of the ponds becomes clearer upon review of bathymetric maps (depth charts) of the ponds (see Figure 4-1). Mashpee-Wakeby, John's and Ashumet Ponds show rather deep bottoms, with maximum depths of 87, 62 and 65 feet respectively. Santuit Pond, on the other hand, is extremely shallow, with a maximum depth of only 9 feet and a mean depth of 4.2 feet. Moody Pond has a maximum depth of 14 feet and averages approximately 8 feet in depth.

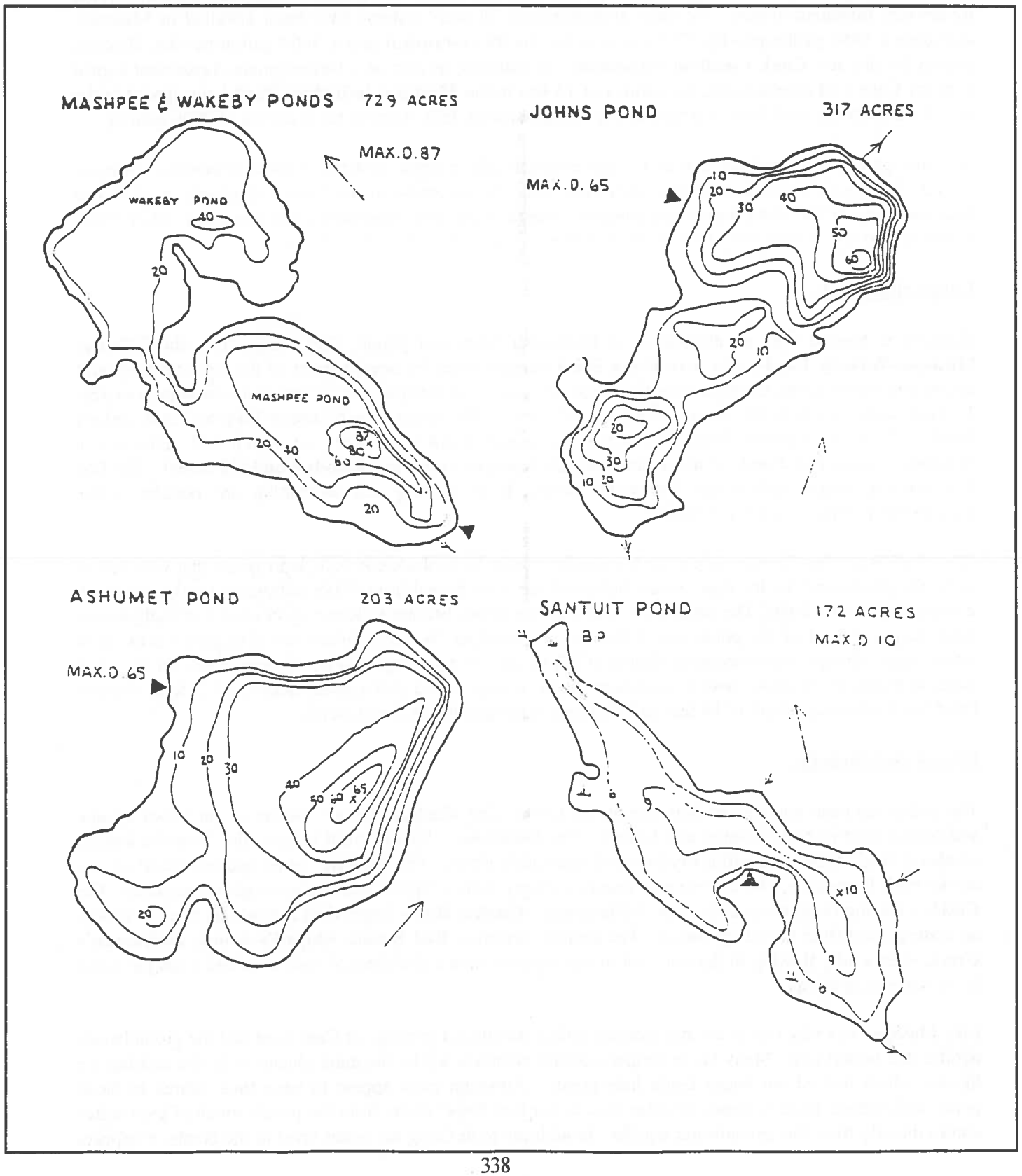
Rivers and Streams

The traditional heart and soul of Mashpee are its rivers. The **Mashpee River** - bearer of our Town's name and central to it in both location and history. The **Quashnet** - famous trout stream, the "world's longest cranberry bog", focus of a nationally-honored restoration effort. The **Santuit** - quiet and unnoticed on our border with Barnstable, site of towering beeches, dainty ladies slippers and archaeological treasures. The **Childs** - herring river, reduced by man, hidden away. **Quaker Run** - larger than it looks, an ancient valley, an underground river not easily tamed. The smaller streams - **Red Brook, Abigail's Brook, Dutchman's Creek** - peacefully flowing to the sea. All of our streams have a character of their own and a unique value in the scheme of things.

Like Mashpee's ponds, our rivers and streams reflect the glacial geology of Cape Cod and the groundwater aquifer that underlies it. Many lay in former outwash channels left by the main glacier or by the melting ice blocks, which formed our larger kettle hole ponds. Although most appear to have their source in those ponds and, indeed, large volumes of water flow to our four larger rivers from the ponds, much of their water comes directly from the groundwater aquifer. In addition to defining the water level in the ponds, it appears

Major Ponds
BATHYMETRY

Figure 4-1



in hundreds of springs and seeps along our riverbanks and in the beds of the rivers. Indeed, Red Brook and Dutchman's Creek have no apparent source, rising solely from groundwater springs and the resulting wetlands. As part of the Town's efforts to protect these streams, as well as our ponds and coastal bays, their groundwater recharge areas have been mapped to assist in understanding and managing our impact on the quality of their waters (see Map 4-6).

Marine Water Bodies

Mashpee's coast is bounded and defined by two large estuarine systems, **Waquoit Bay** to the west and **Popponesset Bay** to the east. Each includes a number of sub-embayments and salt ponds. The Waquoit system in Mashpee includes **Hamblin Pond** (fed by Red Brook and Dutchman's Creek), **Jehu Pond, Sedge Lot Pond, Little River, Great River** (fed by Abigail's Brook) and, via a man-made ditch, the brackish waters of **Great Flat Pond** (formerly a separate bay which lost its connection to the sea in the 1850s). Both the Quashnet and Childs Rivers also flow to Waquoit Bay through the Waquoit Village area of Falmouth. The portion of the Popponesset estuary in Mashpee includes **Shoestring Bay** (fed by the Santuit River and Quaker Run), the **lower Mashpee River, Ockway Bay, Popponesset Creek** and man-made **Spoondrift Cove** and **Spinnaker Cove**.

The waters of these estuaries are fed by our rivers and by groundwater entering via those rivers or directly along the edge, or through the bottom, of the bays and salt ponds. The rain and snow that fell years ago in Sandwich, at Otis Air National Guard Base and throughout Mashpee has percolated into the groundwater table and made its slow but steady way down to the coast, or has appeared in springs in Mashpee Pond or along the Quashnet River where, joined with the rains that fell last week on the ponds or this morning on the impermeable surface of Route 28, it flows into Popponesset Bay, or Hamblin Pond, or Waquoit Bay. The extent of the areas from which rainfall flows, via groundwater and our rivers, to each estuary and the major sub-embayments is shown on Map 4-6.

Once our rivers meet the bays, the actions of tides have an effect on the speed of water movement and, thus, its ability to carry both mineral and organic sediments and detritus. Where the movement of water is slowed, sediments are dropped to the bottom or concentrated in the water. Materials which settle out form the basis of future salt marshes and tidal flats and the high concentration of detritus and mineral nutrients results in rich feeding grounds for molluscs, crustaceans, worms and small fish who are, in turn, eaten by larger fish. The flats and marshes are, of course, home to our quahogs, soft shell clams and crabs. Once they produced vast numbers of oysters as well, the shucking of which provided employment for many of Mashpee's youth, but they are, sadly, largely a memory for now.

Another species of shellfish that has suffered a steep decline is the sweet bay scallop. The causes of its disappearance are not certain, and its numbers seem to have always been cyclical, but one of the most solid theories relates to the dependence of its young, or "spat" on the eel grass to which they attach themselves at a critical point in their lives. The eel grass beds of Waquoit and Popponesset Bays have been destroyed in recent years. Over-nutrification of our bay waters with nitrogen contributed by septic systems and road runoff cause the growth of excessive amounts of algae, which cloud the water, blocking the sunlight needed by eel grass, then die off and cover the bottom of the bay. Adult scallops, which prefer a clean sandy bottom, are also not happy with the resulting mucky bottom.

The eel grass beds, along with marshes and floating plankton, were also the primary food source for "forage" fish species such as Atlantic silversides, sticklebacks, pipefish, mummichogs and killifish. These, in turn, are eaten by larger species such as the bluefish, cod, mackerel and sea bass that enter bays and estuaries to feed. Thus, the loss of eelgrass in the bays has ramifications far beyond their shores.

Threats to Water Quality

Lakes & Ponds

During the last 30 years, the shorelines of the four major freshwater ponds have become heavily developed, first with summer camps, and more recently with year-round homes. This development has been drawn by the lakes' recreational opportunities, including fishing, boating and swimming, and their natural beauty. However, the development thus attracted to their shores has begun to damage our lakes. Shorelines and their unique plant communities have been severely disrupted by man-made beaches and docks and the footsteps of many visitors. The noise of motorboats has drowned out the sounds of waterfowl. Fishermen and swimmers are disturbed by high-powered boats, water skiers and "jet skis." The aesthetic beauty of the lake experience has been reduced by hundreds of residences located close to the shore. Most insidious of all, however, and most critical to the health and attractiveness of our ponds, has been a rapid decline in the quality of their waters.

Scientists classify the relative health and water quality characteristics of ponds by their "trophic state," referring to the metabolism of a pond and the available supplies of the nutrients nitrogen and phosphorous. Those nutrient supplies are critical to the pond's food chain. However, in excessive amounts they accelerate the process of "eutrophication," or over-nutrification of a pond and lead to excessive plant growth, lack of oxygen as plants die off and take it up as they decompose, loss of fish stocks due to insufficient oxygen, algal blooms and associated foul odors, loss of water clarity and suitability for recreational purposes and eventual filling of the pond with organic matter, creating a wetland.

Due to relatively small surface watersheds, low erosion rates, poorly developed soils and low concentrations of nitrogen and phosphorous in the outwash plain soils, most Cape Cod ponds were originally poorly fed with nutrients, or "oligotrophic". There was little algae or other phytoplankton growth and very little suspended matter, resulting in extremely clear waters. Such ponds support a high diversity of fish species (but in small numbers), are excellent for swimming and boating and are highly scenic. Many of the Cape's ponds retain that status. However, none in Mashpee have survived in that state.

Mashpee-Wakeby, John's and Ashumet Ponds have received increased levels of nitrogen and phosphorous due to heavy development along their shorelines. Septic systems, road drains and fertilized lawns and gardens all leach nitrogen and phosphorous into the groundwater feeding our ponds, or into the ponds directly as runoff during storms. This additional nutrient load has led to a fairly rapid change in their water quality, to what is known as a "mesotrophic" state. Phytoplankton has increased, although it is highly variable, with occasional phytoplankton blooms, including bluegreen algae. Suspended matter is increased, though also variable. Food supplies and habitat are abundant, resulting in relatively high and diverse populations of both bottom fauna and fish.

In all three ponds, both boating and swimming are still enjoyable, while recreational fishing is highly productive. However, there is a critical 4-6 foot layer of water in each which has ideal summer temperature and oxygen conditions for salmonids like trout. Anything that would decrease available oxygen in the water could narrow or eliminate this critical layer. Over-nutrification which results in algal blooms and subsequent algal die-offs during cloudy periods results in rapidly reduced oxygen levels, leading to fish kills. Such events have already occurred in Ashumet Pond.

In addition, other contaminants have assaulted our ponds. There are currently public health advisories against eating fish taken from some of our ponds due to relatively high levels of mercury (0.5 parts per billion). Children under 12, pregnant women and nursing mothers have been advised against eating

smallmouth bass from Mashpee Pond and all fish from John's Pond. All other people are advised to limit consumption of smallmouth bass from Mashpee Pond and all fish from John's Pond to two meals per month. The apparent source of the mercury is acid rain deposition.

Both Ashumet and John's Ponds, along with the Quashnet River, are also in the path of plumes of solvents released into the groundwater on the Massachusetts Military Reservation, although there have been no health advisories issued as a result for fishing, swimming or other activities. The "SD-5", "CS-10" and "Ashumet Valley" plumes (the latter also contains phosphorous) touch Ashumet Pond, while the "SD-5" plume extends to John's Pond and the "eastern Briarwood" plume ends at the Quashnet River (see Map 5-1). The primary contaminants are volatile organic compounds, which pose human health threats at certain concentrations and under certain exposure conditions.

An even more concentrated plume of volatile organics was recently discovered flowing under Mashpee / Wakeby Pond from a former private junkyard in the Forestdale area of Sandwich. Known as the "J. Braden Thompson" plume for the road on which it is located, it contains up to 3,400 parts per billion (ppb) of tetrachloroethane (1,1,2,2 TECA), 1,100 ppb of trichloroethylene (TCE) and 350 ppb of tetrachloroethylene (PCE). The federal drinking water standard for maximum allowable levels of tetrachloroethane is 2 ppb, while the standard is 5 ppb for TCE and PCE. Where it passes under the western shore of the Pond, the main body of the plume is located 234-263 feet below the ground. However, 5.7 ppb of PCE has been found in water samples taken at the bottom at a depth of 29 feet. The site was discovered in 1987 and has been cleaned up by the Massachusetts Department of Environmental protection, but work on cleaning up the resulting off-site plume has not yet been done.

Unlike our other three large ponds, Santuit Pond is very shallow. As a result, its waters are warm and support such warm water species such as bass, pickerel and perch. It is also much more susceptible to over-nutrification and eutrophication. In fact, Santuit Pond has already become"eutrophic", the third and worst level on the trophic scale. It is surrounded on the west and northeast by dense residential development on small lots averaging 1/4 acre and is bordered by a number of active cranberry bogs. No public or community wastewater collection or treatment is in place, and all residences use septic systems or cesspools. Because of the shallow nature of the pond and low flushing rate caused partly by fairly impervious organic bottom sediments, it has become over-nutrified, with dense aquatic vegetation, frequent algal blooms, foul odors and poor quality for swimming and boating. There is a high frequency of flatleaf pondweed (*Potamogeton robbinsii*), which is an indicator of high phosphorous content in bottom sediments. Floating plankton species are dominated by *Microcystis sp.*, a colonial blue green algae capable of creating obnoxious blooms if it windrows.

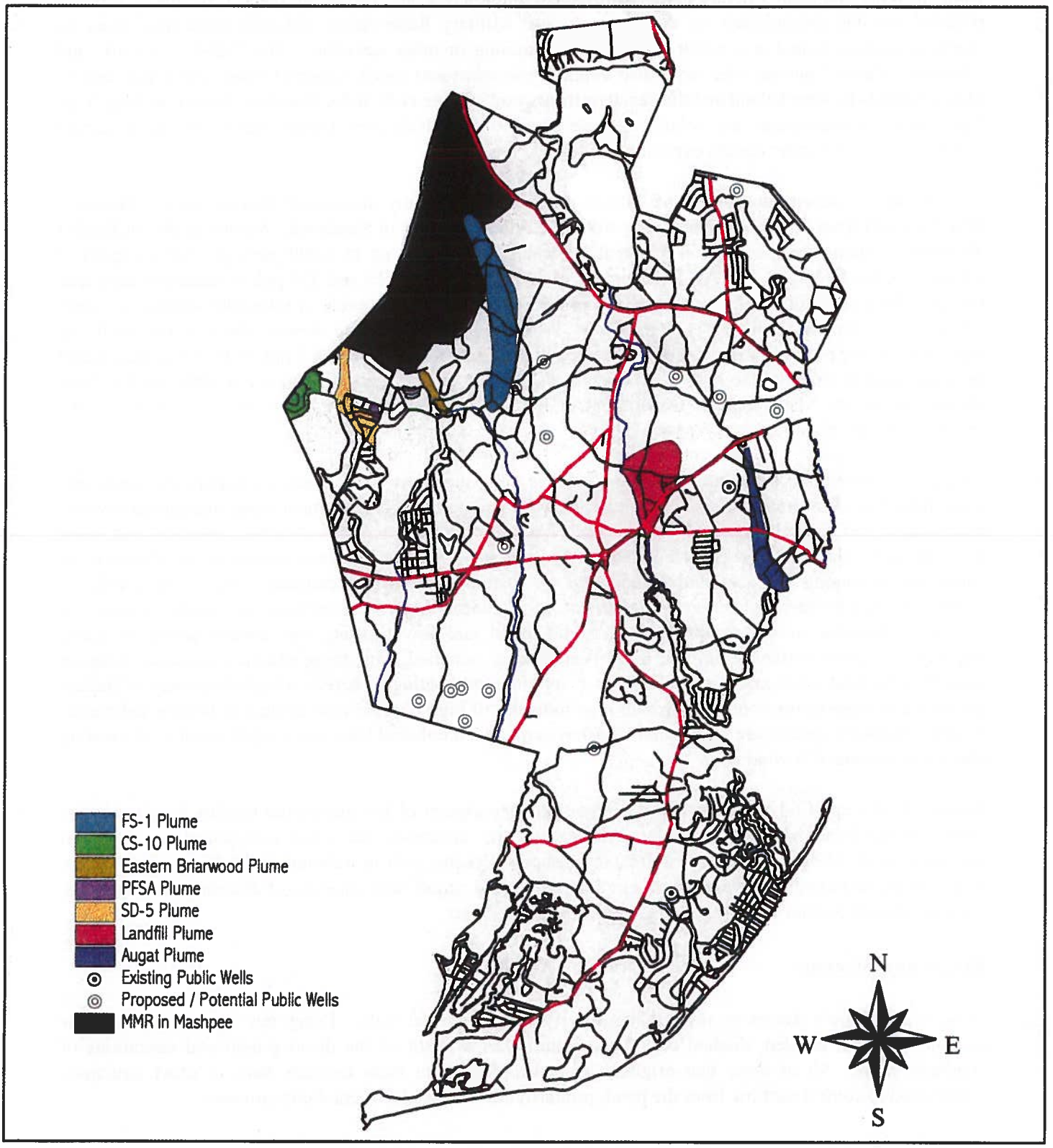
Indeed, of 35 Cape Cod ponds surveyed by the state Department of Environmental Quality Engineering in 1980, Santuit Pond had the highest trophic state score, indicating the worst eutrophication, and total phosphorous of 0.53 mg/l compared to 0.20 in Mashpee-Wakeby, 0.01 in Ashumet and 0.07 in John's Ponds. Major steps, including land acquisition, elimination of road runoff and sewering of adjacent developments, must be taken if Santuit Pond is to be restored as a natural asset.

Rivers and Streams

None of Mashpee's Rivers or streams has survived in its natural state. Every one was at one point or another dammed, ponded, ditched or piped, primarily as a result of the development and operations of cranberry bogs. All of those that originate in ponds flow from them through dams or other structures constructed to control outflow from the pond, primarily for the benefit of cranberry growers.

Groundwater Contaminant Plumes

Map 5-1



Virtually the entire length of the Quashnet River was once turned into what was known as the longest cranberry bog in the world, after having been dammed at Martin Road in Falmouth, had all of its 60+ acres of cedar swamps chopped down and had an artificial connection made to John's Pond. As noted in Chapter 4, the Childs River now flows largely as a man-made ditch servicing still-active cranberry bogs after exiting John's Pond through hundreds of feet of culvert pipe. While Sampson's Mill is long gone from the bank of the Santuit River, its upper reaches service cranberry bogs whose operator has even recently dredged its bottom and filled its banks, while condominiums perch above its mouth. Quaker Run's above-ground flow is almost entirely via active or recently-abandoned cranberry bog ditches through the Willowbend development. The three small streams, Red Brook, Dutchman's Creek and Abigail's Brook were almost totally ditched and diked for cranberry bogs, all of which have now been abandoned.

Only the Mashpee River largely escaped the impact of the cranberry bog mania of the late 19th century, although even it has dams at its head and at Mill Pond (site of Bourne's Mill), and is diked and ditched southward past Great Neck Road North through now-abandoned bogs. Washburn Pond on Great Neck Road North is a flooded abandoned cranberry bog now owned by the State's Division of Fisheries & Wildlife. Many bogs were also built along the lower part of the river, primarily just south of Route 28 and at Canaway's Cove. Those along the river itself were soon abandoned and are now covered in forests but the Canaway's Cove bogs were active up to the late 1960's and may still be impacting the river's water quality. Aside from the sometimes uncontrollable volume of its flow and the steep banks of its middle portion, the preservation of most of the Mashpee River in a semi-natural state can also be attributed to the purchase of most of the land along its banks by John W. Farley and the members of the Mashpee River Trout Club, who protected its banks to maintain its excellent sea-run trout fishery.

Fortunately, except in a few instances, the era of major physical assaults on our rivers ended with the abandonment of most cranberry bog operations and the implementation of the state's Wetlands Act in the 1960s. However, a more insidious threat in the form of declining water quality, evidenced by shellfish closures and other signs, has become an increasing concern.

While it survived the cranberry bog era in the best shape of all our streams, the **Mashpee River** seems to be the most impacted by various natural and man-made factors which contribute to degradation of the quality of its waters, or more particularly, those of its lower, tidal reaches. Since the mid 1980's the river above Orsini Beach (0.5 mile above the river's mouth) has been permanently closed to shellfishing due to excessive levels of fecal coliform bacteria. The area below Orsini Beach out to Gooseberry Island, along with most of Shoestring Bay, has also been frequently closed for the same reason.

Extensive water quality sampling has found that fecal bacteria discharges originated primarily from road runoff during storm events, along with intermittent septic system failures (brief overflows). Particularly high bacterial counts were reported in runoff from the area of the River Bend Motel. Because of the rapid flow of water in the river above Route 28, these bacteria are quickly flushed downstream and the upper part of the river soon returns to low bacterial counts. However, each slug of bacteria washed down the stream then accumulates near the salt / fresh water interface 1.2 miles above the mouth due to normal mixing and dilution processes in the estuary. As a result, the peak concentrations of bacteria in the river are found in that area. Congregations of bird populations, particularly gulls, ducks and Canada geese, can serve as temporary sources of bacteria. However, elevated fecal bacterial counts persist even in the absence of significant bird populations.

The most significant water quality problem in the Mashpee River, which also primarily impacts its lower estuarine portion as well as Popponesset Bay, is an excessive load of nutrients. While elevated levels of both nitrogen and phosphorous were found in the same estuarine portion of the river that had high bacterial counts, largely due to the same accumulation process noted above, nitrogen is the nutrient of most concern

because its levels have the most impact on potential eutrophication in the salt and brackish water of the Mashpee River estuary and Popponesset Bay. Nitrogen levels also affect the levels of salt marsh production.

While additional studies are undergoing to develop a detailed understanding of the existing and potential ecological impacts of nutrients entering the Mashpee River estuary and Popponesset Bay, excessive levels of algae have already been observed in the water column. Decayed organic matter resulting fom the die-off of algae as well as transport of organic materials down the river has also created a thick layer of muck on the river bottom that has degraded fish and shellfish habitat. There is some indication that this muck has provided a hospitable environment for fecal coliform bacteria, extending their normal life span and resulting in increased bacterial counts in the water column when the bottom muck is disturbed by prop wash or other activites on the river.

Man's activities have disturbed the original balance of nutrients, oxygen, water temperature and streambed characteristics which defined our riverine ecosystems. As noted earlier, cranberry bog and mill development drastically changed both streambed and water flow. Waters slowed by dams and dikes become warmer. Warmer water contains less oxygen than colder, fast-flowing water. Trout need high levels of oxygen to survive. Nutrients added to the river both as cranberry bog fertilizer and as detritus from rapidly growing and dying bog vegetation, as well as from septic systems and road drains along the stream, cause excessive aquatic vegetation growth, further slowing and warming the stream, depleting oxygen, attracting unnatural numbers of waterfowl which themselves add more nutrients to the stream in a continuing cycle of stream habitat degradation.

Even more ominous items such as heavy metals and volatile organic compounds are added to our river waters from road runoff, leaking fuel storage tanks, hazardous household wastes dumped carelessly into septic systems, and similar hazardous wastes from both domestic and commercial sources leaching from existing and former landfills (dumps) into the groundwater which feeds our streams.

Recent testing has indicated that there may be unacceptable levels of copper and arsenic entering the Mashpee River just above Route 28 in groundwater leaching from the now-closed Town landfill. Until the landfill is capped, there will be concerns about those and other potential hazardous constituents being leached from the landfill by acidic rainwater. Meanwhile, the Mashpee Board of Health, which manages the landfill, has agreed to conduct an ecological risk assessment study of potential landfill impacts on the river.

The **Santuit River** is a much smaller stream than the Mashpee, but shares some similarities. The upper reaches of the river were dammed and diked for cranberry bog operations that are still active. As with any cranberry bog operation, the use of fertilizers and pesticides leads to concerns about their potential contribution to over-nutrification of the river and its estuary, as well as direct impacts on fish and the food chain on which they depend. In the central portion of the river, bogs were never developed due to the steep banks, so that much of its course is left in its natural state, surrounded by a beautiful beech forest. The main threat to the river here is road runoff from Route 130, Route 28 and, to a lesser degree, Sampson's Mill Road, which flows directly to the river. Every rainstorm dumps petroleum products and other pollutants into the stream. Other potential concerns are nutrients which may be leaching into the stream from horse wastes, particularly a large outdoor manure pile, at Maushop Stables and possible reductions in spring flow as a result of a large well west of the river used to irrigate the Willowbend golf course and its cranberry bogs along Quaker Run. At the river's mouth, the Cotuit Bay Condominiums have not only been built much too close to the marsh, but their septic system wastes may have polluted both the River and Shoestring Bay, which has been seasonally closed to shellfishing due to high levels of coliform bacteria.

Both the **Quashnet** and **Childs Rivers** still host major active cranberry bog operations, both owned by the Town's Conservation Commission but operated by lessees. The Quashnet also has extensive abandoned bogs and also flows through the Quashnet Valley Country Club golf course. As noted previously, cranberry bog operations raise concerns about nutrients from excessive fertilizer use and about pesticide effects on the stream's residents. Similar concerns can arise from golf course operations. Road runoff is also an issue of concern, with both streams crossed by Route 151 and Old Barnstable Road.

Finally, both flow from John's Pond, which is at the downstream end of the SD-5 plume of solvents from the Massachusetts Military Reservation. Additional plumes, known as the Eastern Briarwood plume and the FS-1 plume, flows directly to the upper portion of the Quashnet River. Volatile organics have been found in the Quashnet River and in the skin of cranberries from the Town's bog at John's Pond Park. The berry contamination is at levels that are of concern for consumption by infants, resulting in the loss of the entire crop from the Town Bogs.

Marine Water Bodies

Mashpee's two major estuarine systems, Waquoit Bay and Popponesset Bay, are intrinsically fragile ecosystems. They receive large volumes of nutrients from the streams that flow to them and the marshes along their shores in the form of detritus, algae and various forms of dissolved nitrogen and phosphorous in the water column. Decaying plant and animal matter settles to their bottom, only to be stirred again by the constant mixing caused by tides and currents. Sunlight penetrating their shallow waters, combined with this rich supply of nutrients, allows rapid growth of algae, eelgrass and other plants and one of the most productive ecosystems on earth, serving as a nursery for myriad species of fish and other creatures during critical times in their life cycles.

Over the millenia, Mashpee's bays achieved a balance between nutrient loads, flushing rates and species composition and numbers that supported the native Wampanoag population with a rich harvest of fish and shellfish. In the last three decades, however, this balance has been increasingly disrupted by human activities. Dredging of new channels and waterways, such as at Popponesset Creek, the Bright Coves area of New Seabury and Little River has changed tidal flows within the estuaries, possibly affecting flushing rates. The construction of seawalls, groins and jetties at Popponesset Beach and New Seabury has radically changed the size and shape of Popponesset Spit, causing it to retreat landwards into Popponesset Bay, reducing the size of the latter. Vastly expanded boating activity by larger and higher powered motor boats has stirred bottom sediments, shredded eelgrass beds and scoured the bottom in some areas of previously-existing plant life. Construction of docks to accommodate the boats owned by an increasing population along the shores of both estuaries has damaged marshes and disrupted bottom sediments along the shoreline. Dragging anchor and mooring chains sometimes destroy eelgrass beds and juvenile shellfish. Fuel and other leaks from boats and motors, detergents from boat washing, trash from boat occupants and occasional discharges or leaks from marine heads make their way into our estuarine waters.

Because all of Mashpee is underlain by a very pourous sand and gravel acquifer, our activities on the land often have a direct impact on the groundwater beneath us, which flows inevitably to our rivers, estuaries and the sea. As noted earlier, the two most critical contaminants that are carried to our estuaries are bacteria and nitrogen. Excessive counts of fecal coliform Bacteria have lead to long-term shellfish closures of Shoestring Bay and the Mashpee River above Orsini Beach and seasonal closures of the lower Mashpee River and the area of Popponesset Bay around Gooseberry Island.

The nitrogen problem is more insidious and difficult to deal with. Whereas bacteria have a finite life, can move only a short way in groundwater and likely come from a few fairly well defined sources such as road drains and failing septic systems close to the water, nitrogen in its many forms persists both in groundwater

and the bays until removed from the system either physically by flushing or chemically by conversion to its gaseous state. As a result, it can travel for miles from septic systems and other sources in the watersheds of Waquoit and Popponesset Bays before it reaches the rivers that feed them or the estuaries themselves as springs and seeps on their shores or bottoms. Studies by various scientists, including the Land Margin Ecosystem Research (LMER) project at Waquoit Bay have attempted to determine the sources and quantities of nitrogen flowing to the estuary and its impact on the estuary's ecosystem. One of the primary sources identified is septic system effluent from the thousands of homes and businesses in the bay's watershed. Others are wastewater treatment plants, lawn and agricultural fertilizers, animal wastes and road runoff. Control of those sources is a massive undertaking which will be one of the major local challenges in the coming decades. Another identified source, which will be even more difficult to deal with, is the acid rain and its load of nitrogen oxide brought to us from smokestacks and vehicle exhausts all over the Northeast, the Midwest and beyond.

The resulting excessive nitrogen leads to accelerated growth of microalgae which 1) shade the bottom while alive, reducing available light for photosynthesis by eelgrass, thus leading to its demise, 2) absorb oxygen from the water column when they die and begin to decompose, causing oxygen depletion and occasional resulting fish kills (as has occured in Waquoit Bay), 3) settling to the bottom in a thick layer of organic muck which smothers shellfish beds and eelgrass beds and 4) releasing their nitrogen back into the water column when this muck is stirred up by boating or other activity, feeding further generations of algae. The flushing of water from the bays with each tide can carry away much of this load of algae and nitrogen to feed Nantucket and Vineyard Sounds. However, in both Waquoit and Popponesset Bays, it appears that the current nitrogen load, particularly as evidenced by the accumulation of organic muck, by the virtual elimination of once-extensive eelgrass beds and by occasional fish kills, has exceeded the bays' flushing capacity and upset the critical balance that once made them such outstanding shellfish and fisheries resources.

Finally, while the solvent, fuel and other toxic plumes emanating from the Massachusetts Military Reservation do not extend to the bays and do not yet appear to have affected the streams which flow to them, other plumes have flowed to the waters of the Popponesset bay estuary. As noted earlier, plumes from the now-closed Mashpee landfill and septage lagoons flow to the Mashpee River and may be contributing a number of hazardous materials as well as nitrogen. More recently, an extensive plume of chlorinated volatile organic compounds (primarily trichloroethene and tetrachloroethene) from the now-closed Augat manufacturing plant on Route 28, has been discovered flowing down the valley of Quaker Run and out to Shoestring Bay. Cleanup efforts have been completed at the Augat Plant itself, plans have been developed to pump and treat that portion of the plume north of the Willowbend country club and extensive testing and monitoring has been done on the plume but, unless additional treatment is required by the state's Department of Environmental Protection (DEP), the lower part of the plume may be allowed to flow out to the bay.

Public Water Supplies

To date, there have been no serious instances of contamination in the wells of the Mashpee Water District. All wells except the High Wood #1 well have 400 foot "Zone I" protective radii within which there can be no development. Wading Place Road crosses within the 400 foot radius of the High Wood #1 well and other lands within that radius are privately owned, with private residences and septic systems. As a consequence, that well is used only as a backup well and during peak summer demand periods.

Except for the High Wood #1 well, all of the District's wells have upgradient monitoring wells in place to detect contaminants that may be approaching the well. Those for the T-4 (or "Quaker Run") well are tested on a regular basis under the District's permit due to concerns about potential impacts from the former Town

landfill and septage lagoons and, more recently, from the plume of contaminants discovered downgradient from the former Augat electronics manufacturing facility. The recharge area recently modeled for the well by Earth Tech, Inc. overlaps the plume of contaminants (see Appendix E), indicating the real possibility that chlorinated VOCs could be drawn into the well. A pump-and-treat project has been proposed by Augat to remove and treat the portion of the plume in the area of the T-4 well's recharge area.

The monitoring wells upgradient of the High Wood #2 and #3 wells are not regularly tested but would be available if contaminant spills were ever suspected. As the area upgradient of those wells is ocupied primarily by New Seabury's playfields and by public lands, including land recently purchased by the U.S Fish & Wildlife Service as part of the Mashpee National Wildlife Refuge, their quality appears fairly secure. The only potential threats may come from proposed development of the New Seabury-owned land surrounding the Zone I of those wells (which is owned by the Water District). The developer has agreed that all wastewater from the area will be sewered to a treatment plant whose groundwater discharge will be outside the Zone II of the wells. However, great care will have to be taken in the design and construction of that development to ensure that road, roof and parking lot drainage, fertilizers and pesticides and other potentially hazardous materials are not introduced into groundwater at the site.

While none of the District's current wells are located within 2 1/2 miles of any contaminant plumes discovered to be emanating from the Massachusetts Military Reservation, a number of its future proposed wells, including the Holland Mill, P-1#2, Merganser and P-11 wells are near the affected area or have projected recharge areas that intersect known contaminant plumes (see Map 5-3). Development of those wells may have to await additional definitive information that no other plumes exist and final decisions on treatment methods and schedules for all known plumes in order to ensure that they will not eventually draw from contaminated groundwater.

Water Resource Protection

Existing Regulatory Protections

Local regulatory protection of Mashpee's water resources is currently achieved primarily through three sets of local bylaws / regulations, as well as a variety of regulations enforced by various agencies of the Massachusetts Department of Environmental Protection and, for certain projects, by the Cape Cod Commission.

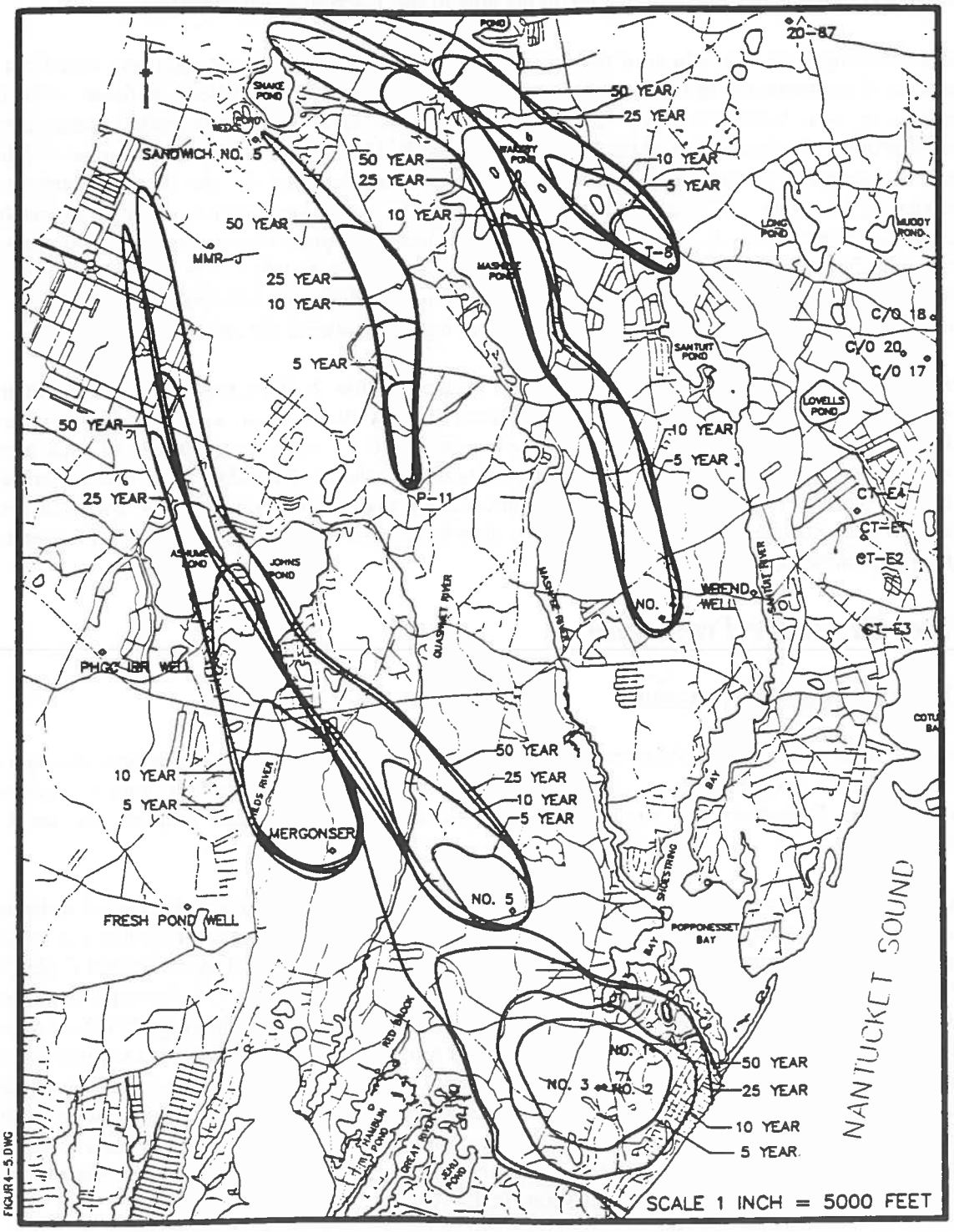
The Board of Health adopts and administers regulations regarding installation and repair of wells and on-site wastewater systems, septage disposal, refuse disposal, and underground fuel storage tanks in addition to its administrative and enforcement responsibilities under Title 5 of the State Environmental Code (310 CMR 15.00). Among the regulations which have been adopted by the Board are a 150 foot separation requirement between any well and septic system (1985), a regulation prohibiting the siphoning of surface or subsurface water into commercial water tank vehicles in order to protect water quality (1993), a requirement that there be a minimum of four feet of naturally occurring pervious soil between the bottom of a leaching facility and the groundwater table, prohibiting mounded systems intended to create such a separation (1990) and a prohibition on new septic systems within 150 feet of any area of active shifting of sands or earth, such as coastal beaches, dunes and banks composed of unconsolidated sediment (1989). The Board's regulations are enforced by its Health Agent and Assistant Health Agent.

The Conservation Commission has adopted and enforces a variety of regulations under the provisions of Chapter 172 of the Code of the Town of Mashpee, and has local responsibility for administration and enforcement of the state's Wetlands Protection Act and the new state Rivers Act. In addition to the usual

Public Well Recharge Areas

EXISTING AND PROPOSED WATER DISTRICT WELLS

Map 5-3

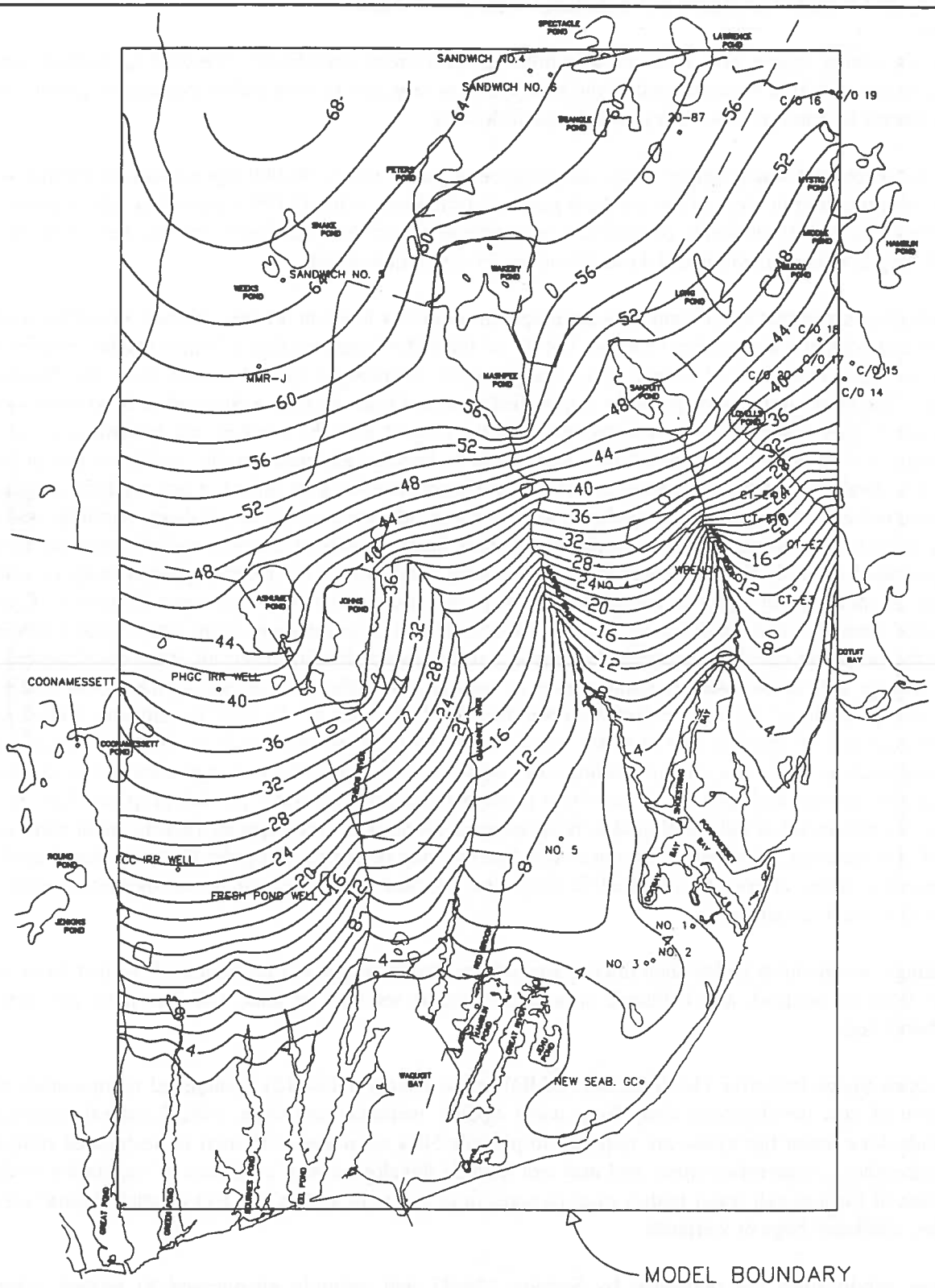


Zone IIs & Groundwater Travel Times for Existing & Future Mashpee Water District Well Sites

Source: Ground Water Model by Earth Tech, Inc. - 1997

Water Table Elevations

Map 5-4



Computer Simulated Steady State Water Table Contours
Source: Ground Water Model by Earth Tech, Inc. - 1997

regulations regarding construction in and physical alteration of wetlands, the Commission has adopted regulations defining and protecting vernal pools and a surrounding 100 foot buffer area and restricting nitrogen loading from new activities within their jurisdictional area. The Commission's regulations are enforced by its Conservation Agent and Assistant Conservation Agent.

The Town's zoning bylaw also contains a number of provisions specifically intended to protect water resources, many of which were adopted in the mid-1980s in response to tremendous population growth and resulting threats to water quality. They include the following:

- In order to protect water supply wells, our ponds and major rivers, 80,000 square foot residential lots have been required in most of the northern portion of the town, with 40,000 square foot lots required in the remainder. Any wetlands or roadway or overhead power line easements twenty feet or more in width may not be counted toward these minimum lot size requirements.

- In order to ensure that significant new development does not have an adverse impact on public wells, ponds and coastal water bodies, Section 174-27 of the bylaw requires that a Water Quality Report be filed for any subdivision of over 5 lots or any project requiring a special permit from the Planning Board. The report must be prepared by a qualified firm and must include a description of a) what wells or water bodies might receive groundwater from the project area, b) whether any hazardous or toxic materials will be produced or stored, how they are to be handled and whether they will have any impact on public health or safety, c) whether or not the development will cause runoff of any roadway drainage or sediment into water bodies or wetlands and if it will adversely affect any fishery, shellfish bed or other wildlife or acquatic vegetative resources, d) how many pounds of nitrogen and phosphorous could be generated annually from all sources, e) the existing condition of the receiving water body or water supply as indicated by specific measurements of physical characteristics and water chemistry, f) any expected change in that condition as a result of the project, g) a comparison of the total nutrient loading from the proposed development with the existing and potential loading from all other development in the recharge area of the receiving water body or well and with the loading rate which would result in total phosphorous of .02 mg/l in freshwater bodies, total nitrogen of .75 mg/l in saltwater bodies and nitrate nitrogen of 5mg/l in public water supply wells, h) what measures will be taken to reduce said nutrient loading where the critical loading rates will be exceeded in the recharge area and i) test well completion reports and logs for at least two permanent monitoring wells per ten proposed lots or 10 acres of commercial or industrial land to be developed, along with water quality reports on an extensive list of contaminants. No project subject to this Section may be approved by the Planning Board until it has made a series of specific required findings and ensured that there will be no significant adverse impact on water resources.

- Buildings or structures (other than docks) are required to be set back a minimum of 50 feet from any water body or wetland, and habitable structures must be set back at least 150 feet from any active cranberry bogs.

- The Open Space Incentive Development (OSID) bylaw (Section 174-46) is intended to encourage the location of new development away from water bodies, wetlands and other critical natural resources. Projects done under the bylaw are required to provide 50% open space, located in designated primary and secondary conservation areas and may not include development or clearance of vegetation within 300 feet of fresh or salt water bodies over 10 acres or of rivers or within 100 feet of other natural water bodies, cranberry bogs or wetlands.

- Cluster subdivisions are permitted by Section 174-47 and strongly encouraged to protect natural resources.

- Article XII of the bylaw establishes the Mashpee River and Quashnet River Protective Districts, extending 100 feet from the "natural bank" of the Mashpee north of the Pirates Cove subdivision and of the Quashnet south of Route 151, within which all structures, except docks, and all dredging, dumping or filling (except as subject to the requirements of MGL Chapter 131) are prohibited.

- Article XIII (which was based on a model bylaw published by the Massacusetts Department of Environmental Protection) establishes Groundwater Protection Districts whose boundaries are based on approved or estimated "Zone II" recharge areas of existing and proposed public water supply wells. Applicable regulations within the Districts prohibit a) most storage of liquid petroleum products, b) storage of liquid hazardous materials except as specified in the bylaw, c) facilities that generate, treat, store or dispose of all but very small quantities of hazardous waste, d) the disposal of sludge, septage, soil conditioners, solid wastes, brush or stumps or the storage of sludge or septage unless done in compliance with the applicable state regulations, e) wastewater treatment works with flows over 10,000 gallons per day, f) outdoor storage of road salt, other de-icing chemicals, fertilizers, herbicides, pesticides and manure, g) industrial uses that discharge process wastewater on site, h) animal feedlots, dry-cleaning establishments or junk and salvage yards, i) any use or establishment which qualifies as a small quantity generator or large quantity generator of hazardous wastes as defined by state regulations, j) the rendering impervious of more than fifteen percent of any lot unless a system of artificial recharge is provided that will not result in the degradation of groundwater quality, k) excavations to within four feet of the historical high groundwater level unless redeposited within 45 days to at least four feet above that level and l) individual sewage disposal systems designed to receive more than 440 gallons of wastewater per day per acre of land under one ownership.

- Article XIV prohibits new structures and most clear-cutting of vegetation within the boundaries of the Waquoit Bay Area of Critical Environmental Concern (ACEC) and a buffer area 25 feet landward of its boundaries, with some exceptions to avoid creating unbuildable lots.

These zoning bylaws are administered by the Planning Board, Zoning Board of Appeals and Building Inspector through their permitting processes and enforced by the Building Inspector and Assistant Building Inspector.

Existing Non-Regulatory Protections

Non-regulatory protections currently in place to protect groundwater and surface water bodies consist primarily of advanced wastewater treatment facilities at a number of larger developments and extensive lands which have been purchased and protected from development.

Large advanced denitrifying wastewater treatment facilities are currently in operation at Willowbend Mashpee Commons Stratford Ponds condominium and at the Mashpee High. Smaller advanced systems have been installed at the 99 and Cooke's Seafood restaurants. Additional large advanced treatment facilities are permitted or planned at the Southport retirement community, the Windchime Point condominium and a proposed retail center at the site of Dick & Ellie's flea market.

Of the 13,863 acres of Mashpee that are not open water bodies or part of Otis Air National Guard Base (1160 acres in Mashpee), 5261 (or 38%) are protected in one way or another from development. Of those acres, 2965 are conservation lands owned by the Town, state or federal government, 105 are other undevelopable public lands, 114 are private lands subject to avigation easements at the end of the Otis runways which severely restrict their use, 455 are owned by land trusts or are subject to conservation restrictions 958 are privately-owned condominium or cluster subdivision open space protected by zoning,

141 are other homeowners association lands, 210 comprise the New Seabury golf courses and another 312 are privately owned land which are undevelopable for a variety of reasons. All of these lands offer protection to our groundwater and / or surface water resources.

Additional Protection Needs and Priorities

Priorities for water resource protection are spelled out in the water resources objectives listed in Chapter 3. A number of those objectives are currently being addressed to various extents through the regulations noted above and through the activities of the Planning Board, Water District and other local, regional and state agencies. Some are not being adequately addressed and require additional efforts on the part of those agencies and Mashpee residents.

The most prominent unadressed protection needs relate to excessive nitrogen loading to our estuaries and its impact on shellfish resources, the overall ecological health of the estuaries and public enjoyment of their waters. Other than "large lot" zoning belatedly adopted in most of the Town and the limited impact of conditions applied to special permits for cluster subdivisions by the Planning Board on the basis of required Water Quality Reports, no significant regulatory or infrastructure activities have been undertaken. The greatest challenge the Town will face in the next few decades will be finding an acceptable cost-effective way to reduce current nitrogen loading to the watersheds of the Mashpee River, Shoestring Bay and Waquoit Bay. It is clear that a combination of activities will be required to address this problem, including 1) development of public wastewater collection and treatment facilities in densely-developed areas, 2) relocation of treated effluent outside critical recharge areas, 3) use of denitrifying on-site and / or clustered wastewater systems in less-dense areas, 4) adoption of stricter zoning and other regulations, 5) acquisition of additional conservation lands in critical watersheds such as that of the Mashpee River, 6) possible dredging to increase tidal flushing in constrained portions of the estuaries, 7) reduction of stormwater inputs of nutrients, 8) maintenance and protection of wetlands along streams feeding the estuary, 9) possible management of vegetation along rivers and old ditches and springs that feed them to reduce natural sources of detritus and 10) public education regarding lawns, fertilizers, wastewater treatment options, costs and other aspects of the nutrient problem and solutions. Finding the funding which will be required to implement most of these activities will be our most difficult task. Identifying the level of nitrogen removal necessary to ensure the health of each sub-embayment of the Waquoit and Popponesset estuaries will also be critical.

Shellfish resources, or at least our ability to harvest them safely, have also been impacted by bacterial contamination of some of our waterways, most prominently the Mashpee River and Shoestring Bay. The sources of these contaminants were fairly well researched and identified by K-V Associates in studies prepared for the Town in the late 1980s. However, implementation of the studies' recommendations has been slow in coming. Using grant funding, the Town has been able to construct catch basins to divert runoff from Meetinghouse Road that had formerly flowed directly to the Mashpee River. A similar project is proposed for runoff from Route 130 (Main Street) and Great Neck Road North. Along with a reconstruction of the Route 28 drainage system completed by the Massachusetts Highway Department, these projects will remove the majority of direct road runoff to that river. No similar work has been done on the Santuit River and other sources of runoff to Shoestring Bay or on our other streams. The Town may need to consider an accelerated program of direct runoff removal, including the use of vegetated swales and other "best management practices" to remove not only bacteria, but nitrogen and phosphorous sources to our streams and ponds, using Town funds if necessary rather than waiting for outside funding sources to cover the costs.

Phosphorous loading in the recharge areas of our fresh water bodies must be managed or, as necessary, reduced to ensure that it does not exceed a level which could damage the health or integrity of their ecosystems. Because phosphorous binds to soil particles, it can not travel significant distances once it

reaches groundwater from septic systems or other sources. Based on studies done in soil conditions similar to our own, three hundred feet has been established as the greatest distance within which phosphorous loading to groundwater (except for extremely large point sources over many years, such as a sewage treatment plant) should be of any concern regarding nearby water bodies. Phosphorous can, however, flow directly to such water bodies in stormwater runoff and in water flowing from fertilized cranberry bogs. As a result, solutions to phosphorous loading problems can be much more localized to areas around ponds and streams, and much less costly, than solutions to our nitrogen problem. Because of its shallow depth and heavily developed northern and western shoreline, Santuit Pond is apparently impacted by excess phosphorous which has accelerated its eutrophication. A thorough scientific study of phosphorous loading, eutrophic state and potential solutions is required for that pond. In addition, a preliminary survey of other ponds in the town, particularly some of the small shallow ones, should be undertaken to determine their current trophic state and identify any phosphorous overloading or other problem areas. Based on the results of such studies, remediation programs will then have to be developed, funded and implemented.

Protection of our sources of public water supply remains a top priority for the Town and for Mashpee residents. For new development, the Water Quality Report and Groundwater Protection District zoning bylaws have been fairly effective, but could use some improvements, primarily with regard to stormwater management practices, encouragement of denitrifying wastewater treatment alternatives to individual "Title 5" septic systems and in follow-up and enforcement of project approval conditions and monitoring programs. For other undeveloped lands within identified "Zone II" recharge areas of existing and proposed wells, land acquisitions should be continued where necessary to maintain nitrate nitrogen in the wells below 5 milligrams per litre (mg/l) or to avoid other contaminant threats. Current zoning should also be reviewed within mapped "Zone II" areas to determine if minimum lot size increases or other changes are advisable to maintain nitrates under 5 mg/l or avoid other potential negative impacts on the Town's water supply. For existing developed areas, public education programs need to be strengthened regarding use, storage and disposal of fertilizers, pesticides, petroleum products and other hazardous materials, landscaping options to reduce fertilizer and pesticide needs and options for alternative wastewater treatment systems. In critically loaded recharge areas, regulations requiring denitrifying wastewater systems for existing homes and businesses may need to be considered, as may development of public wastewater collection and treatment systems.

The Town must ensure that water withdrawals are managed in a way to minimize or prevent any adverse effects on surface water resources, wetlands, existing wells or the safe yield of the aquifer. Toward that end, improved coordination is required between the Water District and Town and state agencies regarding the selection and development of new public well sites in order to 1) avoid Water District conflicts with municipal plans, 2) minimize conflicts with existing and proposed land uses which may have an impact on water quality and 3) avoid degradation of other natural resources such as wetlands and rare species habitat. The conflicts which have occurred regarding the location of the proposed "Holland Mill" well in an area of great environmental concern and the approval of high density development around the District's #2 and 3 ("Rock Landing Road") wells illustrate both the problems which can occur and potential opportunities for compromise and cooperation.

There is an ongoing need to ensure that the cleanup of all existing and future groundwater or surface water contamination sites in Mashpee is expedited. These include the multiple contaminant plumes emanating from the Massachusetts Military Reservation, the solvent plume associated with the Augat site and the nutrient and toxic plumes originating from the Town landfill and septage lagoons.

Finally, in order identify problem areas, analyze potential causes and solutions and to assess the effectiveness of cleanup measures, the Town needs to ensure that adequate and current data is available regarding the condition of Mashpee's groundwater, wetlands and surface water resources.

Inter-Town Management Needs

Inter-town management needs relate primarily to 1) protection of other towns' public water supply wells and 2) reduction of nitrogen and bacterial loads to shared estuaries, ponds and streams.

Under the Town's Groundwater Protection District zoning bylaw, the mapped "Zone II" recharge areas of both Falmouth's and the Cotuit Fire District's existing and proposed wells have been protected within Mashpee on the same basis as Mashpee Water District wells. Meanwhile, the Zone II recharge area of the Mashpee Water District's proposed T-8 well (along with those of a number of Cotuit and Centerville-Osterville-Marstons Mills Water District wells) extends into the Town of Sandwich. Zoning and other appropriate regulatory and planning protection of that well by the Town of Sandwich is critical to its viability as a water supply.

The Waquoit Bay estuarine system is shared by Mashpee and Falmouth, as are the Quashnet / Moonakiss and Childs Rivers and Ashumet Pond. The Popponesset Bay estuary is shared by Mashpee and Barnstable, along with the Santuit River and Shoestring Bay. At the head of the recharge areas of both estuarine systems sits the Town of Sandwich. Coordination efforts to date between the Towns have been limited and will have to be greatly increased.

Mashpee's Watershed Management Committee, which does not allow voting members from outside of Mashpee, can serve as the springboard for a more formal working arrangement which will be needed with the Towns of Barnstable and Sandwich regarding future management of Popponesset Bay and its watershed. Because, as has been demonstrated by the LMER study, Waquoit Bay suffers from the same over-nutrification problem seen in Popponesset Bay, a similar formal working arrangement will be required with the Towns of Falmouth and Sandwich regarding management of that estuary and its recharge area. Both regulatory and infrastructural measures are likely to be required in both recharge areas, with willing participation required from all four towns in adopting and enforcing required regulations and fairly sharing the costs of required infrastructure. Such cooperation must be achieved in order to ensure that effective measures will be taken to reverse the decline of our bays.

Water Facilities

Existing System

The Mashpee Water District was established in 1987 through an act of the state legislature which made it the exclusive municipal water supplier within the boundaries of Mashpee. At the time, water lines had been built in the Tri-Town Circle / Horseshoe Bend Way and Briarwood areas by the Town of Mashpee, with water purchased from the Town of Falmouth, which also handled billing on a contract basis. The U.S. Government had agreed to fund the cost of most of that distribution system, which had been necessitated by plumes of groundwater contamination found in those neighborhoods and apparently originating on the Massachusetts Military Reservation.

A second contaminant plume had been discovered in the Ashers Path area, apparently originating on the Town's landfill property. The state had cited the Town with responsibility for the contamination and required the Town to fund water lines for the Sachem's Village subdivision on Ashers Path and the Summerwood Condominium on Route 28. Water was initially supplied through a contract between the Town and the private High Wood Water Company. Later, the "T-4" well was developed on Town land adjacent to Willowbend to serve as the supply source for both that development and the Town's water lines

in the area. With the creation of the Water District in 1987, the Town-owned water lines and the "T-4" well site were transferred to the District.

The High Wood Water Company had been incorporated in the early 1960s by the owners of the New Seabury development to provide water to that area. Its charter was subsequently expanded to extend water service to Mashpee Commons and to the Southport planned retirement community on Route 151. On July 1,1991, the Mashpee Water District purchased the High Wood Company, becoming the only public water supplier in the town. The purchase increased the District's customer base six-fold, to 2650 services as of December 31, 1991.

Since that time, the District has rapidly expanded its system (see Map 4-1) and doubled its services to 5220 as of July, 1997. Those services supply 5202 residences, of the 8074 estimated total as of that month, or 64.4 % of the town. Most businesses, except for those in the Route 130 area west of Great Neck Road and other isolated properties, are also connected to the Water District's system.

The District's system is currently supplied by four wells, three of which were inherited with the purchase of the High Wood Water Company. The oldest is High Wood #1 on Wading Place Road, built in 1961. It has a 125 gallons per minute (gpm) vertical turbine pump, for a maximum potential capacity of 180,000 gallons, or a safe yield of roughly 144,000 gallons. However, only 40,000 gallons per day are allowed by the Department of Environmental Protection's Division of Water Supply. The well does not have a completely protected 400 foot "Zone I" radius and has had elevated concentrations of iron and manganese. Because of these problems and its limited capacity, it is used only occasionally as a backup supply during periods of peak demand.

High Wood #2, located Between Rock Landing and Great Oak Roads, was built in 1966. It has a 700 gpm variable speed turbine pump which operates to maintain a constant pressure in the distribution system. Maximum daily capacity is 1,008,000 gallons, with maximum safe yield of approximately 806,400 gallons. The District owns a full 400 foot "Zone I" protective radius around this well. There are no current water quality problems.

The High Wood #3 well was built in 1984 adjacent to #2. It also has a 700 gpm capacity using a variable speed submersible pump, and its 400 foot "Zone I" radius is owned by the Water District. It has no current water quality problems.

The "T-4" well, now referred to as the "Quaker Run Pumping Station", was placed into operation in July, 1990. It has a 350 gpm variable speed pump and its 400 foot "Zone I" protective radius is located primarily on Town land, to which the District was granted an easement, with a small portion on land purchased from private parties by the District.

Supplementing these wells for the purpose of meeting peak hour demand and fire protection needs are two storage facilities. In 1990, High Wood Water Company constructed a 1.5 million gallon concrete reservoir at the site of its #2 and #3 wells, along with a booster pumping station having two 700 gpm centrifugal pumps to move the stored water from the on-grade tank into the distribution system. In addition, a three million gallon above-ground steel storage tank, located on Back Road adjacent to the Massachusetts Military Reservation, was brought on line by the Water District in January, 1995. A connection to the Military Reservation's water system was also established, as part of an agreement by which the military funded a number of water system projects in areas subject to contamination from MMR and the District agreed to provide up to 300,000 gallons of water per day to MMR if requested.

The portion of the town north of Wakeby Pond, along Pimlico Pond Road, is serviced by the Sandwich Water District, under contract with the Mashpee District. In 1997, there were 80 residences connected in that area, using 12,880 gallons on an average day.

The Tri-Town Circle / Horseshoe Bend Way / Lakeview area west of Ashumet Pond was the first neighborhood provided with water lines by the Town because of the MMR contamination plumes. Water supply was provided by the Town of Falmouth Water Department under contract with the Town. Those water lines remain separated from the rest of the Mashpee Water District's system and water is provided by Falmouth through an exchange of water with the Water District, which bills the customers in that area.

Projected Needs

The Water District's Operations Manager has prepared a capacity analysis identifying projected future demand and necessary water supply. Done in April, 1997 it projected maximum day demand of 1,717,260 gallons in 1997, 2,331,820 in 2000, 2,478,386 in 2005, 2,746,731 in 2010 and 2,943,534 in 2015. However, demand on a Friday in July, 1997 hit 2.7 million gallons.

Based on that 2.7 million gallon day vs. known current residential units being served, as well as the average maximum day demand per service for the years 1980 to 1995, and the Planning Department's projections of housing units in 2004 and at buildout of the town, additional projections of potential water demand were prepared. The 2.7 million gallon day translates to 519 gallons per day (gpd) per residence. Using that figure, projected worst case maximum water demand would range from 4,881,000 to 5,161,000 gpd in 2004 *if all residences were connected to the system (this includes those currently serviced by Sandwich and Falmouth)*. Using the 1980-95 average maximum day use of 540 gpd, the 2004 figure would range from 5,079,000 to 5,369,000 gpd. At buildout of the town under current zoning and approved projects, the two usage figures translate to 6,903,000 or 7,182,000 gpd, assuming all residences in the town are connected to the system. Based on the proposals contained in this Comprehensive Plan, an adjusted buildout level of development would result in worst case maximum day usage of 6,596,000 to 6,863,000 gallons.

In order to ensure an adequate water supply at all times, maximum well capacity required to be on line at those points in time would be greater. Because wells can not be pumped constantly at full capacity, a figure of 80% of rated well capacity is more appropriate to protect the wells. In addition, the District needs to maintain a "redundancy factor" in its well capacity to compensate for the potential loss of one of its wells. As the District's largest wells have a capacity of about one million gallons per day, that is the factor used here and in the Operations Manager's projections. Finally, based on the previously noted agreements with the Massachusetts Military Reservation related to their funding of a large portion of the District's infrastructure in areas affected by MMR contamination plumes, the District is committed to providing MMR with up to 300,000 gallons of water per day if needed.

As a result, worst case maximum 2004 well capacity required, *assuming all residences are connected to the District system by then*, would range from a low estimate of 4.881/.8 + 1.3 = 7.40 million gpd to a high of 5.369/.8 + 1.3 = 8.01 million gpd. If not all residences are connected, actual needs would obviously be lower. Normal usage, even during the summer, would typically be significantly lower than this worst case projection. At buildout, worst case maximum required capacity would range from a low estimate (per land use as proposed in the Comprehensive Plan) of 6.596/.8 + 1.3 = 9.55 million gpd to a high estimate (under current zoning) of 7.182/.8 + 1.3 = 10.28 million gpd, again *assuming that everyone in the town is connected to the District system.*

The District's projections assume that their proposed Holland Mill and Merganser wells will be brought on line by 2005, resulting in a total available supply of 4,751,200 gpd. This is significantly lower than the

projections for 2004 worst case maximum well capacity needs noted above. However, the District's projections assume 7362 service connections by that time vs. the total number of 9405-9943 town residences projected in 2004 by the Planning Department. The actual number will depend on how quickly the District's system is extended to additional neighborhoods in the town and how rapidly residences along those extensions actually connect to the water lines. (In addition, it should be kept in mind that these projections are done on the basis of the rate of growth in the number of residences, assuming that non-residential water services will roughly maintain their current ratio to residential services.)

Potential Water Supplies

In addition to the Holland Mill and Merganser wells, the District projects development of the 1 million gpd "T-8" well, located on Town land at the north end of Santuit Pond, by 2010, for total available supply at that time of 5,751,200 gpd. By 2015, the "P-11" well, located on Bearses Road between John's Pond Park and the Steeplechase subdivision, had been projected to add 500,000 gpd for a total available supply of 6,251,200 gpd. That would leave the district two million gallons short of the worst case maximum need projected above for buildout as proposed in this Comprehensive Plan and four million gallons short of the worst case maximum projected under current zoning.

However, in late 1997 it was determined that there is a plume of EDB, an aviation fuel additive, which extends between the western side of the Massachusetts Military Reservation just north of Ashumet Road, and the Town's cranberry bogs in John's Pond Park (see Map 5-1). That plume appears to pass within a few hundred feet of the P-11 well site and is almost coterminous with the well's recharge area as mapped by Earth Tech, Inc. (see Map 5-3). As a result, it is now unlikely that the P-11 well can be developed on the schedule that the Water District had projected, if ever.

In order to make up projected water supply shortfalls, and to provide for replacement of the inadequately-protected High Wood #1 well and any wells which might become contaminated or be reduced in capacity over the years by siltation, additional well sites must be identified and protected. A number of such sites have been identified over the years. When the Town conducted its original well exploration program in 1986, fourteen sites were investigated. In addition to T-4, T-8 and P-11, the "T-5" site on Town conservation land east of Noisy Hole Road and four wells in the "P-1" area were recommended favorably (see Map 4-4). The "P-1" area was expected to eventually supply as much as 5 million gallons per day (5 mgd). The T-5 well had a potential to supply in excess of one million gallons per day based on preliminary pump tests. It is located on Town conservation land east of Noisy Hole Road, adjacent to an existing 12 inch Water District main.

Of the four wells in the P-1 area recommended favorably, two are on the Merganser property recently purchased by the Water District. Both had the potential for 1 mgd. In the locations at which the test wells were done, two such large wells might compete for the same water and reduce total capacity. However, as the site is more than 60 acres in area, an alternate location on the property might be found which could produce an additional million gallons. The Water District has begun development of one well on the property, which they now refer to as their "Turner Road" well for the dirt road on which it is located.

The P-1 #5 well was located on private land west of the Merganser property. Initial pump tests indicated fair potential, but with excessive fine sand. As the property is still undeveloped and is a high priority site for protection as part of the Mashpee National Wildlife Refuge, additional exploration might be considered on this 70+ acre parcel to determine if a site can be found which does not have this siltation problem.

The P-1 #2 well, with a potential of at least 1000 gpm (1,440,000 gpd), is the best well site ever found in Mashpee. However, the state's Division of Fisheries & Wildlife has prevented development of that site

because of concerns regarding potential impact on spring flow to the Quashnet River or on its trout fishery. While development at this time has been frustrated, the site must be kept in mind and protected for future use due to its outstanding potential.

In addition to those sites, a number of other possibilities remain. The Water District is currently considering acquisition of an existing well site that formerly serviced the TCB Mashpee Village housing project. While the existing well itself is not usable, the site may have a potential for up to 1000-1100 gpm based on existing information. Development of a 1 mgd well may be possible with acquisition and removal of some existing structures within the required 400 foot "Zone I" protective radius. However, more work must be done to determine if this well could be successfully developed and if it might be eventually impacted by MMR contaminant plumes.

Another proven well site was developed for the proposed "Meetinghouse Village / Cranberry Hollow" condominium between Meetinghouse and Noisy Hole Roads. The project was never built, but an 8-inch well was installed in 1987 and a prolonged pumping test was conducted at a pumping rate of 326 gallons per minute (469,440 gpd). Water quality met public water supply standards and the state's Department of Environmental Quality Engineering (now DEP) approved the installation of two 8-inch wells to serve the 144 unit project in July, 1987. As the probable recharge area of this well site is relatively undeveloped and it is located adjacent to the 12 inch water main in Noisy Hole Road, it would appear to be an appropriate site for consideration as a source of public water supply, with probable potential for at least 500,000 gpd.

A number of other sites appear to have some potential for development of public water supply wells. When the "P-11" area was originally tested by the Town, there were two fairly promising test wells, with one in the vicinity of the current "P-11" well noted above, and a second farther to the east, north of the Steeplechase subdivision. There is a significant amount of undeveloped land in that area which could warrant further exploration once the complete extent of contamination from the Massachusetts Military Reservation is determined and if the area is found not to be impacted.

Just to the south of the Steeplechase subdivision, the 160+ acre "Belcher" or "Mingo" property was one of the first considered for well exploration by the Town. At the time, it was Town-owned and had been designated a conservation area by Town Meeting in 1976. However, a suit was brought against the Town in 1983 by the heirs of Walter Belcher, who claimed that there was a defect in the tax taking by which the Town acquired title from him in the 1940s. On the advice of Town Counsel, all plans for well development were put on hold. The Town lost the case and the property in 1995. As the property lies within the boundaries of the Mashpee National Wildlife Refuge and constitutes a large portion of its northern section, it may be appropriate to purchase the entire parcel for public conservation and well purposes, as is recommended by the Open Space, Recreation and Agriculture section of this Plan.

Finally, should the "P-1 #2" well never become available for development, or if demand requires, a 19 acre Town-owned conservation parcel (Assessors Map 92, Block 4) adjacent to the Merganser property and "P-1 #2" may be worth exploring for potential well use.

In addition to pursuing new well sites within the Town of Mashpee, the District, along with four other upper Cape public water suppliers, have had discussions with representatives of the Massachusetts Military Reservation on location of public water supply wells on the Reservation to compensate for groundwater resources lost to MMR contamination. An initial five million gallons of supply are being sought. Should these discussions bear fruit, Mashpee may be able to acquire at least 1 mgd of additional water supplies.

Development of a new groundwater supply costs $500-600,000 and typically requires three to five years to implement to allow for responsible planning, allocation of funding, engineering, environmental assessments

and regulatory review. Therefore, it will be critical to begin the process of developing new well sites as far in advance of projected need as possible. In addition, based on the experiences gained from the P-1 #2 and Holland Mill well development and approval processes, it may be advisable to maintain a number of alternative sites ready for construction to avoid unforeseen water supply "emergencies".

Distribution and Storage Facilities

In addition to development of new wells, the Water District will continue to expand its distribution system and is likely to require at least one additional storage tank.

While plans were developed in 1987 and 1992 by the firm of SEA Consultants, Inc. for an orderly expansion of the town's water distribution network based on water quality problems, projected future population and water demands, the expansion of the Mashpee Water District's network has been driven largely by resident petitions for service. The resulting network, because of that factor, the acquisition of the High Wood Water Company and the widely separated location of the original water lines developed by the Town due to contamination problems, contains a variety of gaps and dead ends. While petitions are likely to continue to be an important factor in system extensions (assuming adequate supply can be established), the District also needs to take proactive measures to connect existing dead ends into loops to improve system hydraulics and avoid potential service disruptions. Depending on water main size, project size and construction conditions, new mains currently cost between $60 and $90 per foot.

A connection to the Sandwich water system, in addition to those already in existence with Falmouth and Cotuit, should also be considered once the two towns' distribution networks grow closer, and particularly if water becomes available from the Massachusetts Military Reservation, in order to provide mutual backup supplies.

As noted earlier, the District now has two storage facilities, a 1.5 million gallon ground-level storage reservoir and booster pump station on Rock Landing Road and a 3 million gallon steel tank on Back Road. These statistically meet buildout system needs for meeting peak hourly demand (assumed to be 35% of peak daily demand) and for fire protection (630,000 gallons needed for a three hour fire flow of 3500 gpm to achieve the Insurance Services Office's highest Public Protection Classification). However, the full capacity of the Back Road tank is not completely usable, as water pressure in the Briarwood area is reduced noticeably when only one million gallons is withdrawn. The 1992 SEA report recommended one additional storage tank, a one million gallon elevated tank to be located at the "T-8" well site at the north end of Santuit Pond. Current cost of such a structure would be approximately $1 million. The report recommended construction between 2005 and 2010, a schedule that is endorsed by the Water District's Operations Manager.

Wastewater Facilities

Background / Previous Work

The Waquoit and Popponesset Bay estuaries are currently suffering from the ecological impacts of excessive levels of nitrogen. The chief sources of that nitrogen within the groundwater recharge areas of the estuaries are wastewater generated by residential and non-residential development (50-75%), lawn fertilizers, direct atmospheric deposition (acid rain), runoff from paved areas and roofs and leachate from landfills and septage lagoons.

Current conditions, under which almost all development is served by individual "Title 5" septic systems or older cesspools which have little nitrogen-removal capability, must be changed if progress is to be achieved in reducing the levels of nitrogen entering our bays. In order to facilitate an improved approach to wastewater treatment, Town Meeting voted on July 27, 1987 to establish a public wastewater collection and treatment system in accordance with Massachusetts General Laws (MGL) Chapter 83, Sections 1, 2, 3, 3A, 5, 6 and 14 through 24 and to establish an elected board of Sewer Commissioners pursuant to MGL Chapter 41, Section 63.

During the late 1980's, the Sewer Commission developed plans for four wastewater collection systems based on a sharing of costs by proposed commercial and condominium developments that would have resulted in at least a dozen private treatment plants. The East Mashpee system, which involved the developers of Willowbend, Stratford Ponds and two since-abandoned condominium projects called Dolphin Bay and Cranberry Hollow, came closest to fruition, with approval both by Town Meeting and MEPA, before the recession of the early 90's stopped the condo projects and killed the sewer system. A second system involved nine landowners in the rotary area, including Mashpee Commons, Windchime Point, Talanian Realty (proposed Tradewind Plaza shopping center and the flea market), Rothschild Family Trust, Rogers & Marney industrial park, Quashnet Woods, the Mashpee Industrial Park and South Cape Resorts. A consultant engaged by the landowners at a cost of $45,000 determined the best site for the plant, which was vacant land between the Industrial Park and Great Hay Road, but the economic downturn stopped many of the projects and the wastewater system plan. Discussions were also begun with landowners regarding systems focused on the Southport wastewater treatment facility (with the Johns Pond area, Quashnet Valley Country Club and TCB Mashpee Village proposed to be added) and New Seabury, which had proposed three separate wastewater treatment plants. Economic problems also stopped those projects.

In 1990, the Sewer Commission engaged the firm of Dames & Moore to look at alternatives for providing wastewater treatment to Monomoscoy and Seconsett Islands. Two options were considered: connection to the treatment plant then proposed for the Bufflehead Bay development by New Seabury and connection to an on-island recirculating sand filter treatment plant. In both cases, a low pressure septic tank effluent pumping (STEP) system was proposed for wastewater collection (see Figure 8-1). The project was sized to handle 75,000 gallons per day, the projected ultimate buildout flow for the islands. Cost of the first alternative, excluding the Bufflehead treatment plant, was projected to be $3,425,000. Cost of the second alternative, including the treatment facility and acquisition of 3.1 acres for the facility, was $4,691,000.

Potential Options

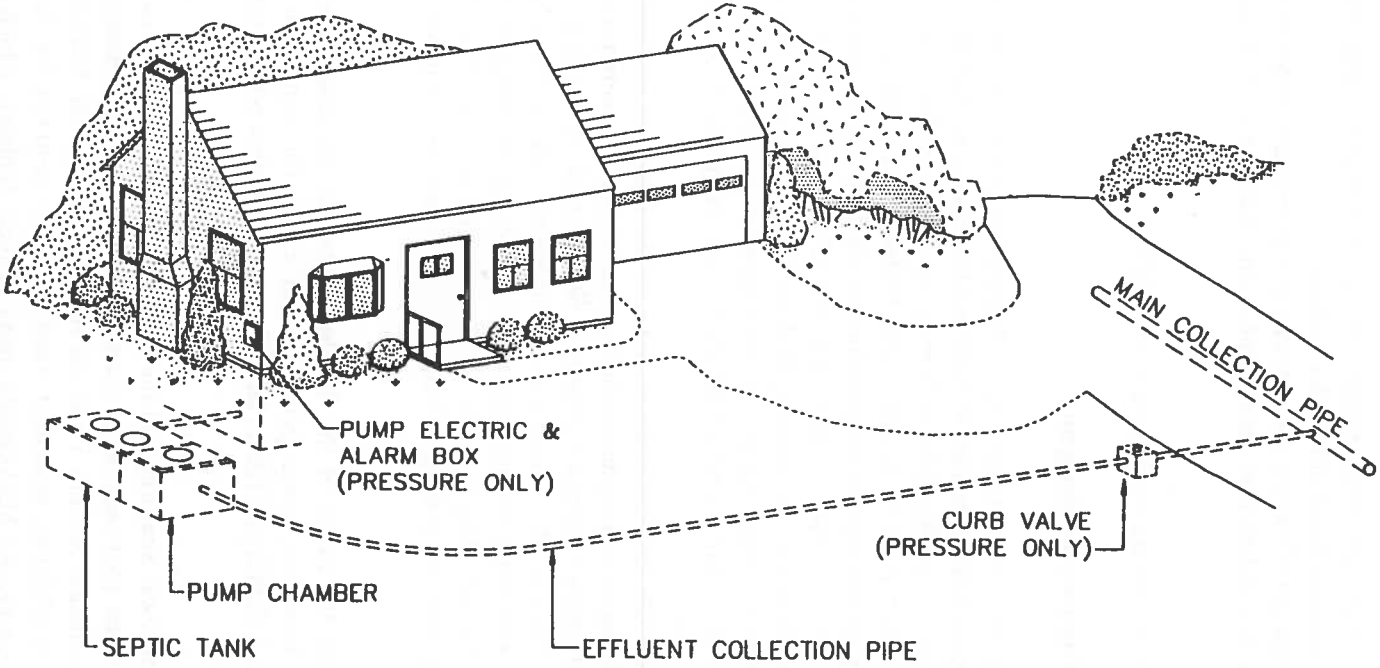
The Mashpee Sewer Commission has been considering a variety of alternatives for significantly reducing the nitrogen contribution to our estuaries from residential and non-residential wastewater. Those alternatives range from traditional gravity sewers and public wastewater treatment plants, to removal of treatment plant effluent from critical recharge areas, to low-pressure grey water collection systems (STEP systems) feeding neighborhood treatment plants, to denitrifying septic systems shared by clusters of homes to individual denitrifying or composting systems. Each option has its advantages and drawbacks under different circumstances, and none is the perfect solution in all cases. Initial conclusions are that two potential options are unacceptable:

1) Relying solely on current Title 5 septic systems and older existing cesspools will most likely have serious negative consequences for the ecological health of both estuaries, as illustrated by projections done by the Cape Cod Commission for Popponesset Bay and the visible problems already occurring in both bays.

2) The cost of a single Town-wide traditional sewer system and single public treatment plant, which was reviewed as an option by the firm of Weston & Sampson in their 1988 Draft (wastewater) Facility Plan for

Septic Tank Effluent Pump (STEP) System

Figure 8-1



TITLE	TYPICAL SEPTIC TANK EFFLUENT COLLECTION SYSTEM	
PROJECT	WASTEWATER STUDY SECONSETT & MONOMOSCOY ISLANDS	
Dames & Moore		
SCALE NONE	DWN. BY J.G.C.	JOB NO. 20962
DATE 7/90	APPR. BY J.B.D.	FIG. NO. 3

the Board of Health, would be extremely prohibitive due to our low population densities and the long runs of expensive sewer lines required. In addition, the 90% federal subsidies that allowed such expensive approaches in the past no longer exist. Instead, the Sewer Commission has focused on:

- continuing to take advantage of opportunities to share, merge or piggyback on existing and proposed private wastewater collection and treatment systems,
- relocating treated wastewater from those systems outside of critical recharge areas,
- developing small-scale neighborhood and cluster systems,
- finding ways to encourage use of on-site systems that reduce nitrogen impacts and
- developing approaches to Commission management and maintenance of each of the above facility types.

Brief summaries of these issues and the work done to date follow.

Expansion on Private Wastewater Systems

While most of the opportunities for merging and expanding on private systems have gone by the boards since 1990, there are still possibilities related to both existing and potential private projects. The special permits for both the Willowbend and Windchime Point projects require that they transfer ownership of their treatment facilities to the Town if so requested. The **Willowbend** plant and sewer system, the largest currently existing in Mashpee, has significant potential as the basis of an expanded system servicing the Cotuit Bay, Pheasant Run and Sea Oaks Condos, the Bowdoin Road area, the East Mashpee commercial area and intervening residential areas. Its Rotating Biological Contactor (RBC) type plant, designed to treat up to 114,000 gpd, and collection system might also be expanded to include other areas such as Clippership Village, Summerwood Condos, Cotuit Corners, Sachem Village and portions of Mashpee Neck.

The **Windchime Point** plant has less potential to serve as the basis for an expanded system on its own, although it might be useful as part of a system based on the Mashpee Commons plant. As an independent entity if merger with the Mashpee Commons system is not pursued, connections might be explored to the Sandalwood neighborhood, the Sea Mist timeshare condominiums and the Talanian commercial properties. While connection of those properties to this proposed denitrifying 40,000 gpd Amphidrome plant would benefit the Mashpee River by providing a higher level of treatment, removal of the leachate to a location outside the river's recharge area, as discussed below, would make this a much more effective focus for Town involvement.

Because of uncertainty about the future of the **Southport** project, no discussions were possible with the owners for many years. However, some potential still exists for expansion to connect neighboring properties to that unfinished 172,000 gpd RBC plant given a cooperative project owner and sufficient public funding or other incentives.

Under an agreement between **New Seabury** and the Town regarding relocation of units into "Section 5" of their 1964 special permit area (between Rock Landing and Great Oak Roads), they will construct a wastewater treatment plant outside Section 5 and the recharge area of the Mashpee Water District's High Wood #2 and #3 wells. In addition, treatment plants may be required for future development in the "Promontory Point" and Popponesset Marketplace areas of New Seabury, which are permitted for a large number of residential units and commercial floor area but have very limited undeveloped land available. There could be opportunities to use one or more of those required facilities to develop municipal systems in those portions of New Seabury and Popponesset Beach which lie in the Popponesset and Waquoit Bay recharge areas and the Zone II of the High Wood wells.

The **Mashpee Commons** sewer system and treatment plant (80,000 gpd RBC plant designed for expansion to 120,000 gpd), which would have to be roughly doubled in size to deal with their proposed commercial and residential expansion, is a prime candidate for expansion under the auspices of the Sewer Commission. Because they would like to sell off individual sewered lots, which is not currently allowed by the state for privately sewered areas, there is an incentive for the owners to become part of a Town-owned system. Such a system could include those properties mentioned above regarding Windchime Point, plus Deer Crossing, the Town elementary schools, police and fire stations, library and senior center, Homeyer Village and Christ the King Church, the Kirsner Family Trust property (behind and east of the Prime Place office building), the Quashnet Valley Country Club development, the commercial / industrial area along Route 28 south to the Mashpee Industrial Park and Great Neck Road North. In order to achieve maximum benefit to the Mashpee River, within whose recharge area all these properties lie, treated effluent from such a system could be discharged outside the River's recharge area.

The **Stratford Ponds** treatment plant, a recently completed 40,000 gpd Tetra recirculating filter plant with a high level of denitrification potential, is a small facility with limited area for expansion. However, the potential for connecting neighboring homes in the Main Street, Sunset Strip and Santuit Pond Area should be investigated with the new owners of the project.

The **Massachusetts Military Reservation** treatment facility lies fairly close to the Briarwood and Falmouth-Sandwich Road areas of Mashpee. Connection to that plant or construction of an adjacent facility that might take advantage of portions of the plant or its wastewater discharge facilities may be worth considering.

The **Mashpee High School** treatment plant could be considered as the basis of a treatment facility that could serve TCB Mashpee Village, Lakeside Estates trailer park and other nearby areas.

The treatment facility which will be necessary for the Town's **next elementary school**, proposed in our school facilities plan for a location behind Town Hall, could instead be a municipal plant designed from the start to serve a larger area along Route 130, South Sandwich Road and Cotuit Road, with effluent possibly piped to an area outside the Mashpee River recharge area.

All of these options require extensive study and input from wastewater engineering consultants before they can be anything more than concepts. Costs and payment mechanisms will be especially critical issues that need professional input. The Town will have to decide in the very near future if it is going to recognize the need to explore such means of dealing with its wastewater problems by providing funding for the necessary planning and engineering studies. Further delay only eliminates more opportunities for cooperative efforts with private developers and increases the eventual cost of retroactively dealing with the wastewater issue.

Relocation of Treated Wastewater

Even with the best levels of nitrogen removal currently attainable, growth of the Town's population and commercial areas will most likely lead to unacceptable levels of nitrogen in some of our most sensitive estuarine areas, such as the lower Mashpee River and, to a lesser extent, Shoestring Bay. The Town should target Class SA status for all of our coastal water bodies. These are waters designated for the uses of a) protection and propagation of fish, other aquatic life and wildlife, b) primary and secondary contact recreation (such as swimming and water skiing, as well as fishing and boating) and c) shellfish harvesting without depuration in approved areas (as opposed to Class SB, where depuration is required).

While there is no direct nitrogen standard established by the state which is tied to these water quality classes (there are specific SA standards for dissolved oxygen, temperature, pH and total coliform bacteria), nitrogen

levels may contribute to degradation in those water quality measurements. In addition, there are minimum water quality criteria that have been adopted for all waters of the Commonwealth. These include the criteria that "all waters shall be free from pollutants in concentrations or combinations that: (a) settle to form objectionable deposits, (b) float as debris, scum or other matter to form nuisances, (c) produce objectionable odor, color, taste or turbidity or (d) result in the dominance of nuisance species". Excessive nitrogen levels contribute to virtually every one of those problems. In addition, the state standards specify that nutrients "shall not exceed site-specific limits necessary to control accelerated or cultural eutrophication", which is clearly a problem in some of our water bodies (314 CMR 4.03).

The Town's Watershed Management Committee has begun the process of implementing a more rigorous and extensive water quality testing and monitoring program in the Popponesset Bay estuary to determine the current condition of the various sub-embayments and to establish their critical levels of nitrogen loading and, consequently, what amount of nitrogen inputs must be removed from their groundwater recharge areas. This program will focus on the Mashpee River and Shoestring Bay, but will also look at Ockway Bay for the first time, separate from the rest of the lower Popponesset Bay.

The results of the Cape Cod Commission study, which showed a massive projected overload of nitrogen to the Mashpee River, implied that in order to bring nitrogen levels down to acceptable levels consistent with meeting the SA standards in the Mashpee River and, possibly, the Shoestring Bay recharge area, a massive reduction or relocation of nitrogen is necessary. Even replacement of new and existing septic systems for all residences in the watershed with currently-available denitrifying on-site systems was said only to maintain current nitrogen loading levels, rather than reduce them.

If the results of the Town's new water quality testing and monitoring program confirm that conclusion, one of the most cost-effective means of quickly removing a large amount of nitrogen from the river's recharge area may be relocation of treated effluent disposal from some or all of the existing and proposed wastewater treatment plants in that area. The most likely candidate for such a move is effluent from the Mashpee Commons and Windchime Point treatment plants, as well as the plant proposed for the Talanian property, the treatment facilities proposed under the Mashpee Industrial Park's Development Agreement with the Cape Cod Commission and any others developed in the central area of the Town. Should a municipal system be developed in that area as suggested above, such an approach would be even more feasible and would include effluent from a larger portion of the recharge area.

Three options are under consideration for relocation of effluent disposal. The primary option being considered is piping effluent south to property on Great Neck Road South owned by a company related to Mashpee Commons just north of the former Queen of All Saints Chapel. This site lies outside the recharge area of the Mashpee River and of any public water supply well. It lies within the recharge area of lower Popponesset Bay, which has sufficient flushing to minimize nutrient impacts, according to studies done for the Cape Cod Commission. However, it more specifically lies in the recharge area of the outer portion of Ockway Bay which, as noted above, has never been separately studied relative to its ability to handle additional nitrogen loading. The results of the Town's water quality testing program and resulting analyses will be critical to determining whether or not this option is acceptable.

The second option is relocation further south in the area of the New Seabury Country Club clubhouse or of the Popponesset Marketplace, which lie outside any recharge area other than that of Nantucket Sound, within which nutrient impacts from effluent disposal would be infinitesimal due to large water volume and rapid water movement. This disposal area could be developed in conjunction with wastewater treatment facilities developed for New Seabury. Should it be economically feasible, this would be the ideal effluent disposal location.

A third option which has been proposed is injection of treated effluent into sufficiently deep wells that it will not be discharged from the groundwater table until it reaches the coast. This will require a fairly complete understanding of the sediments between the discharge point and the ocean but may be cheaper than building effluent pipelines and disposal areas. However, preliminary indications from scientists assisting the Watershed Management Committee are that this option is not likely to be effective.

Aside from the central area system, piping of effluent may also make sense for other treatment plants located in the Mashpee River and Shoestring Bay recharge areas. Effluent from a new treatment plant located at the next proposed elementary school site near Town Hall could be piped to a connection with the central area system and pipe to South Mashpee. Alternately, effluent from that plant, along with those at Stratford Ponds, Willowbend and any other future denitrifying treatment facilities in the East Mashpee area could be piped to a location near Frog Pond Close where disposed effluent would enter the main body of Popponesset Bay, with its apparent high flushing and high nitrogen capacity. A third option would be to pipe effluent from all of those plants to the central area and South Mashpee.

While more detailed work must be done on projected nitrogen levels resulting from the various treatment and wastewater relocation options, it is quite possible, in some watersheds, that effluent relocation from large projects and treatment plants could be more cost effective at reducing overall nitrogen levels than use of denitrifying on-site systems or some of the other nutrient reduction options being considered for widespread use in the area (although public vs. individual homeowner costs might be higher).

Neighborhood Cluster Systems

One of the more promising approaches to wastewater treatment in an area with Mashpee's development pattern, which includes significant high-density subdivision areas widely separated by intervening open space or low density development, is a neighborhood treatment plant approach. A number of the denitrifying technologies being proposed for on-site use are actually scaled-down versions of larger plants which can easily be scaled back up to accommodate any number of homes or businesses. The Amphidrome and Bioclere systems appear to be particularly well suited to this role, along with recirculating sand filters.

In neighborhoods of existing homes with an installed base of septic tanks already paid for, these systems could involve septic tank effluent only, using either a low pressure sewer (see Figure 8-1 STEP system diagram) or gravity flow where topography permits. In new neighborhoods, the system could be designed from the start to allow gravity flow of all household effluent to one or more central septic tanks (equalization tank) feeding a central denitrifying wastewater treatment facility. In appropriate locations and conditions, these systems could also be tied into the proposed effluent relocation pipelines from larger systems.

Ownership and management of such systems could be by the Town through the Sewer Commission, which would also ensure that septic tanks are pumped on a regular three-year schedule. (This is particularly necessary with STEP systems where grease and other items can clog or narrow the small diameter collection system pipes.) Residents would receive a utility bill for these services (which might also cover capital costs paid through municipal borrowing) just as they do from the Water District and other utilities.

Compared to individual on-site denitrifying systems, the cost of such systems should be significantly reduced, along with space needs and homeowner hassles. Should regulations be adopted requiring denitrifying systems on new and existing development, such an approach may become the best way to deal with homeowner costs. From the Town's point of view, this approach may be attractive as well, because it allows development of denitrifying systems in critical areas in smaller increments, involving smaller amounts of up-front capital costs.

On-Site Denitrifying Systems

There are a number of denitrifying on-site wastewater treatment systems currently approved for use in Massachusetts. These systems typically involve the septic tank and leaching facility which comprise a traditional "Title 5" septic system, along with additional filters or other treatment units which enhance the system's ability to remove nitrogen from the effluent (usually by converting it to gaseous form). The following are current costs for installation of some of the more popular systems (in addition to basic septic system costs):

Bioclere	$5-6000	RUCK	$7-8000
FAST	$5500-6000	Cromaglass	$7550-7800

As with traditional septic systems, they are intended to be located on the same lot as the residence or business being served and are usually constructed, along with a new building or as a replacement system, at the expense of the property owner. The Town is not likely to get involved in the construction or funding of private on-site systems unless state regulations are changed. However, the Sewer Commission may have a role in management and operation of such systems (see below).

The Conservation Commission has adopted a regulation restricting nitrogen loading from new facilities within their jurisdictional area under the state Wetlands Act and Town wetlands bylaw. Although not mandating how nitrogen is to be reduced, the regulation has frequently resulted in the use of denitrifying on-site wastewater systems. Otherwise, regulations requiring denitrifying on-site systems are the domain of Town Meeting and the Board of Health. To date, a number of suggestions have been put forward for requiring such systems either for all new construction, or for new construction with wastewater flows over 1000 gallons per day, or whenever a residence or business is sold, or for all residences in the recharge areas of nitrogen sensitive embayments. Use of such systems should be instituted / required in coordination with an overall wastewater management plan for the town in order to ensure that they do not preclude or adversely impact opportunities for more cost-effective neighborhood cluster or public sewer systems and that they are used where they will have the most benefit to nitrogen sensitive embayments.

Management and Maintenance

The Sewer Commission has been established by Town Meeting under the provisions of MGL Chapter 83, which gives it the power to "lay out such main drains or common sewers as they adjudge necessary for the public convenience or the public health, in public or private ways or in the land of any person, and may take land by eminent domain ... which may be necessary therefor, and may prescribe the manner in which and the materials with which such drains or sewers shall be built.... They may also lay out particular sewers from common sewers to the boundary of the way. Drains and sewers so laid out shall be built, repaired, maintained and owned by the town." The Commission may also "upon request of the owner of land and payment by him of the actual cost thereof, construct a particular sewer from the street line to a house or building."

In addition to construction and operation of traditional sewer systems, these powers allow the Commission to develop cluster systems and associated treatment facilities. Increasingly, similar agencies are also involved in maintenance and operation of neighborhood cluster and even on-site systems. Regular inspection and pumping of septic tanks by the municipality, billed to the homeowner, is an increasingly common practice. With the growing use of new denitrifying technologies that involve more complicated processes and equipment and increased maintenance, it is even more appropriate for the municipality to become involved to ensure proper operation of the system. The Sewer Commission may have a role in this regard as part of an overall wastewater management plan for the town.

Because of the technical nature of the skills required and the likely gradual increase in the number of facilities and services that might come under the Town's management, it is highly likely that most, if not all, of the design, construction and maintenance activities associated with a municipal wastewater management system would be contracted out to private firms which specialize in the field, as is now done by most private wastewater treatment plant owners and the high school. This would facilitate the pass-through of the costs of such services to system customers under an "enterprise account" funding arrangement vs. maintenance of permanent tax-supported personnel and facilities.

Recommendations / Concept Plan

The primary recommendation of this plan is that the Town fund a two-phased wastewater facilities and management plan under the direction of the Sewer Commission, possibly using zero interest loan funds from the State Revolving Fund.

The first phase of the plan would be a professionally prepared report on the variety of options realistically available in Mashpee for on-site, cluster and larger public wastewater collection and treatment systems and for wastewater relocation facilities, including unit costs for design, construction and operations in Mashpee, cost-effectiveness, effectiveness at removing nitrogen and other contaminants, potential funding mechanisms, regulatory issues and management issues. The intent of this phase would be to provide a solid basis for discussion of alternate means of dealing with nitrogen inputs to our estuaries as well as other water quality issues related to domestic and non-residential wastewater. It is intended that this first phase be conducted in parallel with the Popponesset Bay water quality monitoring and analysis program initiated by the Watershed Management Committee so that, upon completion of that work and a determination of the levels of nitrogen reduction which might be required in the recharge areas of each sub-embayment, work can be begun immediately on development of a specific nitrogen and wastewater management plan for each sub-watershed. The second phase of the wastewater facilities and management plan would consist of those sub-watershed plans, a coordinated overall construction and management plan for required Town-owned or operated facilities, preliminary engineering designs and preliminary costs for a phased development of any recommended facilities.

The Sewer Commission and Planning Department have developed a concept plan demonstrating a potential approach to providing denitrifying wastewater treatment in critical areas of Mashpee (see Map 8-2). The plan incorporates a combination of the options identified above. It should be noted that, based on ongoing and future studies of nitrogen loading impacts to the bays and on future well locations, such treatment may not be necessary in all parts of the town. In any case, priorities would have to be established for funding, based primarily on those studies and on the consultant work for the proposed wastewater facilities and management plan.

Map 8-2 indicates the existing and permitted private wastewater treatment plants, their sewer systems and the areas served or proposed to eventually be served by their current owners. Expansion of a number of these private service areas is illustrated. Gravity sewer extensions and force mains are shown, along with areas served, where topography makes such extensions feasible. In other adjacent areas, low pressure sewers or STEP systems are suggested to transmit septic system effluent to the sewage treatment plant.

Expansion of the Willowbend system is suggested to include the 1) Cotuit Bay condos, the Chestnut street area and Pleasant Park Drive / Angelos Way via gravity sewers and a force main, 2) Sampsons Mill Road, Pheasant Run condos, Bowdoin Road, Sea Oaks condos, the East Mashpee commercial area on Route 28, the Center for Optimum Care nursing home, Shellback Place office condos, the Sunset Strip area and Sarakummit Village via gravity sewers, 3) Orchard Road, Rainbow Lane, proposed affordable housing on Ashers Path and treated effluent from a proposed cluster treatment facility at the Ashers Heights subdivision via gravity sewers and 4) Cotuit Corners, Summerwood condos and Sachem's Village via gravity sewers and a force main. As suggested for Ashers Heights, treated effluent from a potential cluster system serving Clippership Village might also be pumped into the Willowbend system (or alternately to a new plant suggested at the southern end of Mashpee Neck). The Willowbend plant's effluent is currently disposed via subsurface leaching pits under the development's driving range. In order to handle the additional proposed flows, a second disposal area would most likely be required. A rapid sand filter bed is suggested either adjacent to the plant or on existing Town owned lands south of the plant just north of Quinaquisset Avenue. Alternately, effluent could be piped to a filter bed at the new treatment facility suggested for Mashpee Neck.

The Stratford Ponds treatment plant could serve the Jonas Drive area, Emma Oakley Mills Road and Main Street from Cotuit Road east to the Barnstable town line via gravity sewers and a small force main.

While very limited in capacity, the treatment plant recently built for the high school might be enlarged to serve TCB Mashpee Village and the commercial area at the intersection of Route 151 and Old Barnstable Road. In addition, should other alternatives not be available, it might serve the Lakeside Estates mobile home park and the adjacent Mashpee Housing Authority property.

Should the high school plant not be usable, the same properties might be tied to an enlarged Southport plant. In addition, the area between Southport and Johns Pond could be served by a low pressure sewer or STEP system tied to the Southport plant.

If wastewater treatment is desired for the Tri-Town Circle / Horseshoe Bend Way / Lakeview Drive area, the most cost-effective means might be a STEP system tied to the existing treatment plant located nearby on the Massachusetts Military Reservation.

As noted previously, three private treatment plants are currently proposed in the central area of Mashpee, not including the two on-site denitrifying facilities recently built for the 99 and Cooke's restaurants. In addition, it is likely that future development on the Kirsner Family Irrevocable Trust property northeast of the rotary will require some sort of wastewater treatment plant. All of these properties were previously part

of a proposed Central Mashpee sewer service area, for which a new shared treatment plant was proposed on land adjacent to the Mashpee Industrial Park.

The Mashpee Commons plant is positioned topographicaly to be the logical recipient of gravity sewer flows from future development on the Kirsner property and others north of the Comons. Any new plant to deal with Commons expansion and other properties in the area would most likely be located either on the previously-suggested Industrial Park site or on a Town-owned parcel adjacent to the Madaket Place office condominiums. At either location, it might also receive either sewage or treated effluent from the Mashpee Industrial Park, whose development agreement with the Cape Cod Commission limits nitrogen loading and mandates recirculating filter or similar treatment systems for lots with flows over 2000 gpd. Effluent from the new plant, along with that from the existing Mashpee Commons plant, the Windchime Point plant and the Talanian plant, if built, would be pumped to a rapid sand filter bed or other disposal area outside the recharge area of the Mashpee River or any public wells.

Should such a central area system be established, it could serve a large portion of the Mashpee River's recharge area along Great Neck Road North and South, Lowell Road and Route 28, including the Deer Crossing, Quashnet Valley and Sandpiper condominiums, The Highlands, Greenwood Estates, Sandalwood, Teeberry Estates and Quashnet Valley subdivisions, the South Cape Resorts and Sea Mist timeshare condos, Madaket Place, Deer Crossing Shopping Center, Prime Center, the Coombs and Quashnet Schools, the police and fire stations, the library and senior center, Christ the King church, Homeyer Village, the Quashnet Road area and other developed and potentially developable properties in the area. Most could be served with gravity sewers (carrying either sewage or septic system effluent), with low pressure STEP systems more likely in the Quashnet Road area, Teeberry estates, Quashnet Valley subdivision and part of Greenwood Estates.

As noted earlier, New Seabury has committed to sewering their "Section 5" area, which is permitted for an additional 424 residences and 305,015 square feet of commercial area (although there are currently no immediate plans for development), and disposing of the effluent outside the recharge area of the High Wood #2 and #3 wells. In addition, the Popponesset Marketplace area ("Section 10") is permitted for an additional 360 residential units and 159,490 square feet of commercial area while the Promontory Point area ("Combined Section") could see an additional 280 residences and 49,715 square feet of commercial area. Because available land to accommodate this development is limited, it is likely that future development in these areas will be high density, necessitating wastewater treatment. As a result, as many as three private treatment plants might be necessary. Alternately, a single municipally owned plant could be built, which could also accommodate additional effluent from existing development in the vicinity. The effluent disposal area for wastewater treatment plants in New Seabury would be most appropriately located outside the recharge areas of Popponesset and Waquoit Bays and the High Wood #2 and #3 wells, in the vicinity of the New Seabury Country Club clubhouse. As noted earlier, this is also a location for effluent disposal for the central Mashpee area, with which development costs could be shared.

In addition to these proposed private plants, two others may eventually be required to support proposed and potential development. The special permit for the Quashnet Valley Country Club allows a large number of additional condominium and single-family residences west of Old Barnstable Road. Although there has been no activity relative to that area since the mid-1980s, it was proposed to be serviced by a private treatment plant at that time and, presumably, would have to be in the future if it was developed. On the south side of Route 151 behind Cormier's Shell service station is a large tract of land zoned partly for commercial, partly for residential use. Significant development on that site would likely necessitate some sort of treatment facility, which could be shared with the Lakeside Estates mobile home park and adjacent commercial and residential areas on Route 151 and Old Barnstable Road.

The School Facilities element of the Comprehensive Plan suggests that a new elementary school will be needed soon after the year 2002 and recommends a site behind Town Hall. A denitrifying wastewater treatment facility should be built to serve the school because of its location in the Mashpee River recharge area. Rather than build a stand-alone facility, it is suggested that a municipal treatment plant be constructed to also serve the Town Hall area, Oak Hollow Condominium, Lovell's Lane the South Sandwich Road area and Route 130 between Heritage Park and Cotuit Road via gravity sewers and force mains, as well as Mashpee Shores, the Riverbend Motel and the Timberlane / Cotuit Road area via STEP systems. Should They not be connected to the Willowbend plant as suggested earlier, the Sunset Strip and Sarakummit Village areas could also be connected to this plant via gravity sewers and a force main. Discharge would be either nearby outside the Mashpee River watershed or via an effluent pipeline to the Mashpee Commons area and thence to the effluent disposal area suggested previously.

Two other significant municipal treatment plants are also suggested in the concept plan. The larger would service Pirates Cove via a STEP system and the remainder of Mashpee Neck south of Willowbend via gravity sewers. In addition, treated effluent from a suggested cluster system at Clippership Village might be fed to this system for disposal. The second would serve the Santuit Pond Estates neighborhood and the Beechwood Point condominium. As these sites are in residential areas, the use of solar aquatic treatment plants, such as those developed by Ocean Arks International, might be considered to increase the attractiveness and "neighborhood friendliness" of the treatment facilities. Effluent disposal in both cases would be on-site via rapid sand filter beds.

Acting as smaller scale sewer systems serving anywhere from five to fifty or more homes, "cluster" wastewater collection and treatment systems are suggested in many existing densely-populated neighborhoods throughout the town which are not easily serviceable by existing or proposed sewage treatment plants These would collect septic tank effluent by means of gravity or STEP lines and utilize larger versions of the denitrifying technologies now authorized by the state for on-site use. Treatment facilities could be located in common areas, on undeveloped lots, on easements or, if necessary, within road layouts. Effluent discharge would most likely be via subsurface leaching. These facilities would be owned and maintained by the Sewer Commission, with users billed for capital, operating, maintenance and management costs. Under such an ownership pattern, they would most likely qualify for federal / state funding assistance via no / low interest loans from the State Revolving Fund.

A number of areas (indicated in green on Map 8-2) do not appear to require intensive levels of denitrification or public involvement in wastewater facilities, or are not conducive to clustered approaches, or may consist of properties that may not really need to take advantage of cost savings possible with clustered systems. For example, in the High Wood village of New Seabury, where the combination of one acre lots and very low year-round occupancy make wastewater loading per acre very small, nothing beyond proper management of existing septic systems or any advanced on-site systems which may be installed can be justified financially. On the outer shore of Popponesset Island, the owners of million dollar properties may not need public assistance in funding denitrifying on-site wastewater facilities, so only proper management of those facilities is required. In seasonal areas like portions of the shorelines of our large freshwater ponds, low year-round occupancy results in low wastewater loadings per acre on one hand and difficulty in operating STEP systems or some advanced on-site treatment systems on the other. In areas like most of Popponesset, Rock Landing and Maushop Village, though modeling indicates that at maximum future summer pumping rates groundwater may be drawn to the High Wood #2 and #3 wells, occupancy is extremely seasonal and groundwater flow is generally to Nantucket Sound. In those areas, denitrifying on-site systems may be required on some properties based on localized factors (such as proximity to Popponesset Creek and Deans Pond), but proper construction and maintenance of standard septic systems is probably sufficient to avoid significant environmental impacts (although there may be bacterial or viral contamination issues which require special treatment in some cases).

Finally, for single family lots of two acres or more, particularly those not easily connected to cluster or other systems, no special treatment appears to be warranted due to low per-acre wastewater loadings.

Any of the approaches described on the Concept Plan will require large amounts of funding. Although the Plan attempts, based on the limited knowledge currently available, to identify the approach which is likely to be most cost-effective in removing nitrogen from our estuaries, a number of critical decisions must be made by the Town before putting such a plan into effect:

- The first is to decide whether the issue of over-nutrification of our estuarine waters and fresh water ponds is important enough to us to merit serious attention both with regard to regulations and to funding.
- The second is to decide, based on the best available science, where and how much nitrogen must be removed from the watershed of each sub-embayment of the estuaries, where phosphorous must be removed from freshwater pond recharge areas, or where protection of public wells requires something more than reliance on traditional septic systems.
- The third is to decide whether we will try to impose the costs of dealing with wastewater impacts entirely on private individuals through regulation or will develop municipal facilities to improve cost-effectiveness and financial fairness.
- The fourth is to determine how any municipal facilities are to be funded and, more specifically, whether there is enough concern on the part of Mashpee residents about those water resources to merit contributions, via the general tax base, toward constructing wastewater treatment facilities. For example, using no interest loans from the State revolving Fund (not available to private borrowers), the long term borrowing costs for capital facilities would be cut in half vs. market rate borrowing. Would the Town be willing to fund half of the remainder (one quarter of the market-rate cost) with the rest paid for by individual property owners connected to the facility?
- The last major issue is prioritization of a) watersheds and b) potential facilities projects within those watersheds. Based on the results of scientific studies of the estuaries and of the proposed wastewater facilities and management plan, some projects are likely to give more "bang for the buck" and merit implementation sooner than others.

How we answer these questions will go a long way toward determining the quality of life in Mashpee for ourselves and for future generations.

Recommended Policies

The following recommended policies, which are intended to be expressed through new or revised bylaws or regulations or through the ongoing regulatory or other activities of Town departments and boards, are intended to be formally adopted principles which will guide the process of achieving the goals and objectives identified previously.

Water Resources

IT SHALL BE THE POLICY OF THE TOWN OF MASHPEE:

1. To require that any new development or expansion projects shall not have a significant adverse effect on our groundwater, wetlands or surface water bodies and that all new development or redevelopment shall not exceed a 5 mg/l loading standard for impact on groundwater based on the methodology contained in Cape Cod Commission Nitrogen Loading Technical Bulletin 91-001 or any later revision, unless a

cumulative impact analysis and / or the nitrogen sensitivity of receiving water bodies indicates a more stringent loading standard is necessary.

2. To encourage the improvement of wastewater and stormwater facilities associated with existing development by application of the best available technologies and management practices in order to reduce existing negative impacts on groundwater or surface water bodies, including wetlands, and to help restore the ecological integrity of our surface water bodies.
3. To maintain or achieve Class SA water quality standards in all of our marine waters and Class A standards in all of our fresh water bodies and streams.
4. To encourage the management of water withdrawals in ways which would minimize or prevent any adverse effects on surface water resources, wetlands, existing wells or the safe yield of the aquifer.
5. To require that, as part of the local permitting process, any significant development or expansion projects provide a professional analysis of their projected water quality impacts which meets the guidelines and content requirements established by Town bylaws and by regulations adopted by local, county or state permitting agencies.
6. To demand the earliest possible containment and cleanup of all contamination plumes in Mashpee associated with the Massachusetts Military Reservation, the town landfill and any other contamination sites and to seek active participation in the development and management of any containment or cleanup measures.
7. To maintain and update clear plans for response to, and mitigation of, any hazardous materials spills in Mashpee and to coordinate the Town's response and mitigation planning with that of all other responsible agencies.
8. To encourage existing and proposed residential and non-residential developments to minimize the use of chemical fertilizers, pesticides and herbicides.
9. To prohibit incompatible uses, particularly those involving the use, treatment, generation, disposal or storage of significant quantities of hazardous materials or waste, with the exception of household quantities, in existing or projected recharge areas of public water supply wells.
10. To require that development densities in areas not served by public water systems allow for adequate separation between water wells and wastewater facilities to prevent well contamination.
11. To require that new development located within existing or projected public water supply recharge areas, when taken in conjunction with all other existing and permitted uses within the recharge area, will not result in projected nitrate nitrogen loading in excess of 5 mg/l within said area in order to ensure that the federal and Massachusetts nitrate standard of 10 mg/l for drinking water can be consistently met at the wellhead.
12. To require DEP-approved alternative on-site septic systems with enhanced nitrogen removal or wastewater treatment plants designed for 5 mg/l total nitrogen or less in plant effluent for all new development and redevelopment: 1) that is in existing or projected recharge areas of public water supply wells where a cumulative loading assessment of the recharge area indicates projected buildout nitrate nitrogen levels in the well in excess of 5 mg/l; 2) that is subject to approval as a Developments of Regional Impact by the cape Cod Commission within the recharge areas of marine embayments, unless a cumulative nitrogen loading assessment of the embayment or recharge area indicates that nitrogen loading from a standard Title 5 septic system is acceptable; or 3) where indicated due to projected water quality impacts or where recommended by the Department of Environmental Protection, Board of Health or Conservation Commission within their respective jurisdictions.
13. To prohibit new development or expansions, including subdivision roadways and wastewater treatment and disposal systems, within 400 feet of existing or identified future well sites.
14. To encourage the development, permitting and use of appropriate proven new or innovative wastewater treatment technologies to reduce nutrient loading to the aquifer.

15. In order to limit phosphorous inputs, to prohibit subsurface disposal systems within the groundwater recharge areas of fresh water ponds where such systems would lie within 300 feet of mean high water of such ponds.
16. To require that stormwater discharge from roadways and other surfaces be disposed of in a manner that is consistent with current best management practices and which will not lead to significant degradation of groundwater or surface water quality and that stormwater discharge and treatment facilities be properly maintained on a regular schedule. New direct discharge of untreated stormwater, parking lot runoff and / or wastewater into marine and fresh surface water and wetlands shall not be permitted. Stormwater shall be managed and disposed of on site. Development and redevelopment shall use best management practices, such as vegetated swales, to minimize runoff and maximize water quality treatment. A maintenance schedule shall be developed for all drainage structures. Stormwater drainage should be based on a projected 25 year 24 hour storm or more conservative figures where appropriate.
17. To require that the storage and disposal of solid waste and hazardous materials be done in a manner that protects groundwater and surface water quality.
18. To support regular monitoring of the water quality of public and community water supply wells, wastewater treatment discharges and water bodies and to encourage the regular monitoring of private water supply wells.
19. To require that road salt be stored in enclosed sheds and that the use of road salt be reduced, eliminated or replaced, where feasible, with other materials in areas that impact public and private water supplies and surface water bodies.
20. To require that new development or expansions in the recharge areas of water bodies, in conjunction with all other existing and permitted uses within the recharge area, not cause nutrient loading which could damage the health or integrity of their ecosystems. Land which has been purchased by the Town for conservation purposes shall be treated as developable, per existing zoning regulations, in calculating such loading rates.
21. To require that new development and redevelopment make use of the best available appropriate water conservation technologies and to encourage the refitting and use of said technologies for existing development.
22. To sponsor educational programs and materials designed to inform our residents and visitors regarding the potential water quality impacts of development, of household products and activities and of typical recreational activities.
23. To apply the minimum Water Resources performance standards and development review policies adopted by Barnstable County as part of its 1996 Regional Policy Plan to development and redevelopment which qualifies as Development of Regional Impact and to other development and redevelopment as applicable, with specific reference to the RPP "water resources classification system". Under that system the Town recognizes and will protect "Wellhead Protection Areas", "Fresh Water Recharge Areas", Marine Water Recharge Areas" and "Potential Public Water Supply Areas", but no portions of the Town of Mashpee shall be treated as "Impaired Areas" or "Water Quality Improvement Areas".
24. To prohibit conversion from seasonal to year-round uses in FEMA A flood zones or within 100 feet of wetlands unless the proponent installs a DEP approved alternative wastewater system with enhanced nitrogen removal and demonstrates that the project will not have other adverse impacts on groundwater or adjacent surface water bodies.
25. To prohibit private wastewater treatment facilities unless there are no feasible public treatment facility options available or planned.
26. To require that the construction of private sewage treatment facilities (PSTFs) be consistent with the Town's capital facilities and wastewater facilities plans, where they exist, and that the Town have the opportunity to assume ownership and maintenance of such PSTFs where desired by the Town.

27. To acquire, and to encourage other public agencies to acquire, lands within the groundwater recharge areas of surface water bodies and public wells for the purposes of open space preservation and water quality protection.
28. The construction of private sewage treatment facilities shall not allow development to occur at higher density than would be otherwise be allowed by the zoning bylaw.

Water & Wastewater Facilities

IT SHALL BE THE POLICY OF THE TOWN OF MASHPEE:

1. To support the extension of public water supply facilities to all areas of the Town with existing small lot development, high levels of commercial development or known drinking water quality problems, and to other areas as appropriate based on public health, safety and cost-effectiveness.
2. To seek the cooperation of the Mashpee Water District in the provision of adequate public water supplies to support the Town's economic development efforts.
3. To promote the development of any public wastewater treatment and disposal facilities required to support the Town's economic development efforts or to protect or improve water quality in public water supply wells and fresh or marine water bodies and and to seek funding from private, betterment or grant sources prior to use of local property tax revenues.
4. To cooperate with private developers in the construction and operation of wastewater treatment and disposal facilities where warranted by resulting water quality benefits or cost savings to the taxpayers.
5. To require that all developments provide the highest feasible level of wastewater treatment.
6. To require that all public wastewater treatment plants and private sewage treatment facilities be designed to achieve denitrification to 5 mg/l or less total nitrogen in the plant effluent and include a plan for sludge disposal and to prevent their construction in FEMA V zones and floodways, Areas of Critical Environmental Concern (ACECs), wetlands and their buffer areas, barrier beaches, coastal dunes or critical wildlife habitat.
7. To require that the long-term ownership, operation, maintenance and replacement of private sewage treatment facilities be secured in accordance with Town, county and state guidelines.
8. To develop and / or maintain an appropriate system for monitoring and ensuring the safety of public and private wells.
9. To cooperate with the Mashpee Water District in the development, acquisition and protection of adequate public well sites to meet projected future water supply demands.
10. To encourage the development and use of public water supply conservation programs and incentives.
11. To develop appropriate public sewage collection and treatment facilities in areas where the intensity of existing or proposed development or other factors make adequate protection of groundwater or surface water resources through other means either infeasible or less cost effective.
12. To develop and maintain the highest quality practices and facilities for septage pumping, haulage, disposal and treatment and for disposal of solids from wastewater treatment facilities.
13. To maintain high quality management, maintenance, operations and monitoring of public wastewater collection and treatment facilities.

Action Plan

In response to the recommended goals, objectives and policies listed previously and to the issues and problems identified in developing this plan element, the following specific actions are recommended, both in the next five years and over the long term, to ensure that the water supply needs of Mashpee's citizens are met while our water quality and environment are protected from degradation:

Five Year Plan

The following is a listing of projects and activities which are recommended for completion in the next five years. It is based on the adopted goals and objectives and our analysis of critical issues and needs, tempered by the realities of limited Town staff and budgets, and is focused on the following areas:

1. upgrading local bylaws and regulations intended to protect the town's water resources;
2. continued development of data and improvement of our knowledge of Mashpee's water resources, the factors which may be negatively impacting them and the means by which we might deal with those factors;
3. ensuring adequate public water supplies to meet the needs of our citizens;
4. initiating development of municipal wastewater treatment facilities where needed to deal with existing or projected degradation of our water resources;
5. other activities designed to protect and improve groundwater and surface water quality or the ecological health of streams and water bodies.

Specific proposed activities during the next five years are as follows:

1. Regulatory Actions

a. Update the Groundwater Protection District zoning bylaw and the Planning Board's subdivision regulations regarding treatment and disposal of storm runoff and artificial recharge to groundwater.
b. Extend application of the Groundwater Protection District bylaw to the Zone II area in Mashpee of all existing and proposed public water supply wells, including those in adjacent towns. Seek similar protection of Mashpee well sites in adjacent towns, particularly the Town of Sandwich.
c. Update the Water Quality Report zoning bylaw and adopt any required additional zoning bylaws or other appropriate regulations requiring that all new development or redevelopment shall not exceed a 5 mg/l loading standard for impact on groundwater based on the methodology contained in Cape Cod Commission Nitrogen Loading Technical Bulletin 91-001 or any later revision, unless a cumulative impact analysis and / or the nitrogen sensitivity of receiving water bodies indicates a more stringent loading standard is necessary.
d. Adopt Board of Health regulations requiring DEP-approved alternative on-site septic systems with enhanced nitrogen removal or wastewater treatment plants designed for 5 mg/l total nitrogen or less in plant effluent for all new development and redevelopment: 1) that is in existing or projected recharge areas of public water supply wells where a cumulative loading assessment of the recharge area indicates projected buildout nitrate nitrogen levels in the well in excess of 5 mg/l; 2) that is subject to approval as a Developments of Regional Impact by the cape Cod Commission within the recharge areas of marine embayments, unless a cumulative nitrogen loading assessment of the embayment or recharge area indicates that nitrogen loading from a standard Title 5 septic system is acceptable; or 3) where indicated due to projected water quality impacts or where recommended by the Department of Environmental Protection, Board of Health or Conservation Commission within their respective jurisdictions provided that such facilities are coordinated with overall wastewater facility planning for the town.
e. Consider minimum lot size increases in areas where necessary to maintain nitrates below 5 mg/l in public water supply wells or to avoid other potential negative impacts on the town's water supply or nutrient-sensitive water bodies.
f. Consider incentives to encourage use of denitrifying wastewater treatment and neighborhood cluster systems where not required by town, county or state regulations and where the Town's wastewater facility plans do not call for municipal wastewater collection and treatment within the next 10 years.

g. Coordinate regulation and management of nutrient impacts to the Popponesset and Waquoit Bay estuarine systems with the other towns in each watershed either through the designation of a District of Critical Planning Concern (DCPC) or other formal means.
h. In order to deal with phosphate impacts on freshwater ponds, adopt appropriate bylaws or regulations prohibiting subsurface wastewater disposal systems within the groundwater recharge areas of freshwater ponds if they are located within 300 feet of the mean high water mark of such ponds or adjacent wetlands.
i. Adopt zoning and / or Board of Health regulations requiring that all public and private wastewater treatment plants be designed to produce an effluent containing 5 mg/l or less total nitrogen, have a sludge disposal plan, and that any plant components not be constructed in FEMA designated "V" flood zones, state-designated Areas of Critical Environmental Concern, wetlands, wetland buffer areas, barrier beaches, coastal dunes or endangered wildlife species habitats. In addition, treatment plant effluent discharge should be prohibited within Zone II areas of public water supply wells unless the facility is built to address existing water quality problems and will not allow development within the Zone II to occur at higher densities than would be allowed with conventional on-site septic systems.
j. Adopt a comprehensive bylaw regarding use, storage and control of hazardous materials and wastes. Such a bylaw should address existing hazardous material use and include registration and inspection provisions and prohibit incompatible uses, particularly those involving the use, treatment, generation, disposal or storage of significant quantities of hazardous materials or waste, with the exception of household quantities, in existing or projected recharge areas of public water supply wells.
k. Adopt appropriate bylaws and regulations requiring that stormwater discharge from roadways and other surfaces be managed and disposed of on site in a manner that is consistent with current best management practices to minimize runoff and maximize water quality treatment and which will not lead to significant degradation of groundwater or surface water quality, prohibiting new direct discharge of untreated stormwater, parking lot runoff and / or wastewater into marine and fresh surface water and wetlands and that stormwater discharge and treatment facilities be properly maintained on a regular schedule. Stormwater drainage should be based on a projected 25 year 24 hour storm or more conservative figures where appropriate.
l. Adopt a bylaw prohibiting conversion from seasonal to year-round uses in FEMA A flood zones or within 100 feet of wetlands unless the proponent installs a DEP approved alternative wastewater system with enhanced nitrogen removal and demonstrates that the project will not have other adverse impacts on groundwater or adjacent surface water bodies.
m. Adopt a bylaw prohibiting private wastewater treatment facilities unless there are no feasible public treatment facility options available or planned.
n. Adopt a bylaw requiring that the construction of private sewage treatment facilities (PSTFs) be consistent with the Town's capital facilities and wastewater facilities plans, where they exist, and that the Town have the opportunity to assume ownership and maintenance of such PSTFs where desired by the Town.

2. Data / Knowledge

a. Implement a thorough scientific study of phosphorous loading, eutrophic state and potential mitigation and management measures for Santuit Pond, including possible impact of cranberry bog operations.
b. Undertake a preliminary survey of the current trophic state and any existing or potential nutrient overloading problems for all ponds in the town, particularly small, shallow ponds.
c. Develop a long-term water quality sampling program for Popponesset Bay and its sub-embayments, in coordination with the Town of Barnstable, to facilitate planning for, and monitoring the effects of, efforts to reduce nutrient loading and other contaminants.
d. Participate in similar water quality sampling for Waquoit Bay in conjunction with the Waquoit Bay National Estuarine Research Reserve and the Town of Falmouth.

e. Obtain a thorough quantitative ecosystem analysis of the Popponesset Bay and Waquoit Bay estuarine systems to determine what levels of nitrogen loading from the watershed of each sub-embayment will result in healthy bay ecosystems. This data would be used to determine the amount of nitrogen which could be safely contributed to groundwater in each watershed and, conversely, how much existing nitrogen loading must be removed from each watershed by new treatment facilities or other means.
f. Engage an appropriate consulting firm to conduct a two-phased wastewater facilities and management plan under the direction of the Sewer Commission, possibly using zero interest loan funds from the State Revolving Fund. The first phase of the plan would be a professionally prepared report on the variety of options realistically available in Mashpee for on-site, cluster and larger public wastewater collection and treatment systems and for wastewater relocation facilities, including unit costs for design, construction and operations in Mashpee, cost-effectiveness, effectiveness at removing nitrogen and other contaminants, potential funding mechanisms, regulatory issues and management issues. Costs and payment mechanisms will be especially critical issues which need professional input. The second phase of the wastewater facilities and management plan would consist of those sub-watershed plans, a coordinated overall construction and management plan for required Town-owned or operated facilities, preliminary engineering designs and preliminary costs for a phased development of any recommended facilities.
g. Develop Zone II wellhead protection area delineations for all future well sites necessary to meet projected "buildout" water supply needs for the town.

3. Water Supply

a. Develop 1-2 million gallons of additional public water supplies by 2000.
b. Secure public ownership of all parcels required for the siting of public water supply wells required to meet "buildout" water demands of 8-10 million gallons per day.
c. Begin to acquire lands critical to protection of existing and proposed public well sites, such as the Merganser and Holland Mill sites.
d. Continue efforts to secure public water supplies from appropriate locations on the Massachusetts Military Reservation.
e. Improve coordination between the Water District, Town, County and state agencies regarding the selection and development of new public well sites in order to 1) avoid Water District conflicts with municipal plans, 2) minimize conflicts with existing and proposed land uses which may have an impact on water quality and 3) avoid degradation of other natural resources such as wetlands and rare species habitat.
f. Loop existing dead ends in the Water District's distribution system as system extensions become economically justified or are required to deal with water quality problems.
g. Develop and implement coordinated Town / Water District / other appropriate agencies water conservation programs and incentives.

4. Wastewater Facilities

a. Continue to take advantage of opportunities to share, merge or piggyback on existing and proposed private wastewater collection and treatment systems, with particular focus on the existing Willowbend and Mashpee Commons collection systems and treatment plants.
b. Initiate discussions on potential expansion of the Southport wastewater system with any new owners of that property.
c. Determine the feasibility of relocating wastewater from treatment facilities within the recharge areas of Nitrogen-sensitive water resources to discharge locations outside those areas. If feasible, coordinate development of a shared discharge facility for the Mashpee Commons, Windchime Point, Talanian, Mashpee Industrial Park and other wastewater treatment facilities in the central area of Mashpee.

d. Initiate development of at least one neighborhood cluster wastewater collection and treatment system.
e. Initiate discussions / planning / design regarding use of the treatment facility which will be necessary for the Town's next elementary school, proposed in our school facilities plan for a location behind Town Hall, as a municipal plant designed from the start to serve a larger area along Route 130, South Sandwich Road and Cotuit Road, with effluent possibly piped to an area outside the Mashpee River recharge area.
f. The potential for connecting neighboring homes in the Main Street, Sunset Strip and Santuit Pond Area to the Stratford Ponds treatment plant should be investigated with the new owners of the project.

5. Other Actions

a. Continue to press for immediate containment and cleanup of contaminant plumes originating at the Massachusetts Military Reservation and at the former Augat factory.
b. Cap the Mashpee landfill in 1998 and continue groundwater and in-stream monitoring programs to track contaminant plumes originating at the landfill.
c. Complete and implement the recommendations of the Mashpee Pond water level management study.
d. Pursue dredging at the mouth of the Mashpee River to improve flushing if sufficient water quality benefits can be demonstrated.
e. Review cranberry bog management practices in Town-owned bogs and those of cooperative private owners to determine and implement best practices to protect and improve water quality in adjacent streams and downstream receiving waters.
f. Continue to construct stormwater retention and treatment facilities where runoff from Town roadways currently contributes bacteria or other contaminants to our ponds, streams or estuarine waters. Adopt DEP-recommended "Best Management Practices" for drainage systems in Town roadway construction and reconstruction projects to minimize bacterial, nutrient and other contamination of groundwater or water bodies.
g. Based on the initial work done for Mashpee's "Watershed Year", establish an ongoing public education program regarding potential homeowner and business impacts on our groundwater, wells and water bodies and means of reducing or eliminating those impacts. Such a program should include information regarding use, storage and disposal of fertilizers, pesticides, petroleum products and other hazardous materials, landscaping options to reduce fertilizer and pesticide needs, water conservation measures and options for alternative wastewater treatment systems.

Long Range Plan

Many of the actions required to improve, or ensure the long-term protection of, our water resources can not be completed in five years, or involve long-term ongoing activities. Of necessity, the following list of suggested long-term activities is less also specific and should be considered a flexible outline of activities whose implementation will depend on what choices are made by the Town, and what activities are accomplished, during the next five years.

1. Regulatory Actions

a. Continue to upgrade Town water quality bylaws and regulations based on the best available science and guidance from federal, state and other expert sources.

2. Data / Knowledge

a. Continue long-term water quality sampling programs for Popponesset and Waquoit Bays and their sub-embayments, in coordination with the adjacent towns, the Waquoit Bay National Estuarine Research

Reserve and other interested agencies and organizations, to facilitate planning for, and monitoring the effects of, efforts to reduce nutrient loading and other contaminants.

3. Water Supply

a. Extend public water supply facilities to all areas of the Town with existing small lot development, high levels of commercial development or known drinking water quality problems, and to other areas of the Town as appropriate based on public health, fire protection needs and cost-effectiveness.
b. Develop public water supplies required to meet "buildout" water demand of 8-10 million gallons per day.
c. Continue to acquire lands critical to protection of existing and proposed public well sites.
d. Maintain coordination between the Water District, Town, County and state agencies regarding the selection and development of new public well sites in order to 1) avoid Water District conflicts with municipal plans, 2) minimize conflicts with existing and proposed land uses which may have an impact on water quality and 3) avoid degradation of other natural resources such as wetlands and rare species habitat.
e. Complete elimination of dead ends, where feasible, in the Water District's distribution system.
f. Continue the development, improvement and implementation of water conservation programs and incentives.

4. Wastewater Facilities

a. Develop appropriate municipal wastewater collection and treatment systems for all parts of the town where they would provide the most cost-effective and environmentally sound means of protecting water quality in public water supply wells, streams and surface water bodies.
b. Consider / negotiate / design / implement use of one or more of the potentially-required New Seabury wastewater treatment facilities to develop municipal systems in those portions of New Seabury and Popponesset which lie in the Popponesset and Waquoit Bay recharge areas and the Zone II of the High Wood wells.
c. Determine feasibility / implement use of the Mashpee High School treatment plant as the basis of a treatment facility which could serve TCB Mashpee Village, Lakeside Estates trailer park and other nearby areas.
d. Continue to take advantage of opportunities to share, merge or piggyback on existing and proposed private wastewater collection and treatment systems.

5. Other Actions

a. Continue to coordinate regulation and management of nutrient impacts to the Popponesset and Waquoit Bay estuarine systems with the other towns in each watershed.
b. Implement required activities to reverse the impacts of over-nutrification in Santuit Pond and any other degraded freshwater ponds identified by the study identified under the Five Year Plan.
c. Develop, fund and implement remediation programs for identified nutrient loading problems in the town's other freshwater ponds.
d. Design and implement stream management plans to protect and enhance water quality, herring runs, other fisheries and ecological health in each of Mashpee's rivers and streams.
e. Continue active participation in ensuring the containment and cleanup of contaminant plumes originating at the Massachusetts Military Reservation.
f. Maintain dredging projects which improve flushing and water quality in our estuarine waters.

g. Continue to construct and maintain stormwater retention and treatment facilities on Town and other roadways, parking areas or in other areas which contribute bacteria or other contaminants to our ponds, streams or estuarine waters.

h. Maintain an ongoing public education program regarding potential homeowner and business impacts on our groundwater, wells and water bodies and means of reducing or eliminating those impacts.

Bay, River & Pond Recharge Areas

Map 4-6

Source: Cape Cod Commission

Wastewater Facilities Concept Plan

Map 8-2