SECTION 5

IDENTIFICATION AND EVALUATION OF WASTEWATER PLAN COMPONENTS

A municipal wastewater system has three principal components, as illustrated in Figure 5-1:

- Collection
- Treatment
- Disposal or Reuse

This section of the report identifies and evaluates feasible options applicable to Orleans for each of these components. It also looks into methods to reduce current and future wastewater flows and associated pollutant loads so that each component can be smaller and less expensive. Also reported are the results of a search for sites for wastewater treatment and disposal. The last portion of this section discusses non-traditional methods for reducing nitrogen loads from wastewater and other sources.

5.1 WASTEWATER FLOWS AND LOADS

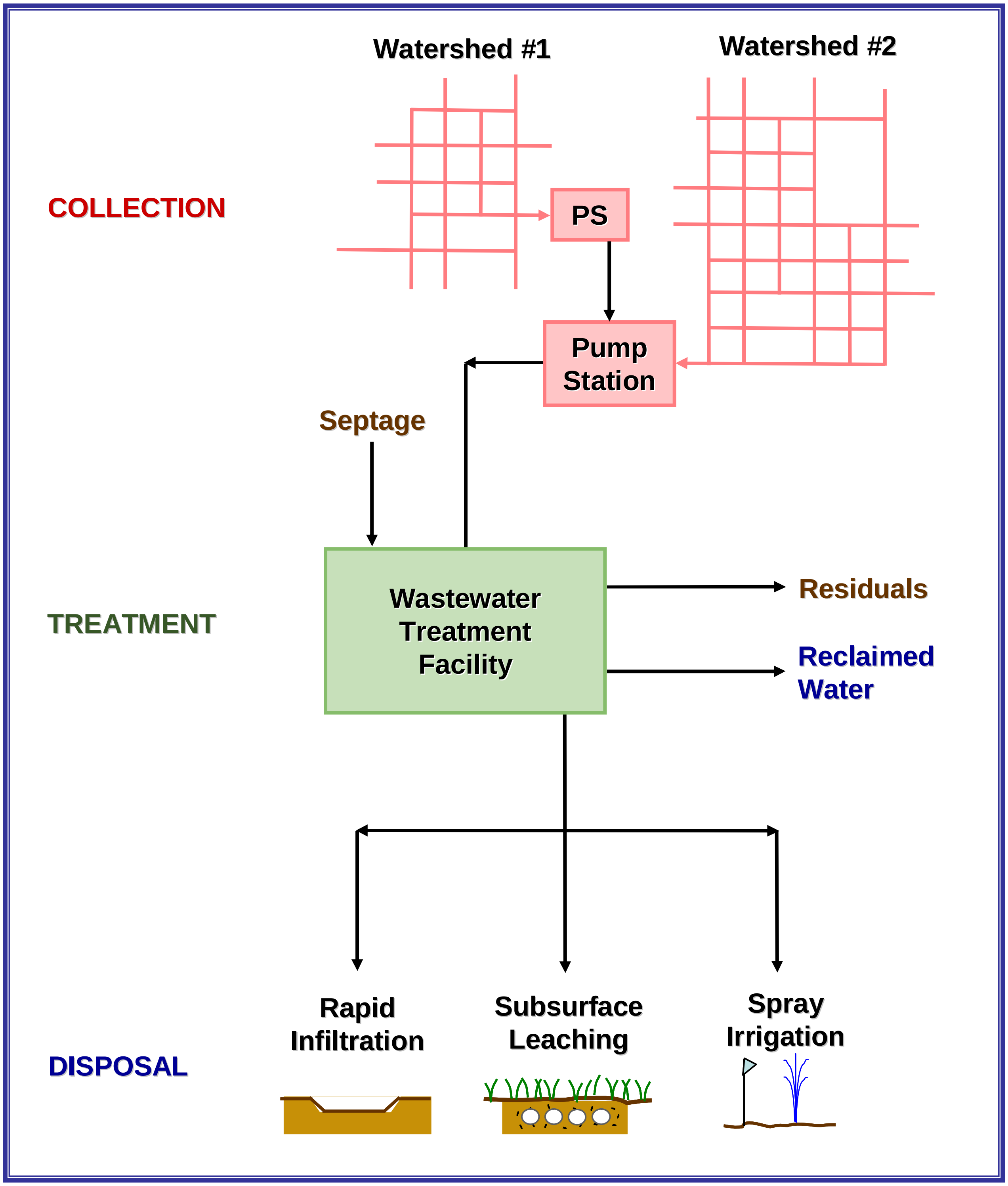
Before alternative wastewater management options can be identified and evaluated, it is first necessary to document the quantities of wastewater that must be managed. It is also important to consider ways to reduce the wastewater volume, or manage its rate of growth, and to reduce the contaminants contained in the wastewater.

5.1.1 Summary of Wastewater Management Needs

The needs assessment is presented in Sections 2, 3 and 4 of this report. Table 4-2 is a summary of that assessment. For each of the major watersheds in Orleans, this table documents the

FIGURE 5-1

GENERIC WASTEWATER MANAGEMENT SYSTEM



number of parcels and the current and projected future wastewater flows for five categories of need, as follows:

1. Ensuring sanitary conditions
2. Protection of public and private drinking water supplies
3. Protection of surface waters against nutrient enrichment
    - Nitrogen loading to embayments
    - Phosphorus loading to freshwater ponds
4. Addressing convenience and aesthetic issues
5. Enabling sustainable economic development

It is clear from Table 4-2 that the control of nutrient loading to surface waters (specifically nitrogen loading to embayments) is the principal wastewater need in Orleans. Surface water protection accounts for a large fraction of needs in the Pleasant Bay and Nauset estuary systems. In the Cape Cod Bay watersheds, nitrogen control, sanitary issues and convenience/aesthetics are all significant.

5.1.2 Strategies for Reductions of Flows and Loads

As technologies are identified to address the needs summarized earlier, it is appropriate to ask: "Could the costs for satisfying these needs be reduced if the quantities of wastewater or the associated pollutant loads were reduced at the source?"

"Wastewater flows" are the volumes of wastewater generated over a given time period, expressed in such units as gallons per day (gpd). "Wastewater loads" are the quantities of pollutants contained in the wastewater, expressed in mass-per-time units such as pounds per day.

Table 5-1 lists all of the alternative wastewater components that have been considered in this report. The first column of that table summarizes the wastewater flow and load reduction measures that may be appropriate to Orleans. These options are discussed in detail in

TABLE 5-1
SUMMARY OF ALTERNATIVES FOR
WASTEWATER MANAGEMENT COMPONENTS

A Flow and Load Reduction	B Wastewater Collection	C Wastewater Treatment	D Effluent Disposal	E Effluent Reuse	F Non-Traditional Nitrogen Control
Low-flow Plumbing	**Conventional Gravity**	<u>**Large Scale**</u>	**Subsurface Leaching**	**Landscape Irrigation**	**Fertilizer Controls**
Progressive Pricing	Low Pressure STEP	**Sequencing Batch Reactors**	**Rapid Infiltration**	**Toilet Flushing**	**Stormwater Management**
Outside Showers	**Grinder Pumps**	**Oxidation Ditches**	**Spray Irrigation**	Aquifer Recharge	**Density Controls**
Alternative Toilets	Small diameter	Rotating Biological Contactors	**Drip Irrigation**		**Natural Attenuation**
Eliminate Garbage Grinders	Vacuum	**Membrane Bioreactors**	**Wicks**		Permeable Barriers
		Biological Aerated Filters			**Flushing Enhancements**
		<u>**Small Scale**</u>			Sediment removal or Alteration
		Amphidrome			Aquaculture
		Bioclere			
		FAST			
		Nitrex			
		Chromoglass			

Legend:
Included in plans for more detailed review
Not evaluated further

Appendix B. The highlighted technologies in Table 5-1 are those considered most applicable to Orleans and are candidate "building blocks" for composite wastewater management plans. These options are:

Low-flow plumbing fixtures: Low-flow washing machines and sink and shower fixtures are now readily available that can reduce water consumption by at least 10% over older devices. Reducing water consumption with modern fixtures will reduce the wastewater production, save costs for wastewater treatment and disposal, and perhaps reduce the number of effluent disposal sites that must be developed.

Outside showers: Outdoor showers are widely used on Cape Cod in the summer time. This current practice provides a significant reduction in wastewater generation by removing this otherwise indoor activity from the wastewater stream. While there are benefits to wastewater system sizing and cost, this practice is not allowed under current DEP regulations.

Progressive water pricing: Water service pricing is an effective tool for promoting flow reduction. A progressive pricing structure includes fees that are based on the size of the service and the quantity of water used. The larger the service connection, the higher the quarterly fee. The quantity of water used is billed incrementally. Generally, the first fee bracket covers the majority of the water used in a water-conserving single-family residence. Subsequent brackets are associated with higher fees. Water pricing can also vary seasonally. It is feasible to charge increased rates in the summer when demand is the highest. All of these practices can provide an economic incentive to reduce water consumption and subsequently reduce wastewater generation rates and wastewater management costs.

Elimination of Garbage Grinders: Disposing of food waste through garbage grinders adds pollutant load to the wastewater stream. Instituting a ban on this practice, or enforcing existing such rules, will help reduce the cost of wastewater management. Conventional wastewater constituents would be reduced by about 25% and nitrogen load would be reduced by about 5%. (Removing food waste from the wastewater stream means that it must be incorporated into an alternative waste stream, such as municipal refuse or home composting. Proper disposal or reuse of food waste is important to prevent nutrients from reaching receiving waters by other means.)

There is a disincentive for garbage grinder use built into Title 5. Homes that have garbage grinders are required to have two-compartment septic tanks and to oversize their leaching systems by 50%. That disincentive disappears when a homeowner ties into a public sewer system. The Orleans Board of Health should institute a ban on garbage grinders to both sewered and unsewered properties, and the public outreach program associated with this CWMP should emphasize the importance of this ban.

Alternative toilets (e.g., composting toilets and urine diverting toilets) were investigated as a means of reducing both wastewater flows and pollutant loads. While some significant benefits may accrue, this option is not likely to gain sufficient public acceptability for it to be widely used. It has not been carried forward as a principal part of this program, but may have applicability in certain circumstances in Orleans. A pilot program may be warranted to better assess effectiveness and public acceptability.

5.2 WASTEWATER COLLECTION

To address the wastewater needs identified in Orleans, wastewater from certain homes and businesses must be collected and conveyed to one or more locations for treatment and disposal. The collection system is a major structural component of a municipality's wastewater management system. The best type of collection system for a given community is determined by comparing use, capacity, costs, operation and maintenance requirements, and benefits to the specific environment and landscape. The collection system includes all components from the source of the wastewater (typically the internal building plumbing) to the treatment plant. (The pipe from the home or business to the public system in the street is called the "service connection" and it is usually the responsibility of the property owner.) With some collection system options, the publicly-owned system may include components on the property to be served.

In addition to selecting collection technology, Orleans must also develop a strategy for determining which properties will be served by the collection system.

5.2.1 Collection System Options

As listed in Table 5-1, the proven technologies for wastewater collection include conventional gravity systems, low pressure (STEP and grinder pump) systems, vacuum systems, and small diameter gravity systems. Appendix B provides a detailed description of each of these options, lists their advantages and disadvantages, and provides local examples.

This evaluation of alternatives has identified the most appropriate system for Orleans; see the highlighted technologies in Table 5-1. The Town should plan to use a conventional gravity sewer system, supplemented with grinder pumps and low pressure sewers in those locations where gravity system is expensive or environmentally disruptive. This choice provides ease in long-term maintenance, cost-effectiveness, lowest energy use and the best ability to deal with power outages.

5.2.2 Criteria for Identifying Properties to be Served

The Needs Assessment has shown that nitrogen control is the largest driving factor for municipal wastewater systems. In certain areas of town, sanitary needs, pond protection, and convenience/aesthetic factors also come into play. As town-wide plans are developed, certain criteria should guide the layout of a wastewater collection system. Important considerations include:

- Connect the lots with the highest wastewater nitrogen load per lot. The Town's lot-by-lot database will allow for the identification of those parcels with the highest water use which generally indicates the highest wastewater nitrogen load. If, say, a 65% nitrogen load reduction is required in a certain watershed, it should be possible to achieve that goal with fewer than 65% of the properties sewered.
- Connect all commercial lots in areas with nitrogen needs. These parcels tend to have higher-than-average water use and may have higher nitrogen concentrations in their effluents.
- Focus on those streets with the highest wastewater flow per mile of street length. This approach should result in the most "efficient" sewer systems, that is, the least amount of pipe per property served.

- Give priority to lots closest to the embayment or pond to be protected, preferably within the 10-year groundwater travel time.
- Other factors being equal, avoid those neighborhoods requiring grinder pumps or numerous conventional pump stations. (Note that this goal may be contrary to focusing on lots nearest the shore from a travel-time perspective.)
- Provide sewer service that can address multiple needs. That is, try to include those parcels with sanitary or other non-nitrogen needs as part of the overall nitrogen-control goal. Even where a documented need does not exist, try to include those properties that face high costs for future Title 5 replacement.
- Consider opportunities for natural attenuation of nitrogen in wetland systems (avoid reliance on ponds for natural attenuation due to potential for negative impacts).
- Locate neighborhoods that could be easily added to the core system when growth dictates the expansion of the system to offset new nitrogen loads.
- Consider the locations of potential treatment sites to minimize transport costs.
- Consider connecting more properties than indicated by Orleans' strict pro-rata share of Pleasant Bay nitrogen control needs to account for areas in Brewster that are not easily served by public facilities.

When wastewater collection, treatment and disposal alternatives are combined into composite plans, these collection priorities should be accounted for.

5.3 WASTEWATER TREATMENT

Where high levels of nitrogen removal are required to protect estuarine water quality, wastewater treatment systems will be needed as the principal nitrogen control mechanism. Wastewater treatment can also provide high levels of phosphorus removal if necessary for pond protection. It is important to consider the likely effluent limitations that will govern wastewater treatment, the proven technologies available to meet those limits, and the handling of residual solids that are a byproduct of treatment.

5.3.1 Effluent Limitations and Expected Performance

The selection of technologies for wastewater treatment must be driven by two goals:

- Adherence to effluent limitations established by a DEP Groundwater Discharge Permit and
- Ability to achieve low effluent nitrogen concentrations to ensure TMDL compliance at the lowest possible cost.

Table 5-2 summarizes the effluent limits that have been established by DEP for a range of applications, as well as assumptions related to the phosphorus limits that might also be put in place in the future. Table 5-2 addresses the conventional parameters, such as Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), as well as the principal nutrients of concern (nitrogen and phosphorus). The expected effluent limitations for these parameters are shown for 5 scenarios, as follows:

1. Traditional groundwater discharge permit standards, such as are in force for numerous small wastewater treatment plants across Cape Cod.
2. A higher level of nitrogen removal for those cases where this nutrient must be reduced to the minimum concentration achievable by current technology.
3. Conventional removal of phosphorus using low-cost chemical addition.
4. A higher level of phosphorus removal, as might be needed where phosphorus must be reduced to the lowest level possible with available technology; and
5. Effluent reuse standards, in three categories that apply to such activities as landscape irrigation, toilet flushing and agricultural activities.

The traditional limits of a groundwater discharge permit are common and well established. The DEP's Water Reuse Standards define the effluent standards quite definitively. For phosphorus removal and the higher level of nitrogen control, there is much less precedent on the effluent limits. Therefore, it will be important to gain DEP's concurrence on the projected limits on phosphorus limits that might in the future be included in groundwater discharge permits.

The wastewater treatment technologies that are selected for more detailed evaluation must, of course be capable of meeting the various standards shown in Table 5-2. As a practical matter,

TABLE 5-2
EXPECTED EFFLUENT LIMITATIONS

	Effluent Discharged to Groundwater				5. Effluent Reuse		
	1. Traditional GWD Permit	**2. High Level N Removal**	**3. Average P Removal**	**4. High Level P Removal**	**Class A**	**Class B**	**Class C**
BOD, mg/l	30	30	30	30	10	30	30
TSS, mg/l	30	30	30	30	5	10	30
Nitrogen, mg/l							
Nitrate/Nitrite	10	5	10	10	---	---	---
Total	10	5	10	10	10	10	10
Oil & Grease, mg/l	15	15	15	15	---	---	---
pH, Standard Units	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5
Phosphorus, mg/l	---	---	1.0	0.3	---	---	---
Turbidity, NTU							
Average	---	---	---	---	2	---	---
Maximum	---	---	---	---	10	---	---
Fecal Coliform, #/100 ml							
Mean	200	200	200	200	---	---	---
Median	---	---	---	---	0	14	0
Maximum	---	---	---	---	14	100	200

Notes: Class A reclaimed water may be used for: irrigation where the public is likely to come into contact with the water, toilet flushing, agricultural use, industrial process water, commercial laundries, carwashes, fire protection and the creation of wetlands and recreational impoundments. Class B reclaimed water may be used for: irrigation at locations where the public is not likely to come in contact with the water, unprocessed food crops where there is no contact between the water and the edible portion of the crop, dust control, soil compactions, mixing concrete and washing aggregate, and street cleaning. Class C reclaimed water may be used for: agricultural irrigation of orchards and vineyards where there is no contact between the water and the edible portion of the crop, industrial process water, and silviculture.

most technologies are capable of even better performance, and will be conservatively designed to meet the applicable standards with a safety margin. Since the embayments are sensitive only to annual average nitrogen loads, it is the average effluent concentration, not the monthly permit limit, that is pertinent to TMDL compliance. Therefore, in formulating composite wastewater systems for more detailed evaluation, it is important to predict the annual average performance of each technology. Table 5-3 presents information on the expected performance of conventional technologies at various sized plants.

The performance of any given wastewater technology is very size-dependent. The smaller the facility, the less its ability to adapt to changing influent flows and loads, which become relatively more pronounced at lower flows. For the smallest satellite plants, it should be assumed that the average performance will be very close to the permit limits. At plants greater than 200,000 gpd, the average effluent concentration will be 30 to 50% below the permit limits.

The performance estimates in Table 5-3 are very important. The extent of sewers needed to reach the TMDL, other things being equal, will be proportional to the average nitrogen concentration in the treatment plant discharge. That is, a collection system leading to a treatment plant with a 7-mg/l average nitrogen discharge will be about 10% smaller than a collection system leading to a plant with a 10-mg/l discharge. Therefore, it is very important to accurately predict the average performance of these systems, and it is critical that DEP concur in these estimates. Table 5-3 has been reviewed by DEP, whose staff members view these effluent concentrations to be appropriate for wastewater planning.

This concept also provides support for a phased program. If the Town moves forward with a treatment plant based on an expected effluent quality of 8 mg/l, and the plant actually produces 7 mg/l, then later phases of the program can be scaled back or deferred accordingly.

TABLE 5-3
EXPECTED EFFLUENT QUALITY

			Nitrogen, mg/l		Phosphorus, mg/l	
	Flow Range, gpd		Effluent Limit	Expected Performance	Effluent Limit	Expected Performance
	From	To				
Title 5 Systems						
Individual	400	2,000	None	35	None	10
Cluster	2,000	10,000	None	35	None	10
Title 5 Systems w/ Enhanced Treatment						
Individual	400	2,000	19	19	N/A	9
Cluster	2,000	10,000	19	15	5	5
Satellite Systems						
Small						
Traditional GWD Permit	10,000	25,000	10	10	N/A	9
High Level N Removal	10,000	25,000	N/A	N/A	N/A	9
P Removal	10,000	25,000	---	---	2	2
Medium						
Traditional GWD Permit	25,000	75,000	10	8	N/A	9
High Level N Removal	25,000	75,000	N/A	N/A	N/A	9
P Removal	25,000	75,000	---	---	1	1
Large						
Traditional GWD Permit	75,000	200,000	10	7	N/A	9
High Level N Removal	75,000	200,000	5	5	N/A	3
P Removal	75,000	200,000	---	---	1	0.5
High Level P Removal	75,000	200,000	---	---	0.3	0.3
Centralized Systems						
Traditional GWD Permit	200,000	1,500,000	10	7	---	---
High Level N Removal	200,000	1,500,000	5	3	---	---
P Removal	200,000	1,500,000	---	---	1	0.5
High Level P Removal	200,000	1,500,000	---	---	0.3	0.2

In some cases, phosphorus control is the primary concern with respect to surface water protection. Phosphorus removal from wastewater is easily achieved by chemical addition to the secondary or tertiary treatment process. Once a nitrogen removal technology is selected, an "add-on" for phosphorus removal is easily incorporated into the treatment design for those systems that serve areas tributary to freshwater ponds and lakes that require phosphorus load reduction. For this reason, this report focuses on a detailed evaluation of nitrogen-removing technologies.

An important decision in wastewater planning is the number and size of wastewater treatment facilities that will be developed. Many towns elect to build a single centralized plant. Other towns have developed decentralized systems that combine a number of small-scale plants. It is helpful to consider four categories of wastewater systems:

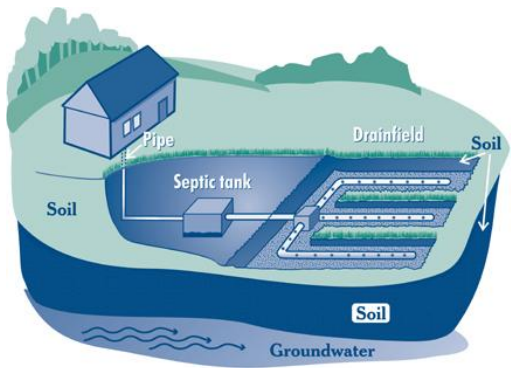
- Individual on-site systems,
- Cluster systems,
- Satellite plants, and
- Centralized plants.

These terms are defined and illustrated in Table 5-4. The first three types of systems are the building blocks of a decentralized system. Decentralized options are best suited to serving dispersed pockets of wastewater needs, because they reduce costs for transporting wastewater long distances. They also are well-suited for communities with no suitable sites for large centralized plants.

This evaluation of wastewater treatment technologies looked separately at large-scale (design flows over 200,000 gpd) and small-scale (smaller than 200,000 gpd) applications. Large-scale options relate to centralized and larger decentralized plants. Small-scale technologies are applicable to decentralized plans.

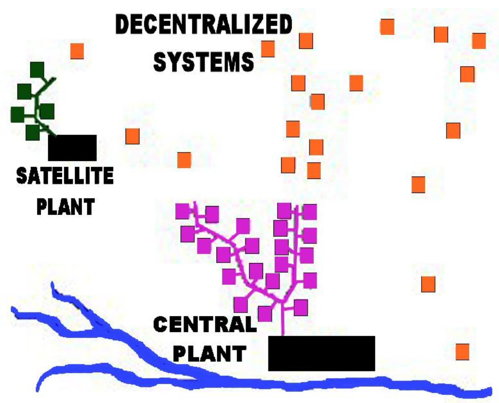
TABLE 5-4

GENERAL CATEGORIES OF WASTEWATER SYSTEMS



Individual On-site Systems: generally, septic tank and leaching field systems serving a single home or business, and located on the same parcel as the home or business. In Massachusetts, these are typically referred to as Title 5 systems, which imply treatment in a simple septic tank prior to discharge to a subsurface disposal system. Some individual on-site systems involve nitrogen and/or phosphorus removal. These systems are permitted by local boards of health and managed by individual property owners.

Cluster Systems: systems for wastewater collection, treatment and disposal that involve multiple parcels and multiple wastewater generators, served by a single system. Cluster systems typically have capacities between 1,000 and 10,000 gallons per day (gpd). In Title 5 these are also called "shared systems". Cluster systems may be as simple as gravity pipes leading to a shared septic tank and shared disposal field, but may also include grinder pumps, low pressure sewer systems and modular plants providing enhanced treatment. These systems are typically permitted by local boards of health and by DEP, and are managed by associations of property owners.



Satellite Systems: those facilities for wastewater collection, treatment and disposal that require a DEP groundwater discharge permit (that is, have wastewater flows exceeding 10,000 gallons per day) and are intended to serve a closely defined area. Many of the satellite systems on Cape Cod have been built by private developers to serve condominium projects, nursing homes, and shopping centers. While many are privately developed, satellite systems can be publicly owned. Private satellite plants are typically managed by the commercial property owner or condominium association; publicly-owned satellite plants are managed by the local public works department, school department or other town entity.

Centralized Wastewater System: the provision of public sewerage through a wastewater collection system leading to a publicly-owned wastewater treatment plant with effluent disposal. These systems are typically managed by local sewer commissioners or departments of public works.

Source: Wright-Pierce, "Enhancing Wastewater Management on Cape Cod: Planning, Administrative and Legal Tools", July 2004.

Column C of Table 5-1 lists the wastewater treatment technologies considered for Orleans. Appendix B contains a description of each technology, as well as a discussion of advantages and disadvantages and a listing of local examples. The highlighted technologies in Table 5-1 are those considered most applicable to Orleans and are candidate "building blocks" for composite wastewater management plans.

Large-Scale Alternatives

The most applicable large-scale technologies for Orleans are all variations of biological treatment systems that use bacteria to remove organic matter and nitrogen. They differ in the manner in which the bacteria are exposed to the wastewater and the means by which the bacterial culture is then removed and recycled. The best options are:

Sequencing Batch Reactors (SBRs): SBR systems operate on a very simple concept of introducing a quantity of waste to a reactor and providing several process steps in a sequence that would traditionally require a single tank for each step. That sequence includes filling the reactor with wastewater, and then providing sequential periods of aerobic treatment, settling, and anaerobic treatment. Then the effluent can be decanted and a portion of the sludge removed before the process is repeated. Combing several treatment steps into a single tank reduces the land area requirement over other technologies, and the tanks are covered.

Oxidation Ditches: Wastewater is treated as it flows around a long oval-shaped concrete channel. Instead of providing several process tanks like some other technologies, the length of the channels allows for different types of treatment to occur as the wastewater moves around the ditch. Wastewater alternately passes through aerobic and anoxic zones allowing a mixed culture of bacteria to remove organic matter and nitrogen. A separate tank (a clarifier) is needed for removing and recycling the bacteria. This technology requires a relatively large footprint to accommodate the ditch. Unlike other technologies, the oxidation ditch is nearly always located outside. It has been widely used in the U.S. and is capable of reliably achieving a low nitrogen concentration.

Membrane Bioreactors. Membrane Biological Reactors (MBRs) include a semi-permeable membrane barrier system, either submerged in, or following an activated sludge process, that provides the solids separation that is accomplished in a clarifier with other technologies. This technology ensures removal of virtually all suspended pollutants.

The membrane technology is relatively new, and operating data from systems installed in the past few years is promising, with results indicating that very high effluent quality is achievable. Membranes are expensive and require regular cleaning and periodic replacement. The cost of the membrane is partially offset by the smaller building needed to house the system, compared to other technologies. This treatment process requires a relatively small footprint, and above-grade or below-grade installation of the treatment process is possible.

Biological Aerated Filters (BAFs): This system consists of flooded tanks filled with polystyrene beads which provide the required surface area for biological growth and filter the wastewater as it passes through. The BAF unit acts as a "fixed film" process resulting in reduced sludge production, roughly 60%, in comparison to SBR, oxidation ditch and MBR "suspended" growth processes. The BAF unit can be housed inside or outside and either above or below grade. The overall footprint of this process can be very small relative to traditional alternatives.

Small-Scale Alternatives

As with the large-scale systems, the most applicable small-scale technologies for Orleans are all variations of biological treatment systems that use bacteria to remove organic matter and nitrogen. The small-scale systems are largely proprietary modular systems consisting of factory-built components installed with pre-cast concrete tanks. The best options are: 1) Amphidrome, a fixed-film sequencing batch reactor; 2) Bioclere, which uses a fixed-film trickling filter process; 3) Cromaglass, which provides treatment in a sequencing batch reactor sludge system; 4) MBRs as described above; and 5) FAST, which utilizes both fixed- and suspended-growth nitrogen removal methods. Nitrex is a new technology that uses a nitrate-reactive media to convert nitrate to nitrogen gas, following a nitrification step to convert other nitrogen forms to nitrate. Early testing shows promise, but the long-term cost and performance are yet unproven.

These small-scale technology choices have been widely used for flows less than 50,000 gpd. For larger decentralized systems (50,000 gpd to 300,000 gpd), the large-scale technology options are more appropriate.

5.3.2 Management of Residuals

Wastewater treatment systems (whether they are on-site septic systems, cluster systems, satellite plants or centralized wastewater treatment facilities) purify wastewater and create concentrated byproducts in various forms. These "residuals" fall into the following categories: 1) septage, including grease; 2) grit and screenings; 3) liquid sludge; and 4) dewatered sludge or sludge "cake". The CWMP must include cost-effective and environmentally sound means to handle these residuals.

The Tri-Town Septage Treatment Facility (see Figure 5-2) is near Namskaket Marsh and is owned by the Orleans Brewster Eastham Groundwater Protection District. It now receives septage from Orleans, Brewster and Eastham (the members of the three-town District), septage from other Lower Cape towns, and some limited quantities of liquid sludge from small-scale wastewater treatment systems (cluster and satellite plants). The sludge generated from processing this incoming waste is dewatered on-site and hauled by contractor to out-of-town disposal locations. A study of the Tri-Town facility, conducted in 2005 and 2006, showed that it has capacity to receive septage generated in the three District towns well into the future, after significant repair and upgrading needs are addressed. If Orleans were to build wastewater treatment systems elsewhere in town, either a single centralized plant or a series of decentralized facilities, Tri-Town is the only logical destination for the liquid sludges generated from those wastewater facilities. The sludge produced through wastewater treatment would be offset by the reduction in Orleans septage quantities (resulting from elimination of septic systems on those lots served by public sewers).

If the Tri-Town site were the home of a new wastewater treatment plant, that facility would be designed to thicken and dewater its own sludge. That new sludge handling equipment could be easily enlarged to handle the septage now received at the existing Tri-Town plant, allowing the demolition of the now 20-year-old facility. Out-of-town disposal of dewatered sludge is the best method for Tri-Town because the site is not large enough for processing options such as composting, and their cost-effectiveness is hampered by the relatively small quantities of sludge. For the same reasons, any new wastewater facility would be best served by out-of-town sludge disposal. The transport and disposal of dewatered sludges is a mature industry with significant competition. The Town of Orleans should make use of those private options for both sludge cake and grit/screenings. Therefore, no detailed evaluation of on-site sludge processing facilities is recommended.

FIGURE 5-2

TRI-TOWN SEPTAGE TREATMENT FACILITY

5.4 WASTEWATER REUSE AND DISPOSAL

Once wastewater is collected and treated, it must then be properly disposed of or put to productive use. Unlike other parts of the country where surface water discharge is a viable option, effluent disposal on Cape Cod must be land-based and is land-intensive. The available disposal technologies must be carefully considered to match the availability of appropriate disposal sites. Given the site limitations in Orleans (see Section 5.5), the Town should consider opportunities for reuse of effluent that allow more sites to be considered.

5.4.1 Wastewater Disposal Technology

Five technologies are listed in Column D of Table 5-1 that are applicable for effluent disposal in Orleans. These include subsurface leaching, rapid infiltration, spray irrigation, drip irrigation and wicks. Appendix D provides a detailed description of each of these option, lists their advantages and disadvantages, and provides local examples. All of the identified effluent disposal options may have applicability to Orleans. Two alternatives, wicks and drip irrigation, are less common and subject to more regulatory constraints, and should be considered further only if the more traditional options prove inadequate. (Drip irrigation may have applicability for effluent disposal on ballfields in either the "disposal" or "reuse" setting. Experience with this technology has expanded significantly in recent years and it is viewed favorably by DEP in some circumstances.) The three more traditional alternatives should be part of the composite plans that are evaluated in more detail. Those traditional effluent disposal options are:

Subsurface leaching: By far the most common example of this type is the soil adsorption system found in the backyard of the typical Cape Cod home. A soil adsorption system includes a network of rigid perforated piping buried below grade that distributes effluent into surrounding gravel trenches or beds that provide dispersal of effluent over a large area at a low dosing rate. If well maintained, these systems last for at least 20 years. Land must be available for the active disposal area as well as additional space earmarked as reserve, which can be developed in the event of a failure. These systems are designed to operate year-round and work best with regular dosing of effluent. The entire disposal system is buried which eliminates the chance of human contact, and can be located under public parks or sports fields, and under parking lots with proper design. Subsurface leaching requires more land than rapid infiltration (see below) and is usually more expensive.

Rapid Infiltration: Also referred to as open sand beds, these systems can operate at high loading rates on sites with good permeability and significant depth to groundwater. Year-round application is routine, but there is little opportunity for dual use of a site. The significantly reduced footprint compared with other technologies often outweighs the benefit of dual use. A smaller disposal footprint also broadens the number of parcels that could be viable disposal sites. The reduced footprint sometimes allows a single site to provide both treatment and disposal, which is less likely for other systems. Locating the treatment and disposal processes on the same site minimizes the transport costs.

Spray irrigation: Landscape irrigation is another example of technology that can be used on a site with another use. Effluent can be applied to parks, sports fields, golf courses, or landscaping. All of these activities are associated with human interaction and require meeting the DEP Water Reuse Regulations, which usually adds to the cost of wastewater treatment (see Section 5.4.2 below). Irrigation is certainly restricted to seasonal operation which requires either winter storage or a complementary effluent disposal system, either of which can add substantially to the cost. This technique uses moderate application rates. Spray irrigation can also be accomplished at public-access-controlled sites, which with adequate buffers may be permissible without meeting the DEP water reuse requirements.

5.4.2 Wastewater Reuse Opportunities

Given the lack of large traditional effluent disposal sites in Orleans, the Town should consider a formal effluent reuse program. The fundamental premise behind any reuse program is recognition of the value of water and the nutrients it may carry, tempered by the public health aspects of public contact with wastewater-derived material. The allowable effluent disposal methods following traditional wastewater treatment (rapid infiltration, subsurface disposal, etc.) are in large part aimed at getting the effluent into the ground, and keeping it there, thus protecting the public from contact with a liquid that retains some undesirable characteristics even after tertiary treatment. The DEP water reuse program stipulates higher levels of treatment that address those undesirable characteristics so that certain levels of human exposure are tolerable.

Massachusetts DEP has established a program to guide the reuse of wastewater effluents. Its publication "Interim Guidelines on Reclaimed Water" was issued in January 2000 and was superseded by Water Reuse Regulation in 2009. The new regulations establish 3 classes of effluent quality and permit the following uses for each:

Class A:	Landscape irrigation where public contact is possible; toilet flushing; agricultural use; car washing; and fire protection.
Class B:	Landscape irrigation where public contact in not likely; some agricultural uses; dust control; and concrete manufacture.
Class C:	Some agricultural uses; industrial process water; and silviculture.

The new regulations give DEP the flexibility to allow other uses and to impose use-specific effluent limitation in addition to those shown in Table 5-2.

The use of reclaimed water requires a higher level of treatment than traditional effluent disposal techniques. The more stringent effluent limits relate primarily to suspended solids and bacteria (see Table 5-2). The treatment technologies recommended in Section 5.3 can be readily adapted to meet the DEP Water Reuse Standards, albeit at additional cost for enhanced solids removal and high-intensity disinfection. If membrane bioreactors are chosen for traditional wastewater treatment, they can most easily meet those reuse requirements with only minor cost increases.

A large number of possible reuse applications have been identified: see Appendix B. The most attractive alternatives include:

- Toilet flushing at public buildings,
- Lawn irrigation at public sites,
- Irrigation of ballfields,
- Irrigation of golf courses, and
- Use of reclaimed water in concrete production.

Serious consideration has been given to including reuse in the composite wastewater plans which are evaluated in more detail in Section 7, either as primary means of effluent disposal or as seasonal supplements to traditional methods.

5.5 SITING OF WASTEWATER TREATMENT AND DISPOSAL FACILITIES

5.5.1 Initial Site Identification and First-Level Screening

The staff of the Orleans Planning Department, with assistance from Wright-Pierce, used the Town's geographic information system (GIS) to identify potential sites for wastewater facilities. This GIS search first considered undeveloped sites of 5 acres or greater, with ground surface elevation higher than 30 feet, located outside the water supply Zone IIs. Particular emphasis was placed on sites in public ownership. This search identified only a few such sites, clearly not sufficient for the overall town wastewater needs.

The site search was then expanded to consider all sites greater than 2 acres in size, including privately-owned land. While vacant parcels are preferred, this second search also considered some larger sites that are currently only partially developed (for example, a 5-acre site with a home in one corner, or a site used only for parking).

The sites identified in the GIS search were then reviewed by Wright-Pierce, both from aerial photography and by direct observation in the field. Some sites were eliminated due to significant development constraints. A total of 30 sites were deemed suitable for further investigation.

5.5.2 Target Effluent Disposal Capacity

The Needs Assessment determined that a municipal wastewater system, aimed at satisfying a broad range of current wastewater needs, would accept an average wastewater flow of approximately 500,000 gpd. At the planning horizon, that flow would grow to about 700,000 gpd. (By strategic sewer layouts--see Section 5.3.2--smaller wastewater volumes are possible.) Summer peak flows must be accounted for in the sizing of wastewater facilities, and effluent disposal systems are designed for the short-term (one-day or two-day) peak flows during the summer season. Peaking factors were derived from Town water records, and when applied to the estimated annual average wastewater flows, the following general target capacities were established for site identification and screening:

- Current 1.2 million gallons per day (mgd)
- Planning Horizon 1.7 mgd

Given the uncertainties associated with determining actual site capacities, the goal of the site search was to identify as much as 3 mgd of apparent capacity.

5.5.3 Second-Level Site Screening

Data were compiled on each of the 30 sites identified by GIS methods. This information included surficial soils descriptions, location with respect to ACECs, ready accessibility of public water service, depth to permanent groundwater, potential for perched water table, and distance to the nearest boundary of a public water supply Zone II.

The next step was to prepare scale drawings of each site, using aerial photography from the Mass GIS system. A conceptual layout was prepared for each site, assuming rapid infiltration or subsurface leaching, the most common effluent disposal methods. These conceptual designs were based on effluent loading rates of either 3 gallons per day per square foot (gpd/sf) for subsurface leaching or 5 gpd/sf for rapid infiltration. Set backs were assumed to be:

From property lines of developed parcels:	100 feet	(rapid infiltration)
	50 feet	(subsurface leaching)
From property lines of protected parcels:	50 feet	(rapid infiltration)
	30 feet	(subsurface leaching
From wetlands:	100 feet	(all cases)

Provisions were made for access roads and other peripheral facilities.

Based on these conceptual designs, each site was assigned an estimated capacity range. (Five of the 30 sites were deemed suitable only with non-traditional disposal technologies, such as wicks or drip irrigation, and capacities were not estimated for these 5 sites.) Table 5-5 lists the 25 sites where rapid infiltration or subsurface leaching designs were prepared, and includes the range of estimated disposal capacity.

As shown in Table 5-5, the conceptual designs indicate an aggregate disposal capacity of 3.8 to 4.6 mgd, well in excess of the 3 mgd target. While this is a favorable finding, it must recognized that there are many reasons why the actual capacity could turn out to be less than these estimates:

- The soils may not allow the relatively favorable application rates that were assumed.
- There may be site constraints, such as steep slopes or pockets of poor soils that are not apparent from the available mapping.
- Detailed site design may find that larger setbacks are appropriate.
- Some portion of these sites may be needed for modular wastewater treatment facilities.
- The nitrogen control needs of certain embayments may not allow as much effluent disposal as the site would allow.
- Groundwater mounding may limit the disposal volume.
- Private sites may be available only at very high cost or through an adversarial process.

On the other hand, there may be more suitable areas than were assumed and favorable soils, once fully tested, might allow higher loading rates than DEP currently permits for these disposal technologies.

While a relatively large aggregate disposal capacity was identified, there are several factors that complicate the analysis:

- Only one-third of the apparent capacity is located at sites owned by the Town or by quasi-municipal entities. Land acquisition negotiations and costs for private sites represent significant hurdles.
- There are very few large sites, and providing adequate capacity for all wastewater needs will likely require several sites.

TABLE 5-5
INITIAL CAPACITY ESTIMATES FOR IDENTIFIED DISPOSAL SITES

Site ID	Total Acres	Ownership	Development Status	Disposal Technology	Capacity, gpd	
					Low	High
111	< 2	Private	Parking	SL	60,000	60,000
112	2 to 5	Public	Parking	SL	75,000	75,000
121	5 to 10	Private	Dev--Residential	SL	150,000	150,000
161	< 2	Private	Vacant	SL	30,000	40,000
162	2 to 5	Private	Dev--Residential	SL	125,000	125,000
172	5 to 10	Private	Dev--Residential	SL	150,000	150,000
173	2 to 5	Private	Vacant	SL	60,000	60,000
181	5 to 10	Private	Dev--Recreational	SL	150,000	150,000
191	5 to 10	Private	Dev--Resid/Agric.	SL	50,000	75,000
Pleasant Bay Subtotal					**1,350,000**	**1,415,000**
221	2 to 5	Private	Vacant	SL	70,000	75,000
222	5 to 10	Private	Dev--Commercial	SL	100,000	150,000
231	5 to 10	Private	Dev--Recreational	SL	150,000	150,000
241	> 10	Public	Dev--Utility	RI	500,000	750,000
244	5 to 10	Private	Dev--Utility	RI	200,000	225,000
245	5 to 10	Private	Dev--Resid/Agric.	SL/RI	150,000	200,000
246	> 10	Private	Dev--Commercial	SL	150,000	225,000
247	2 to 5	Private	Dev--Commercial	SL	45,000	60,000
Cape Cod Bay Subtotal					**1,365,000**	**1,835,000**
312	2 to 5	Private	Dev--Utility	SL	50,000	75,000
313	> 10	Public	School	SL/DI	150,000	150,000
314	> 10	Public	School	SL/DI	300,000	300,000
316	> 10	Public	Gardens	SL	120,000	250,000
321	> 10	Private	Dev--Residential	SL	120,000	270,000
322	5 to 10	Private	Dev--Residential	SL	150,000	150,000
323	5 to 10	Private	Dev--Residential	SL	50,000	55,000
Nauset Subtotal					**940,000**	**1,250,000**
411	5 to 10	Private		RI	100,000	120,000
Atlantic Ocean Subtotal					**100,000**	**120,000**
Town Wide Total					**3,755,000**	**4,620,000**

Disposal Technology
- RI Rapid Infiltration
- SL Subsurface Leaching
- DI Drip Irrigation

- Only about 5% of the identified capacity is associated with vacant land. Including land now associated with parking or utility uses, increases that percentage to 12%.
- The identified capacity is well distributed across the major watersheds, although there is a deficit in the Pleasant Bay watershed when aggregate needs are considered.

This analysis leads to the following conclusions:

- The Town may need more than one disposal site, even in a centralized solution.
- Focused subsurface explorations are needed to obtain better estimates of capacity at the most favorable sites.
- Dual use of disposal sites is likely, such as effluent disposal under parking lots or ballfields.
- Sites for significant spray irrigation of effluent do not exist, given Orleans' lack of golf courses. If large-scale spray irrigation is to be considered, it must occur at an out-of-town site.

This site identification and screening process has focused on effluent disposal. The 25 sites listed in Table 5-5 were also evaluated as possible sites for wastewater treatment plants. The traditional 50-plus-acre undeveloped site in a remote area simply does not exist in Orleans. The most favorable sites for a centralized treatment plant are Site 241 (the location of the existing Tri-Town Septage Treatment Facility, where effluent disposal is also possible) and the existing Town landfill (where traditional effluent disposal is not feasible). Other sites for centralized facilities would require acquisition of privately owned land, demolition or relocation of existing structures, and very serious attention to design and set-back issues. Small modular wastewater treatment facilities could be accommodated at many of the effluent disposal sites listed in Table 5-5, albeit with reduced disposal capacity. If further investigation of the sites leads to unidentified constraints, the Town may need to expand its search to include sites in adjacent towns.

5.5.4 Site-Specific Exploration Needs

One drawback to developing multiple small sites is the potential cost of subsurface explorations to better define disposal capacity. Therefore it was recommended that the Town embark on a phased program of subsurface explorations that focuses first on the largest and best-situated sites.

Eight sites were selected for the initial exploration program; they fall in the following categories:

- Publicly-owned sites that are vacant or only partially developed
  - Site 241
- Publicly-owned sites that are developed in compatible uses
  - Site 313
  - Site 314
- Quasi-public sites developed in compatible uses
  - Site 244
  - Site 312
- Privately-owned sites developed in compatible uses
  - Site 246
  - Site 247
  - Site 222

Further study should include these steps:

- Compilation of existing data on soils properties and groundwater levels
- Test pits and percolation tests to supplement existing data
- Hydraulic loading tests and groundwater modeling

The Tri-Town site was evaluated previously by Wright-Pierce (see report dated August 2005). This site was included in the first round of site-specific testing because it has the greatest potential for large-scale effluent disposal. The results of testing at Tri-Town help guide the next phase of this program.

5.5.5 Next Steps

Certain sites listed in Table 5-5 were included in the town-wide wastewater plans that were subject to more detailed evaluation in the next phase of the CWMP. The formulation of those plans considered the wastewater system components (collection, treatment, disposal, etc., as discussed elsewhere in this report), as well as the nature of the wastewater needs in each major watershed and the logistics of linking needs with sites. This formulation and detailed evaluation of wastewater plans was accomplished concurrently with the site-specific investigations noted above. It was recognized that sites could be eliminated from consideration for non-technical reasons including public concerns, cost-effectiveness of decentralized options, acquisition problems with private parcels, etc. Expenditures on detailed site investigations were deferred if targeted sites could be eliminated for these reasons.

Many of the candidate disposal sites are located near the boundaries between the major watersheds. Large-scale application of effluent at these sites could cause those boundaries to shift, resulting in nitrogen migration to a different embayment than is currently the case. This potential for shifting boundaries must be addressed if any of the composite wastewater plans includes large discharges at these locations.

Due to this lack of large suitable disposal sites in Orleans, the Town should closely review flow and load reduction measures, and such non-traditional nitrogen control methods as fertilization reductions (see Section 5.6). This situation should also trigger discussions with neighboring towns about disposal sites, including golf courses, and multi-town facilities.

5.6 NON-TRADITIONAL NITROGEN CONTROL MEASURES

In the needs assessment phase of the CWMP, it has been shown that the control of nitrogen is the largest driving force toward improved wastewater management in Orleans. Nitrogen reaches the embayments from various sources and through multiple pathways. The "traditional" approach to controlling nitrogen is to replace septic systems with public wastewater facilities that remove large amounts of nitrogen, and discharge the effluent, either at appropriate locations within the watershed, or in the watershed of a less sensitive embayment. While public sewerage is a readily permitted and predictable method for nitrogen control, it can also be very expensive. There are a number of "non-traditional" methods for nitrogen control that offer significant cost savings.

In broad terms, non-traditional controls fall into the following categories:

- Options that prevent future nitrogen loads;
- Options that reduce current nitrogen loads before they reach the groundwater;
- Options that take advantage of natural processes that impact groundwater quality as it moves toward the embayments;
- Options that improve the ability of the embayments to assimilate nitrogen loads; and
- Options that remove nitrogen from the water column or sediments within the embayments.

Eight alternatives are listed in Column E of Table 5-1 that are potentially applicable to nitrogen control in Orleans. Appendix B provides a detailed description of each of these options, lists their advantages and disadvantages, and provides local examples. Five of these alternatives (highlighted in Table 5-2) should be considered further and included as supplements to the composite plans that are subject to more detailed review.

Control of Fertilization: When lawn and garden fertilizer is applied, some portion of the nitrogen nourishes the plants, another portion is converted to harmless nitrogen gas by soil organisms, and the excess nitrogen leaches to the groundwater. The MEP technical report for Pleasant Bay estimated that 30% of the un-attenuated nitrogen load from the watershed comes from fertilizer and stormwater runoff, with most of that from fertilizer. Therefore, after septic nitrogen, fertilizer nitrogen is the next largest source. In the Pleasant Bay sub-watershed (one portion of the overall watershed), nearly one-half of the watershed nitrogen load comes from lawn fertilization, principally from three golf courses within that watershed.

There are many steps that can be taken to reduce fertilizer nitrogen load to the groundwater. First, fertilized lawn area can be reduced. Second, where fertilizer is used, the application rate can be reduced, and the timing of applications can be spread out. Third, fertilizers with organic slow-release nitrogen can be substituted for traditional inorganic forms. These steps can be taken by all fertilizer users, but the greatest potential for reduction is where large fertilizer use occurs, which includes golf courses, town parks, and school district ballfields.

Education of the public on the need to modify lawn care practices should occur regardless of other steps. In addition, the Town should institute changes in its own practices and should work with the Nauset Regional School District in a similar fashion. Other possible steps include restriction on lawn area in new development, working with local lawn and garden retailers to stock only more-appropriate fertilizer products, and working with the County to institute a fertilizer ban. While not within the direct control of Orleans, every effort should be made to reduce the very large fertilizer use in the Pleasant Bay sub-watershed at golf courses in Brewster, Harwich and Chatham. Controls on fertilizer use on cranberry bogs should also be considered as appropriate.

Stormwater Management: Precipitation that falls on impervious surfaces runs off and takes with it a variety of pollutants, including nitrogen. If stormwater is discharged directly to a pond or embayment (or to a pipe or channel leading directly there) it is considered a "point source". If runoff infiltrates into the ground and transports pollutants to the groundwater it is considered a "nonpoint source". In either case, actions are warranted to reduce the pollutant load from stormwater. For all of Pleasant Bay, runoff from impervious surfaces is estimated to produce 9,000 pounds of nitrogen per year, or 9% of the total un-attenuated load from all watershed sources.

In general, the Town should try to remove all point sources by infiltrating stormwater instead of discharging it to surface waters. Where this is not possible, some "end-of-pipe" treatment may be warranted, such as exists at Lonnies Pond. While infiltration is most efficient through bare soil, vegetated surfaces provide considerable pollutant removal. Pollutants in runoff can also be addressed at the source, through such programs as regular street sweeping, owner control of pet wastes, requirements for nutrient management plans for large developments, etc.

There are many reasons why stormwater management should occur in Orleans, independent of nitrogen control. Phosphorus transport to ponds is an important issue, as is bacterial contamination at beaches and shell fishing areas from road runoff. These reasons for stormwater management are important enough on their own to warrant a town-wide plan. Implementation of that plan will also reduce nitrogen loads to embayments.

Density Controls through Municipal Bylaws and Regulations: The Needs Assessment documents how current wastewater generation rates in Orleans are expected to increase by 22% over the planning period ending in 2030. Considering a somewhat lower rate of increase in non-wastewater nitrogen sources (such as lawn fertilization), the town-wide nitrogen load may increase by about 20% as a result of growth in the community. Town-wide, the **current** nitrogen load must be reduced by perhaps 20% to 25% (depending on the findings of the MEP studies for the Nauset system). The **growth** in nitrogen load is approximately the same as the amount of the **current** load that must be removed. Any steps the Town can take to slow the growth in nitrogen load will directly impact the extent and cost of structural solutions.

A number of actions have been discussed among the WMSC, the Board of Health and the Planning Board. The most promising ones include:

- Reducing minimum lot sizes for new residential development or reducing the allowable development intensity on commercial properties;
- Instituting nitrogen-based performance standards for expansions and redevelopment, such as the "no net nitrogen increase" approach or a maximum pound-per-acre load (the "fair share" approach);
- Accelerating land purchases or conservation easements; and
- Instituting a "checkerboard" sewer system with limitations on increased flows from properties not served.

Natural Attenuation: As groundwater moves toward and into embayments, it may pass through freshwater ponds and bogs and through salt marshes. In these environments, there may be some removal of nitrogen by natural means that lessens the impact on the embayment. These processes are called "natural attenuation". Natural attenuation has been included in the modeling of embayments on Cape Cod as part of the Massachusetts Estuaries Program. For Pleasant Bay as a whole, natural attenuation is estimated to reduce the raw watershed nitrogen load by 4%.

Natural attenuation can be part of Orleans' overall plan in several ways. First, the selection of properties to be connected to traditional wastewater systems should focus on those properties that are not subject to natural attenuation; that is, once pond protection needs are addressed by sewering in areas immediately upgradient of ponds, wastewater collection should focus first on those properties that are downgradient from the ponds and wetlands that provide natural attenuation.

Second, effluent disposal sites can be located upgradient from these natural attenuation resources to allow further pollutant removals as the effluent-impacted groundwater moves toward the embayment. Great care must be taken to avoid secondary impacts, however, such as overloading the nitrogen attenuation capacity or introducing more phosphorus than is appropriate. Some studies have shown that salt marshes may have significant nitrogen removal capability with less potential for overloading than freshwater systems. In Orleans, where pond protection has high priority, salt marshes represent the best opportunity for natural attenuation and should be considered in effluent disposal siting. The Tri-Town site in Orleans is upgradient from Namskaket Marsh, and the marsh that may now be providing renovation of the Tri-Town plume and might provide attenuation of nitrogen from wastewater effluent infiltrated at the Tri-Town site. Similarly, the salt marshes separating Pochet Neck from Pochet Creek might provide a similar benefit for effluent disposed of in areas that are immediately upgradient.

The third opportunity for taking advantage of natural attenuation is in the restoration of damaged wetlands or the conversion of abandoned cranberry bogs. Some natural attenuation may be occurring at these locations, and restoring them to their original state may allow additional attenuation. In cranberry bogs, deepening the bog or increasing the water surface may increase the detention time of groundwater passing through these systems and allow for greater natural attenuation.

Flushing Enhancement: The residence time of nitrogen in an embayment in part determines the susceptibility of that embayment to water quality degradation. Enhancing the flushing rate of the embayment can improve water quality and lessen the impacts of a given nitrogen load. Dredging channels, widening inlets, and replacing constricting culverts are all ways to enhance tidal flushing. A number of sub-embayments in the Pleasant Bay system (for example Lonnie's Pond and Areys Pond) and perhaps Rock Harbor could potentially benefit from dredging to deepen their inlets. It is expected that less nitrogen control would be needed in the watersheds of these sub-embayments after dredging of their inlets, although additional modeling of the hydrodynamics and water quality would be needed to quantify the impact. (It is important to note that enhanced flushing in "headwaters" sub-embayments does not reduce the overall load to the Pleasant Bay system, but merely moves the load downstream more quickly. In that these sub-embayments are influenced by the quality of the downstream waters that flush them, this technique is less attractive than similar actions in embayments that discharge directly to the Atlantic Ocean or Cape Cod Bay.)

(The MEP technical report for Pleasant Bay predicts that a significantly higher level of nitrogen control will be needed if the current breach off Chatham reverts to its prior, more southerly location. The principal behind this conclusion is the same as discussed above. The towns around Pleasant Bay should formulate a plan to deal with this possible "flushing diminishment".)

Flushing enhancement options have many advantages and disadvantages. Any modifications to the coastal environment require significant permitting. Dredging is only permittable in the ACECs if that location has been previously dredged. (Historical dredging has occurred in Areys Pond, Lonnies Pond and Paw Wah Pond, and perhaps others.) The nitrogen control needs documented in the MEP technical report are intended to restore eelgrass and habitat for benthic organisms. Dredging would certainly destroy, at least temporarily, some of the habitat that the nitrogen control is intended to benefit. Dredging, if permittable, would not be a one-time event, but would need to be repeated over time to maintain the flushing enhancement.

The Town has met with DEP to discuss the merits of these non-traditional nitrogen control approaches. DEP officials have instructed the Town to focus its efforts on the structural aspects of this program and not delay progress to evaluate non-structural elements. Nevertheless, well-documented demonstrations of nitrogen removal through non-traditional means may help reduce the cost of later phases of the project.