Chapter 14

Drinking Water and Wastewater Technologies Screening Summary

CHAPTER 14

DRINKING WATER AND WASTEWATER TECHNOLOGIES SCREENING SUMMARY

14.1 INTRODUCTION

The purpose of this chapter is to screen the various drinking water and wastewater treatment technologies and alternatives identified in Chapters 7 through 13 and develop potential feasible solutions for the areas of Town which require these alternatives. This chapter combines and summarizes the public health and environmental health needs of the Town of Eastham with screened technologies and alternatives. It will also develop alternative management plans the Town should consider for further detailed evaluation as the Plan Evaluation Report is developed.

14.2 PRIORITIZED LISTING OF DRINKING WATER AND WASTEWATER PROBLEM AREAS

A. **Public Health Needs.** The Needs Assessment Summary (Chapter 5) provides discussion on properties identified in the Town of Eastham as having high nitrate levels in their private on-site wells. Because this is a widespread problem the need for public water supply and protection of human health is a Town-wide concern, and therefore the technologies screened will be for the entire Town area.

B. **Environmental Health Needs.** As also discussed in the Needs Assessment Summary, the environmental needs in the Town of Eastham are based on the estimated nutrient removal percentages for specific areas of the Town. As previously discussed in the report, the greatest source of nitrogen loading is from individual on-site septic systems. The Rock Harbor Estuary has a wastewater nitrogen loading reduction requirement of 79 percent, the Nauset-Town Cove Estuary is estimated to have a 55 percent wastewater nitrogen loading reduction, and the Freshwater Pond System Watershed is estimated at 100 percent removal for wastewater phosphorus. The following sections screen the identified wastewater technologies that may be implemented in the Town of Eastham in these areas. Table 14-1 summarizes these needs and outlines the generalized feasible technologies and solutions. A column marked with an "X" indicates that the technology will be screened in the following sections. In addition, Best Management Practices and other non-wastewater and drinking water methods are discussed for use in Eastham to help address these public health and environmental health needs.

14.3 ON-SITE DRINKING WATER AND WASTEWATER TREATMENT TECHNOLOGIES SCREENING SUMMARY

A. **Introduction.** Table 14-2 summarizes key information for each technology alternative for drinking water and wastewater with respect to the screening criteria discussed in Chapter 6. In terms of wastewater, all of the treatment technologies require review and approval by MassDEP and/or the local Board of Health. Table 14-2 includes information only on individual on-site wastewater technologies that are currently approved by MassDEP. Additional wastewater on-site technologies may be approved in the future and should be considered at that time within the context of "MassDEP-Approved I/A Systems."

B. **Screening of On-Site Drinking Water Treatment Technologies.** Reverse osmosis uses a technology in which the source water is supplied to the filter continuously; as pure water passes through the membrane the separated pollutants are washed away by the incoming source water. Reverse osmosis in this context is considered a point of use technology and would be installed on-site within homes underneath sinks. While reverse osmosis systems have high removal rates for nitrates and other pollutants, and relatively low capital costs as compared to municipal drinking water supply, a high percentage of wastewater would be produced from the water that is rejected by the filter. Similar to point of use reverse osmosis, other technologies such as water distillers and ion exchange are available for point of use treatment and have similar needs and are therefore grouped in this category, although they are not discussed in detail. Key information on the on-site drinking water technologies has been summarized on Table 14-2 to allow a side-by-side comparison with respect to a set of standard criteria.

Bottled water purchase tends to fall into this same category of on-site drinking water use and is included in Table 4-2. Bottled water purchase involves the purchase of water either at a store or through a home delivery service.

C. **Findings for On-Site Drinking Water Treatment Technologies.** Point of use treatment for drinking water is considered an interim homeowner specific solution. A primary consideration with point of use systems is the maintenance requirement and cost. Improper maintenance and owner inexperience contribute to questionable performance and possible system failures. Installations by homeowners of these technologies are not a long-term solution to the town-wide drinking water supply issue and therefore will not be considered for further evaluations.

The bottled water option is considered viable for homeowners only as an interim solution because it does not preclude people drinking the water provided by an on-site groundwater pump needed for other uses; and therefore could not reliably protect public health. The Use of Non-Centralized Treatment Devices and Bottled Water is regulated in 310 CMR 22.23, which states that public water systems shall not use bottled water to achieve compliance with an MCL listed in 310 CMR 22.00 unless approved by the MassDEP on a temporary basis to avoid any unreasonable risk to health.

D. **Screening of On-Site Wastewater Treatment Technologies.** Septic systems are a reliable, simple, feasible technology with relatively low capital costs and minimal operation and maintenance requirements. Land requirements for septic systems are relatively low and can be further reduced according to local variance guidelines established in the Title 5 regulations. Typical variances to septic system design requirements include a reduction in the distance between process equipment and property lines (commonly referred to as the setback distance), and a reduction in leaching field area. A typical full individual unit septic system for a three-bedroom home requires approximately 2,000 square feet of land area. A typical individual unit septic system for a three-bedroom home with a reduction in setback requirements and a 25 percent reduction in leaching field area requires approximately 1,000 square feet of land area. Septic systems typically provide moderate treatment of wastewater and are primarily designed for TSS and BOD removal. Nitrogen and phosphorus removal rates in septic systems are quite low, which is the reason that they are the largest source of nitrogen and phosphorus loading to the estuaries and ponds.

Although I/A technologies (as defined by MassDEP) do not provide a significant advantage in land area requirements when compared to septic systems, the potential to design I/A systems with reduced groundwater separation is significant considering the high groundwater elevations in certain areas of Eastham. I/A treatment technologies can provide high levels of treatment for

BOD, TSS, and nitrogen. Nitrogen removal rates can approach 50 percent or better if operated and maintained properly and with year-round use.

Key information on the on-site wastewater technologies has been summarized on Table 14-2 to allow a side-by-side comparison with respect to a set of standard criteria. Because I/A technologies are regulated by MassDEP, selection of any I/A technology to be used will ultimately be made by the individual property owner. The selection process will depend on the particular application (i.e. for repair, nitrogen removal, variance, etc.) and the current MassDEP status of the technology.

A primary consideration with individual I/A systems is the maintenance requirement and cost. Improper maintenance, significant down times due to seasonal use, and owner inexperience all contribute to questionable performance and possible system failures. If properly operated and maintained, those systems approved by MassDEP can achieve higher effluent quality. However, these standard I/A systems are not considered as a feasible alternative for addressing the needs of an area, typically requiring greater than 50 percent nitrogen removal. An analysis was developed for the Rock Harbor Estuary and Nauset-Town Cove Estuary areas in an effort to determine which I/A system treatment levels would be appropriate to meet the existing/estimated wastewater nitrogen loading percentage removals. Table 14-3 summarizes the following key items and findings:

- The estimated wastewater nitrogen percent removals.
- The effluent wastewater nitrogen loadings for:
  - Existing Title 5 systems.
  - I/A system installations with expected effluent nitrogen concentrations of 19 mg/L.
  - I/A system installations with expected effluent nitrogen concentrations of 10 mg/L.
  - I/A system installations with expected effluent nitrogen concentrations of 5 mg/L.

Rock Harbor Estuary has an estimated 79 percent nitrogen removal needed for the watershed and Nauset-Town Cove Estuary has an estimated 55 percent nitrogen removal needed for the watershed. Table 14-3 indicates the wastewater loading goals (maximum allowable loading) at these estimated percent watershed removals. Table 14-3 indicates that I/A systems which achieve an effluent wastewater nitrogen concentration of 19 mg/L as a stand-alone technology (for existing or future flows) would not be viable for the Eastham portions of Rock Harbor Estuary or Nauset-Town Cove Estuary in achieving the respective watershed loading goals. I/A systems which achieve an effluent wastewater nitrogen concentration of 10 mg/L could be viable for the Eastham portion of Nauset-Town Cove Estuary if the 55 percent removal estimate is accurate for existing flows because future flow loading would exceed the 9.78 kg/d required to achieve the loading goal. I/A systems which achieve an effluent wastewater nitrogen concentration of 5 mg/L could be viable for the Eastham portion of Nauset-Town Cove Estuary for both existing and future flows.

To gain a better understanding of the nitrogen removal performance of the technologies approved for nitrogen sensitive areas, Table 14-4A summarizes documented effluent nitrogen concentrations of the I/A systems based on the Barnstable County Department of Health and Environment report entitled, *Performance of Innovative Alternative Onsite Septic Systems for the Removal of Nitrogen in Barnstable County, Massachusetts 1999-2007*. Those technologies currently approved for piloting use have not been included since they are limited in the number that can be applied; however these emerging technologies will have similar advantages and disadvantages as those summarized in Table 14-4A. Table 14-4B summarizes the performance of installed I/A systems in Eastham.

Tight tanks are considered a short-term, or “band-aid” solution to overcome an immediate problem and are recommended for use only on a temporary basis until a long-term solution is found. This was recognized by the MassDEP some time ago and has since resulted in restrictions of their use. Allowable uses include keeping a primary residence open to habitation while a permanent system is installed. Another use applies to specialized situations, such as boat pump-out facilities, that typically are seasonal in nature and may have site conditions that make construction of a standard septic system impossible.

Composting, incinerating, and urine separation toilets are non-traditional wastewater disposal systems, and acceptance of a mandated use is expected to be limited due to the maintenance requirements. Composting systems are not well suited to handle seasonal flows and loadings. The physical handling of composted or incinerated wastes may be objectionable to the public. Public acceptance due to odors is also an issue with these systems. These systems would be best suited for use at comfort stations or other public facilities where the general public would not be responsible for routine system maintenance.

E. **On-Site Wastewater Treatment Technologies Findings.** The Barnstable County Department of Health and Environment report on I/A systems and Tables 14-4A and 14-4B indicate that these technologies do not demonstrate a solid ability to meet these stringent standards at this time. There is some potential for a couple of them but the best performance that they have achieved does not demonstrate long-term compliance. Also it is noted that these systems are typically designed with a focus of BOD, TSS, and nitrogen removals. Most do not remove phosphorus (without added process tanks) and they are not easily upgraded for future treatment requirements that may occur, especially when sites are of limited size. Foreseeable future requirements may include:

1. More stringent nitrogen TMDLs (i.e. higher level of nitrogen removal needed, approaching effluent limits of technology).

2. Phosphorus TMDLs for the watersheds to ponds and lakes.

3. Virus removal.

4. Removal of pharmaceutical products (endocrine disruptors) that persist after traditional treatment in septic systems and in many wastewater treatment facilities.

Therefore, these I/A technologies are only considered for the Nauset-Town Cove Estuary and for the Rock Harbor Estuary for I/As that achieve a total effluent wastewater nitrogen concentration of 5 mg/L or less based on future flows. If I/As were considered for use in either of these areas, use would be in combination with sewers, notably in the Rock Harbor Estuary. I/A selection would also be up to the discretion of the homeowner to choose the appropriate MassDEP approved technology.

In addition, tight tanks, composting, incinerating and urine separation toilets are not recommended for further evaluation.

14.4 COMMUNITY/MUNICIPAL DRINKING WATER AND WASTEWATER TREATMENT TECHNOLOGIES SCREENING SUMMARY

A. **Screening of Municipal Drinking Water Supply Alternatives.** The municipal drinking water supply alternatives for the Town of Eastham are based on the needed development of a Town-wide public water supply system servicing every parcel in the Town of Eastham. In addition to establishing the water supply well locations and support facilities, a distribution system and water storage facilities would need to be constructed. Construction of a municipal drinking water supply system is the only long-term solution available to feasibly sustain the drinking water quality of the Town of Eastham as well as meet the needs of fire protection.

This municipal drinking water supply could be provided by new water supply wells in Eastham, by the existing water supply system in Orleans or future water supply from Wellfleet. Planning efforts to develop cost and implementation schedules for these two alternatives should continue among the Towns.

B. **Findings**. A municipal drinking water supply system is the only long-term solution available to feasibly sustain the drinking water quality of the Town of Eastham. This technology will remain for further consideration.

C. **Screening of Small (Cluster/Community) Wastewater Treatment Facilities.** Small (cluster/community) wastewater treatment systems incorporating rotating biological contactors, sequencing batch reactors, Amphidrome, membrane bio-reactors, FAST, and Bioclere treatment components provide a variety of treatment alternatives with good levels of wastewater nitrogen removal through biological nitrogen removal processes. For instance, Brackett Road in Eastham currently has a SeptiTech system followed by a NITREX™ system. These systems allow for operator control and flexibility, typically take up a small area for the treatment process (not including the effluent discharge area), and can handle a range of flows. Because most of the tanks can be prefabricated, these systems provide good treatment with relatively low capital costs and land requirements.

On the other hand, they typically are not designed to treat to the enhanced nitrogen removal standards of 3 mg/L total nitrogen on average because they are not of a size to make this level of treatment attainable at a feasible cost. As a result, they typically discharge over two times the nitrogen (6-10 mg/L versus 3 mg/L on average) than a larger enhanced nitrogen removal facility and still require additional processes and controls beyond their "standard" packages to achieve this.

D. **Findings**. All small (cluster/community) technologies screened will be retained for further consideration in areas that do not need treatment to 3 mg/L, the highest degree of performance.

E. **Screening of Secondary/Advanced Treatment Technologies for Larger (Community/Municipal) Wastewater Treatment Facilities.** The screening of secondary/advanced treatment technologies is based on the description of each technology, its respective advantages and disadvantages, and the screening criteria established in Chapter 6 of this report. A summary of secondary/advanced treatment technologies with respect to the screening criteria is included in Table 14-5.

The activated sludge/Modified Ludzack-Ettinger process is a proven and reliable technology with moderate capital and O&M costs. Land area requirements for activated sludge process tanks and equipment are relatively low. Primary treatment equipment would not be required, but effluent clarification with final settling tanks would be required.

Rotating biological contactors are less desirable due to their requirement for primary treatment, necessity to cover equipment due to cold weather, high capital costs, and limited process control. However, rotating biological contactors are simple to operate and when coupled with denitrification processes can be effective at achieving <10 mg/L TN.

Sequencing batch reactors perform all treatment phases in a single basin, are highly flexible in operation, and can achieve consistent nitrogen removal to the range of 5 to 10 mg/L and 3 mg/L on average when they are followed by denitrification filters.

Membrane bio-reactors are commonly used in package treatment plants or in significantly larger facilities nationwide. However, a limited but growing number of installations in Massachusetts exist; therefore large-scale performance data in this area is limited. However, smaller installations yield good reliability and proven performance, but with somewhat less flexibility and process control than other technologies.

Oxidation ditches are considered a traditional process and provide good nitrogen removal when using additional pre- and post-anoxic tanks (A^2O or Bardenpho processes) designed for additional nitrogen removal. They can achieve nitrogen removal to 3 mg/L on average when they are followed by filtration. The system provides relatively easy operation, but the large tankage requirements have higher capital costs than other processes.

Aerated biological filters are typically used to provide BOD and TSS removal and nitrification of the ammonia in the wastewater. It would need to be followed by a denitrification filter, which would then denitrify the full nitrate load because minimal denitrification is achieved in the aerated biological filters. This technology takes up minimal space and is useful at treatment plant sites that have no room for expansion or where only nitrification is needed. Aerated biological filters also have high capital costs.

Denitrification filters provide denitrification and filtering of a previously nitrified effluent. They can be used to denitrify the full nitrate load when they are preceded by a nitrification process; or they can be used to denitrify (polish) a greatly reduced nitrate load (approximately 5 to 10 mg/L of nitrate nitrogen) when they are preceded by one of the technologies that both nitrifies and denitrifies. They can be smaller in size, have lower capital costs, and use less methanol (or other supplemental carbon source) when they are used to polish a previously nitrified and denitrified effluent.

Nearly complete (less than 0.2 mg/L) phosphorus removal can be achieved with all of these secondary/advanced treatment technologies. The typical phosphorus removal add-on technology is a metal-salt (alum or ferric iron) reaction and precipitation process that binds with the phosphorus and allows it to be removed through settling or filtration. This add-on process can be incorporated (with other design concepts) if the treated water needs a high degree of phosphorus removal.

F. **Findings**. Due to the high costs, complex controls and need of supplemental processes, Aerated Biological Filters are not considered for further evaluation. The remaining secondary/advanced treatment technologies screened for larger (community/municipal) wastewater treatment facilities will remain for further consideration; activated sludge/Modified Ludzack-Ettinger processes, rotating biological contactors, sequencing batch reactors, membrane bio-reactors, oxidation ditches, denitrification filters (in combination with other technologies to achieve <5 mg/L TN), and phosphorus precipitation (as needed in combination with other technologies and as needed for specific recharge areas).

G. **Screening of Disinfection Alternatives.** Table 14-6 presents a matrix summary of the disinfection alternatives for further evaluation. Sodium hypochlorite is not recommended due to potential liabilities associated with the transportation and storage of hypochlorite, which is corrosive and toxic. In addition, sodium hypochlorite has the potential to produce trihalomethanes in the treated effluent. Ozonation is not recommended for further evaluation due to its high costs, complex operation, and the fact that it may potentially produce toxic compounds. UV radiation has minimal adverse impacts on the environment, ease of operation, cost competitiveness with other alternatives, and reduced risk to operations staff and the environment due to the absence of chemical transportation or storage requirements.

H. **Findings**. UV disinfection will remain for further evaluation.

I. **Screening of Sludge Disposal/Reuse Alternatives.** The screening of sludge disposal/reuse alternatives is based on the description provided for each alternative and the screening criteria established in Chapter 6 of this report. A summary of sludge disposal/reuse alternatives and a side-by-side comparison of screening criteria are included in Table 14-7.

Sludge thickening is a relatively simple process with minimal operation, maintenance, and energy requirements. If a new treatment plant is constructed, sludge thickening could be used. Thickened sludge can also be disposed of at a number of regional facilities.

Sludge dewatering and disposal at a regional facility is not recommended, as the land area for building requirements will either be site restrictive or cost prohibitive. There is also a greater potential for odor generation.

Sludge composting has high capital and O&M costs due to construction of a covered building, large land area requirements, and the purchase and operation of complicated machinery. Performance and reliability are a major concern for composting facilities based on the poor performance of the two municipal composting facilities on Cape Cod (and the one at the Otis AFB WWTF), which were all shut down due to economic factors and the generation of odors. Therefore, sludge composting/stabilization is not recommended for the Town of Eastham.

J. **Findings**. Based on the evaluation of these alternatives, disposal of thickened sludge is believed to be the most practical sludge disposal alternative and is recommended for further evaluation.

14.5 COLLECTION SYSTEM TECHNOLOGIES SCREENING SUMMARY

A. **Screening of Collection System Technologies.** The screening of collection system technologies is based on the description provided for each technology, the respective advantages and disadvantages, and the screening criteria established earlier in this report. A summary of collection system technologies and a side-by-side comparison of screening criteria are included in Table 14-8.

Wastewater collection with gravity sewers and lift stations is a widely used, simple, and reliable technology. Gravity sewers can easily be expanded to accommodate additional flows. The relative cost of gravity sewers depends on environmental conditions and increases with the number of lift stations required and depth of excavations.

Pressure sewers are less widely used than gravity sewers, but have relatively low construction costs and are adaptable to changes in topography. Public acceptance of pressure sewers may be low due to the need for a pump at each individual home or business. In addition, pressure sewers rely on electrical power, and flow backup can occur during power outages.

Septic tank effluent sewers require installation of special pumping equipment and piping at each point of connection to the gravity system. The main advantage of these systems is the reduced amount of solids transported in the collection system and the reduced potential for sewer blockage caused by solids deposition. These systems also require periodic pumping of the individual septic systems, which adds a high operational cost and potential for odor generation. They also do not lend themselves to being added to existing collection systems that transport all the solids.

Vacuum sewers have maintenance requirements similar to low pressure systems and require significant staff training for implementation and operation. Vacuum sewers are not easily expandable and require accurate flow estimates prior to construction. The capital costs of vacuum sewers are typically slightly higher than low pressure systems.

B. **Findings.** All collection technologies screened will remain for further consideration.

14.6 TREATED WATER RECHARGE TECHNOLOGIES SCREENING SUMMARY

A. **Screening of Treated Water Recharge Technologies.** The screening of treated water recharge technologies is based on a general description of each technology, the respective advantages and disadvantages, and the screening criteria established in Chapter 6 of this report. A summary of treated water recharge technologies and a side-by-side comparison of screening criteria are included in Table 14-9. The following text provides a brief discussion of the screening process.

Sand infiltration beds are a simple and reliable effluent discharge technology with relatively low operating costs.

Subsurface infiltration facilities are well understood and reliable. These facilities are constructed below ground and therefore have minimal visual impacts, reduced potential for odors, and can provide secondary use of the land. However, treated water recharge in subsurface infiltration facilities has higher land area requirements, and the facilities are not easily cleaned. Therefore, the life of the facilities will be dependent on the quality of the effluent.

Spray irrigation and drip irrigation are simple and reliable treated water recharge technologies with relatively low construction costs. In addition, they can provide nitrogen uptake and removal, if designed appropriately.

Treated water recharge through well injection has relatively low land requirements and construction costs. Well injection has the potential of plugging at the injection point due to build-up of fine solids and biofouling; effluent would require chlorination or advance treatment increasing the overall project cost.

Treated water recharge through wick wells is a variation of well injection and has similar advantages and disadvantages. Both limited experience and regulatory acceptance of this technology are being gained in Massachusetts, and more complete acceptance is contingent on long-term demonstration of effectiveness.

Ocean outfalls have minimal land requirements and groundwater impacts. However, legislation would not allow Eastham to construct an outfall and therefore is not considered for further evaluation.

Wetland restoration and nitrogen attenuation concepts are being evaluated on Cape Cod and include evaluation and modeling of very site-specific considerations. If they prove to be feasible and acceptable to the regulatory community, they could be low cost methods to discharge highly treated effluent, recharge impacted portions of the watershed, and attenuate nitrogen in the groundwater. Concepts of this technology may be considered for recharge near wetland areas.

B. **Findings.** With the exception of ocean outfalls, the above treated water recharge technologies will remain for further evaluation.

14.7 POND TREATMENT CONSIDERATIONS

As discussed previously in this report, the wastewater phosphorus environmental need is focused on the Freshwater Pond System Watershed. To achieve the 100 percent wastewater phosphorus removal percentage, two alternatives exist. The first alternative is to manage the wastewater by collecting the wastewater from this area, treat it at a municipal/community facility and then recharge the treated water into a watershed outside of the Freshwater Pond System Watershed. The treatment processes are well understood and phosphorus removal to 0.2 mg/L total phosphorus in the treated water is commonly attained at municipal wastewater treatment plants through a combination of biological uptake, chemical precipitation through the addition of iron or aluminum salts and filtration (discussed in Section 14.4). A second alternative would be the chemical application of alum (aluminum sulfate) to eutrophic ponds which would aid in the chemical binding and settling of phosphorus to the pond bottom. Alum plays a dual role in freshwater applications in which it scours soluble phosphorus from the water column, and creates a barrier so the phosphorus in the sediments can’t escape. A second chemical named sodium aluminate is equally important to the chemical application because it acts as a buffer for the more acidic alum.

Pond treatment with alum is an accepted method to remove high phosphorus concentrations in the ponds. It has been used successfully at Hamblin Pond in Barnstable and Ashumet Pond in Mashpee. Long Pond in Harwich and Brewster received alum treatment in 2008 after several years of study. Sampling in 2009 and subsequent years will determine if it was successful as well.

The environmental management community is uncertain if pond treatment with alum should be considered as a feasible long-term management solution. It is unknown if the alum will permanently tie up the phosphorus. In an ideal situation, the continued phosphorus loading to the watershed of the ponds should be removed to prevent more phosphorus entering the ponds in the future.

There are other "pond treatment" alternatives including pond hypolimnion aeration and various pond-water circulation devices that can be installed and operated in the ponds. These systems generally have not proven themselves as long-term solutions.

14.8 ALTERNATIVE DRINKING WATER AND WASTEWATER MANAGEMENT PLANS SELECTED FOR DETAILED EVAULATION FOR SEVERAL AREAS OF HUMAN HEALTH AND ENVIRONMENTAL HEALTH NEED

A. **Introduction.** The following are alternative drinking water and wastewater management plans selected for detailed evaluation for several areas of human health and environmental health need. The following includes a summary of plan components and preliminary capital costs expressed on a per household basis for each plan.

B. **Drinking Water Master Plan to Meet the Town-Wide Human Health Need.** This drinking water plan is municipal drinking water supply to meet the Town-wide human health need resulting from decreasing drinking water quality at individual on-site wells as being developed by on-going Town efforts. Average capital costs of $12,000 per household are estimated based on the total construction cost of $73 million (based on 2006 dollars) divided by 6,088 (the total parcels to be served). The total construction costs were developed as part of the Municipal Water Distribution System Master Plan by Environmental Partners Group and presented at the October 2007 Special Town Meeting. The average capital cost of $12,000 per household does not include betterment, bonding, and other costs also discussed at the Town Meeting. In addition, planning efforts currently include considering long-term agreement to purchase drinking water from the Town of Orleans water system.

C. **Alternative Wastewater Management Plans for the Rock Harbor Watershed.** Three alternative wastewater management plans have been developed to address the environmental health need of this estuary and its watershed. These plans are described below with a preliminary capital cost expressed on a per household basis.

1. **Rock Harbor Watershed Plan 1.** This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Construction of a new community/municipal wastewater treatment facility outside the watershed for treatment and recharge. The best treatment and recharge site will be developed as part of the final plan evaluations.

This plan is feasible, depending on the availability of an acceptable treatment and recharge site, and could be part of a long-term management and remediation plan for Rock Harbor. Typical capital costs for this type of plan are $50,000 per property based on the community/municipal system recently constructed for the New Silver Beach area of Falmouth. Total capital costs for that project are approximately $10.7 million (2007 costs) to serve 230 properties.

2. **Rock Harbor Watershed Plan 2.** This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Connection of this sewer system to the Orleans Wastewater Treatment Facility proposed to be constructed at the Tri-Town Facility site.

This plan is expected to receive preliminary evaluation as part of the study being completed by the Town of Orleans and funded by the Cape Cod Water Protection Collaborative "Shared Watershed, Shared Responsibilities" Grant Program on regional wastewater management solutions for the area. The costs and necessary inter-municipal coordination are not yet known. It is noted that the Draft CWMP developed for Orleans also has an estimated capital cost of $50,000 per household based on a total capital cost of $148.2 million to serve 3,100 equivalent users. This plan is expected to have a similar cost.

3. **Rock Harbor Watershed Plan 3.** This plan would be further evaluation of ideas introduced by Brian Howes of MEP for possible aeration and dredging management of Rock Harbor. This type of management may be possible for Rock Harbor because it is not a natural estuary; it is a tidal creek that is continually dredged to maintain a boat basin. The feasibility of this plan is unknown and would require additional evaluation possibly as a MassDEP pilot study.

D. **Alternative Wastewater Management Plans for the Nauset-Town Cove Estuary Need.** Three alternative management plans have been developed to address the environmental health need of this estuary and its watershed. These plans are described below with a preliminary capital cost on a per household basis.

1. **Nauset-Town Cove Estuary Watershed Plan 1.** This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Construction of a new community/municipal wastewater treatment facility outside the watershed for treatment and discharge as previously discussed in the Rock Harbor Watershed Plan 1 at a similar typical cost.

2. **Nauset-Town Cove Estuary Watershed Plan 2.** This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Connection of this sewer system to the Orleans Wastewater Treatment Facility proposed to be constructed at the Tri-Town Facility site as previously discussed in the Rock Harbor Watershed Plan 2 at a similar typical cost.

3. **Nauset-Town Cove Estuary Watershed Plan 3.** This plan includes the following components:

- Individual on-site systems approved by MassDEP for nitrogen removal supported by an expanded Town Health Department to enforce operation, maintenance and discharge compliance which would be completed by the property owner. A typical cost for this plan is $30,000 per household based on the report prepared by The Barnstable County Department of Health and the Environment in May 2007 entitled, *Projected Use of Innovative/Alternative On-Site Sewage Treatment Systems in Eastham, Under Current Regulations and Policies*. This typical cost is between the initial capital homeowner expenditure of approximately $20,000 that must be paid upon installation and the cost ($30,000 - $40,000) of installing an I/A where there are significant site restraints. This represents a typical cost for an I/A system which is expected to achieve an effluent wastewater nitrogen concentration of 19 mg/L. I/A systems which need to achieve greater removal may increase costs. It should also be noted that individual on-site systems could serve multiple properties (cluster system) if there is sufficient agreement between property owners and available land.

E. **Alternative Wastewater Management Plans for the Freshwater Pond System Watershed Need.** Two alternative management plans have been determined to address the environmental health needs of the ponds and their watersheds. These plans are described below:

1. **Freshwater Pond System Watershed Plan 1.** This plan includes the following components:

- Sewer extension to the properties in the watershed.
- Construction of a new community/municipal wastewater treatment facility outside the watershed for treatment and discharge as previously discussed in the Rock Harbor Watershed Plan 1 and Nauset-Town Cove Estuary Watershed Plan 1 at a similar typical cost.

2. **Freshwater Pond System Watershed Plan 2.** This plan includes periodic treatment of the ponds that exceed threshold levels. The frequency and costs of these treatments is unknown and would need to be evaluated on a pond by pond basis and typically are not expressed on a per household basis.

14.9 REPORT CONCLUSION

In summary, several alternative management plans are recommended for further evaluation after review and concurrence by Town staff and public:

- The ongoing Drinking Water Supply Master Plan which is currently evaluating water supply from new wells sited in Eastham and/or a water supply from the existing Town of Orleans water system.
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- A group of three alternative management plans for the Rock Harbor Watershed to meet the environmental health need as defined by the MEP.

- Rock Harbor Plan 1: Sewering the properties in this watershed and wastewater treatment and recharge at a new community/municipal wastewater treatment facility in Eastham.
- Rock Harbor Plan 2: Connection of this sewer system to the Orleans Wastewater Treatment Facility proposed to be constructed at the Tri-Town Facility site.
- Rock Harbor Plan 3: Further evaluation of possible aeration and dredging management of Rock Harbor.

- A group of three alternative management plans for the Nauset-Town Cove Estuary Watershed to meet the environmental health need as defined by the MEP.
  - Nauset-Town Cove Estuary Watershed Plan 1: Same as Rock Harbor Plan 1.
  - Nauset-Town Cove Estuary Watershed Plan 2: Same as Rock Harbor Plan 2.
  - Nauset-Town Cove Estuary Watershed Plan 3: Individual on-site systems approved by MassDEP.

- A group of two alternative management plans for the Freshwater Pond System Watershed to meet the environmental health need as defined by the MEP.
  - Freshwater Pond System Watershed Plan 1: Same as Rock Harbor Plan 1 and Nauset-Town Cove Estuary Watershed Plan 1.
  - Freshwater Pond System Watershed Plan 2: Periodic pond treatments.

These plans are described in greater detail in the preceding section.

Also the following Best Management Practices for Town-wide application are recommended as part of all of the plans:

- Fertilizer use education to minimize over-fertilization. Reduction of fertilizer induced nitrogen into the environment would be best mitigated with public education. Educational flyers could be developed and distributed to homeowners, discussing the environmental effects of over-fertilization to lawns and other plants on their property. Barnstable County and the Water Protection Collaborative may assist in this effort in the future.
- Stormwater management practices on Town and State roadways as well as at individual homes. Stormwater Management is considered an enhancement to the wastewater management plans identified above. Most structural stormwater Best

Management Practices are designed to mitigate bacterial contamination and reduce runoff from impervious surfaces and are not designed to remove nutrients such as nitrogen and phosphorus. However, some stormwater Best Management Practices such as bioretention areas, rain gardens, constructed stormwater wetlands and extended dry detention basins can remove varying amounts of nitrogen and phosphorus if designed and maintained correctly. As discussed in Chapter 13, stormwater should be directed to vegetated swales or basins where suspended solids and fecal coliform are removed and nitrogen and phosphorus is used by the biological material in the swale or basin. The Town of Eastham should develop improved stormwater management by identifying areas on Town roadways where runoff enters surface waters untreated. Homeowners can also participate in stormwater management by directing runoff from their roofs into natural environments, instituting the use of rain barrels or by the installation of permeable materials in driveway locations.

The alternative management plans identified above are recommended to receive additional detailed evaluation during the development of the Plan Evaluation Report as part of the next phase of the project. In an effort to prioritize areas of need, Table 14-10 was developed, ranking areas of concern by need. As a result, the Town should focus implementation of the following alternative drinking water and wastewater management plans as follows:

Priority 1 – Human Health Need: Public water supply for all properties in the Town of Eastham from a protected water supply source.

Priority 2 – Environmental Health Need: Wastewater and nitrogen management to meet projected nitrogen limits in the Nauset-Town Cove Estuary.

Priority 3 – Environmental Health Need: Wastewater and nitrogen management to meet projected nitrogen limits in the Rock Harbor Estuary.

Priority 4 – Environmental Health Need: Wastewater and phosphorus management to address water quality problems in the Freshwater Pond System Watershed.

These priorities will be further discussed in the Plan Evaluation Report, which will provide guidance on practical implementation for the Town of Eastham. This report will provide guidance on practical implementation for the Town of Eastham which may vary from the order of significance that the Final Interim Needs Assessment and Alternatives Screening Analysis Report identified watershed areas.

A public education program has also commenced to enhance the Town's planning efforts. The public education program includes the following components:

- Project Newsletters.
- Poster production to be used in public spaces and at public workshops.
- Televised presentations to the Board of Selectmen and Board of Health.
- Public presentations and workshops for interested members of the public.
- Town Meeting presentation.

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