Report

Comprehensive Wastewater Management Plan and Environmental Impact Report Phase I – Needs Analysis and Screening of Alternatives Nantucket, Massachusetts

Prepared for:

Nantucket Department of Public Works
Nantucket, Massachusetts

Prepared by:

Earth Tech, Inc.
196 Baker Avenue
Concord, Massachusetts 01742-2167

August 2001

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April 16, 2001

Dear Project Reviewer:

Enclosed please find one copy of the report entitled "Comprehensive Wastewater Management Plan and Environmental Impact Report Phase I - Needs Analysis" (Phase I Report) completed in accordance with the Massachusetts Department of Environmental Protection's "Guide to Wastewater Management Planning" dated January 1996. The review of the Comprehensive Wastewater Management Plan (CWMP)/Environmental Impact Report (EIR) will be through the submission of three documents including: (1) Phase I Report; (2) Phase II CWMP/Draft EIR; and (3) Phase III CWMP/Final EIR.

This Phase I Report is consistent with the general requirements of the MEPA regulations including being circulated per MEPA regulations at 301 CMR 11.16 (3). In addition, three copies will be available for public review at the Town Hall and Department of Public Works. The circulation list is included in the Phase I Report Section 5.

A 45-day public comment period on the Phase I Report will be initiated by a notice of availability for review in the Environmental Monitor. Comments received will be considered in determining the extent to which issues were adequately addressed. If you have comments, please send them to:

Secretary of Environmental Affairs
251 Causeway Street, Suite 900
Boston, MA 02114
Attention: MEPA Unit
MEPA # 12654

If you have questions regarding this project, please do not hesitate to contact the the MEPA office at 617-626-1000.

Very truly yours,
Earth Tech, Inc.

Thomas E. Parece, P.E.
Project Director

enclosures

EXECUTIVE SUMMARY

In 1998, the Nantucket Department of Public Works retained Earth Tech, Inc. to prepare an Island-wide Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR) to identify areas within the Island with sub-surface wastewater disposal problems and to develop a plan to mitigate or eliminate the problems. The Town has established a special procedure for the review of this major and complicated project. This special procedure is a three-phase process during which the scope of future phases is based largely on the results of the preceding phase. The process consists of filing three documents: (1) Phase I, Needs Analysis and Screening of Alternatives; (2) Phase II, Draft Comprehensive Wastewater Plan and Environment Impact Report; and (3) Phase III, Final Comprehensive Wastewater Management Plan and Environmental Impact Report. The results of the Need Analysis and preliminary screening of alternatives are included in this Document. This Document and further, more detailed analysis during the other phases will provide the basis for the design and ultimate construction of the approved plan.

This document contains the results of extensive efforts by Earth Tech, Inc. and the Town of Nantucket to evaluate the available options for improving the existing on-site wastewater disposal systems. In order to obtain as much information as possible on the existing and projected land use, demographic conditions and population, Earth Tech Inc., coordinated efforts with the Nantucket Planning and Economic Development Commission (NP&EDC). The goals of the NP&EDC coupled with "The Nantucket Comprehensive Plan" are used in evaluations and analyses for the community presented in this Document. Other agencies utilized for information and considered herein are U.S. Soils Conservation Services, U.S. Department of Agriculture, U.S. Coast Guard, local planning officials, the Nantucket Historic Commission, the Natural heritage Program and local Town boards including Assessors, Building Department, Board of Health, Public Works Department and Zoning Officials.

A Town-wide needs analysis was performed to determine whether or not conventional Title 5 septic systems will be effective in disposing of wastewater within a given study area throughout and beyond the 20 year planning period. A two stage approach was utilized in the analysis consisting of (1) a rating criteria matrix created to establish or eliminate a study area as a need area, and (2) an evaluation of each study area based on soils classification, groundwater levels, and a combination of system age and lot size to confirm or eliminate a study area as a need area. During the first stage, a rating criteria matrix was developed which consisted of four levels of criteria that were assigned rating points. The highest rating was given to actual failures, as compiled from Board of Health records. The second highest rating was given to imminent failures, which are categorical failures based on current Title 5 regulations. The third highest rating was given to septic systems that have a high likelihood of imminent failure, which were septic systems that: (1) had severe groundwater limitations; (2) had severe soil limitations; (3) had septic systems that were built before 1978; (4) had a lot size of one-half acre or less; and/or (5) had two or more septic tank pump-outs occurring within a calendar year. The fourth highest criteria was given to septic systems that have health/water quality issues associated with septic systems located: (1) in a study area with a density of septic systems greater than two per acre; (2) within 100 feet of a surface water body; (3) within a 100 year flood plain; (4) within a Zone II aquifer recharge area and (5) within Harbor Watershed Line or 3,600 feet of Madaket Harbor.

During the second stage of the analysis, each study area was evaluated based on soils classification, groundwater levels, and a combination of system age and lot size. The three criteria being: (1) 50 percent or more of the lots within the study area meeting the age/lot size criteria (built before 1978 and a lot size of one-half acre or less); (2) 30 percent or more of the study area having severe soils limitations (hardpan, bedrock, slope, flooding and wetness); and (3) 20 percent or more of the study area having severe groundwater limitations (seasonally high water table at the surface to 2 feet deep). If two of these three criteria were met, then the study area would be confirmed as a need area.

A side by side comparison of the results of the two evaluation methods was made to determine: (1) if a given area showed consistent need; (2) areas where there was a conflict in need (e.g. areas that showed a need in one evaluation approach and no need in the other) which were then further evaluated in order to identify the real need; and (3) areas of no need, where existing wastewater disposal systems are adequate. This comparison identified small Sub-study Areas which were reevaluated based on the second stage criteria, which included soils classification, groundwater levels, and a combination of system age and lot size. This two stage analytical evaluation confirmed the areas of need.

Based on the above and on the location of a study area which is located near or in a sensitive area, the following Study Areas are recommended as areas of wastewater disposal need: (1) Madaket, (2) Monomoy, (3) Polpis, (4) Pocomo, (5) Quidnet, (6) Siasconset, (7) Somerset, (8) Shimmo, (9) Town, (10) Town - WPZ, (11) Warrens Landing and (12) Wauwinet.

The CWMP/EIR Phase II document will have a preliminary investigation into the viability of siting wastewater treatment facility(s) and/or highly treated wastewater effluent disposal facilities in Nantucket. Site selection, for both the wastewater treatment facilities (WWTFs), and the effluent disposal field(s) will be the most difficult to resolve. The screening criteria to be used to evaluate these potential sites will be based upon ten environmental criteria as follows: (1) wetlands; (2) soils; (3) drinking water supply - wellhead protection areas (Zone I and Zone II); (4) fisheries; (5) waterbodies (distance from surface water); (6) floodplains; (7) sensitive habitats; (8) park lands; (9) recreational resources; and (10) historical interests. The criteria was developed with respect to whether or not there was an existing environmental "Opportunity" or "Constraint" for a site to be utilized for a wastewater treatment facility and/or disposal location. The application of the screening criteria will result in sites which will be selected for technical and site specific environmental evaluation and cost effective analysis.

Wastewater treatment options were evaluated based on four levels of criteria. The first criteria, Technical Factors, included flow and loading, land/site requirements, suitability for groundwater discharge, climate, sludge disposal and ease of operation. The second criteria, Environmental Factors, included groundwater and permitting impacts. The third criteria, Institutional Factors, included community acceptance, regulatory and legal issues. The fourth criteria, Economic Factors, included construction cost and operations cost. Various wastewater treatment technologies were evaluated based on the above criteria. The following four wastewater treatment technologies are considered the most favorable and will be evaluated in detail in Phase II of the CWMP / EIR process: (1) Anaerobic/Anoxic Systems; (2) Constructed Wetlands; (3) Rotating Biological Contactors; and (4) Sequencing Batch Reactors.

The scope of the CWMP/DEIR Phase II document will analyze the selected alternatives in accordance with the revised scope that will be issued by the Secretary of EOEA and comments received on the Phase I CWMP/EIR document. The CWMP/DEIR Phase II document will present draft recommendations for wastewater management in the identified areas of the Town of Nantucket where existing on-site septic systems are shown to be inadequate for wastewater disposal. Specific recommendations by Study Area will take into account the appropriateness of utilizing: (1) innovative alternative systems; (2) communal systems; and (3) local wastewater collection, treatment, and disposal facilities. The CWMP/DEIR Phase II document will evaluate the environmental impacts, technical design, institutional factors, and project costs associated with each alternative and recommend the appropriate solution to the wastewater disposal problems in the Town of Nantucket on a long term basis.

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1.0 INTRODUCTION

A. BACKGROUND INFORMATION

The Town of Nantucket has undertaken steps in recent years to address the wastewater disposal needs of the entire Island of Nantucket, Massachusetts. In March 1989, the Town began extensive improvements to its existing Wastewater Treatment Facilities located in the Surfside and Siasconset areas of the Island. The Surfside Wastewater Treatment Facility provides primary treatment, with chemically enhanced primary treatment during the summer months, for the wastewater collected from the Town area of the Island. The wastewater collected from the Siasconset area of the Island is discharged directly into infiltration beds located in the village of Siasconset.

In early 1997, the Nantucket Planning and Economic Development Commission retained Earth Tech, Inc. to prepare a Facilities Plan for Wastewater Disposal and Treatment for the Village of Siasconset, Nantucket, Massachusetts. The report entitled "Siasconset Facilities Plan for Wastewater Treatment and Disposal," Nantucket Massachusetts, dated December 31, 1997, (Siasconset Facilities Plan) detailed a solution for the Siasconset Wastewater Infiltration Beds and the lack of wastewater treatment achieved by the infiltration beds. The facilities plan report met the requirements of the Administrative Consent Order between the Town of Nantucket and the Department of Environmental Protection.

In early 1998, the Nantucket Department of Public Works retained Earth Tech, Inc. to prepare an Island-wide Comprehensive Wastewater Management Plan/Environmental Impact Report (CWMP/EIR). In general, the objective of a CWMP/EIR is to identify areas within the Town with subsurface wastewater disposal problems and to develop a plan to mitigate or eliminate the problems. The wastewater treatment solutions presented in the Siasconset Facilities Plan are considered in this CWMP/EIR.

The Town of Nantucket has established a special procedure for review of this major and complicated project. The special procedure consists of a three phase review of the CWMP/EIR Document. The Document has been delineated into three phases, where the scope of future phases is based in part on the results of the preceding phase. This report represents the first of three phases outlined for the CWMP/EIR. The first phase, Phase I, includes the needs analysis and screening of wastewater alternatives. Phase II and III will include the draft environmental impact report and final environmental impact report, respectively. The scope of the Island-wide CWMP/EIR is twofold: (1) to determine the areas on the Island with wastewater disposal problems that cannot be solved with a conventional Title 5 wastewater disposal system; and (2) evaluate and make recommendations on the most viable solution for wastewater disposal in each study area based on environmental, technical, and economic considerations.

B. PURPOSE AND SCOPE

Several large areas of Nantucket are served by privately owned and municipal wastewater collection systems, however a majority of the Island relies on on-site wastewater disposal systems for wastewater treatment and disposal. The intent of the CWMP/EIR is to identify and provide a comprehensive solution to the wastewater and disposal needs of the entire Island. Included in this Plan is an assessment of Nantucket's wastewater disposal needs and an evaluation of the potential collection systems, transmission systems, required treatment levels and technologies, effluent disposal options, residuals handling and disposal options, and facilities siting required to meet the disposal needs.

Once the wastewater disposal needs analysis for the entire Island is completed, the specific areas of need, where a conventional Title 5 System is deemed ineffective, will be identified. Subsequently, a comparison of wastewater collection, transmission, treatment and disposal at: (1) the existing Surfside Wastewater Treatment Facility, (2) satellite wastewater treatment facilities, or (3) a combination of both will be evaluated. Upgrade of the existing Siasconset Wastewater Infiltration Beds to an Advanced Wastewater Treatment Facility is currently being designed, and the upgraded facility will be considered as the fourth wastewater treatment and disposal option for need areas. Treated wastewater effluent disposal site availability within the Town, environmental impacts, and costs are the most important issues and as such, they will be addressed throughout the CWMP/EIR process.

With the advent of the State Revolving Fund (SRF) Loan Program, which was implemented in Massachusetts after the passage of the Legislature's "Hayes Act" (Chapter 275 of the Acts of 1989), authority for requiring and carrying out facilities planning was delegated to the Massachusetts DEP. The Massachusetts DEP has regulated the facilities planning requirements under the Massachusetts Code of Regulations, "310 CMR 41.00 Financial Assistance For The Costs of Water Pollution Abatements Projects." The latest version of these regulations requires communities to have a current CWMP/EIR document prepared and in place before a community is allowed to participate in the SRF Loan Program. A DEP approved CWMP/EIR document is a prerequisite to favorable Priority List placement and advantageous funding, interest rate currently at 0 percent (50 percent grant equivalency).

In summary, the scope of the CWMP/EIR is to investigate, evaluate, and report on the existing environmental conditions in Nantucket and determine the Town's present and future pollution control needs. The focus of the CWMP/EIR is to evaluate and develop wastewater collection, transmission, treatment, disposal and residuals management facilities that will best serve Nantucket's existing and future needs, while maintaining and/or improving the environment. The CWMP/EIR utilizes available data from previous studies and reports performed for the Town to the fullest extent possible.

C. PLANNING AREA AND PERIOD

The planning area for the CWMP/EIR is the entire Island of Nantucket, Massachusetts. The planning area has been divided into 18 study areas, as shown on Figure 1C-1 (pocket). The planning period for this CWMP is 20 years in duration, with a design year of 2020. The CWMP/EIR Phase I Document has been prepared in accordance with the Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Protection, "Guide to Comprehensive Wastewater Management Planning" dated January 1996 and the Massachusetts Environmental Policy Act (MEPA) regulations.

D. COORDINATION WITH OTHER PLANNING ACTIVITIES

One of the most important considerations for the Town of Nantucket and this CWMP/EIR process is to assure that all interested parties in the Town are included in the decision-making process. The Town of Nantucket should strive to assure that the wastewater activities in Nantucket proceed in a direction that complements the goals of other interested parties on the Island.

Earth Tech, Inc. has coordinated the CWMP/EIR effort with the Nantucket Planning & Economic Development Commission, local planning officials, Assessors, Zoning, Building and Public Works Departments, Conservation Commission, Board of Health, Historic District Commission, Coastal Zone Management, the Natural Heritage Program, the Coastal and Marine Department, and the public.

The Siasconset Facilities Plan/Environmental Impact Report, prepared by Earth Tech, Inc., will be integrated into the Island-wide CWMP/EIR Phase II and Phase III Documents. Additionally, the Phase II and Phase III Documents will evaluate the potential for an integrated solution to the wastewater treatment and disposal needs of the Island, which considers combining elements of the Siasconset and Surfside Wastewater Treatment Facilities.

E. REVIEW OF PRIOR PLANNING EFFORTS

A brief review of prior planning efforts, including wastewater treatment facilities planning, regional facilities planning, infiltration/inflow reports, septage management reports, and water quality studies was performed by Earth Tech, Inc. The information gained was utilized and incorporated into the planning efforts presented in this CWMP/EIR Phase I Document.

As mentioned briefly above, the Town of Nantucket and the DEP have negotiated an Administrative Consent Order No. SE-97-1006, signed November 1997, with a revised schedule for the Siasconset Facilities Plan, which provides for completion of an approved treatment facility, and the cessation of the discharge of untreated sewage by May 2002. Earth Tech, Inc., has completed the design of a New Siasconset Wastewater Treatment Facility based on the recommendations of the 1997 "Siasconset Facilities Plan for Wastewater Treatment and Disposal," prepared by Earth Tech. Earth Tech, Inc., is currently is the process of obtaining various permits for the construction and operation of the facility. Coordinating the efforts of this CWMP/EIR Phase I Document with the efforts undertaken on the design of the new Siasconset Wastewater Treatment Facility has been carried throughout this planning document.

2.0 EXISTING CONDITIONS

A. INTRODUCTION

This section provides an overview of the existing conditions on the Island (and Town) of Nantucket, Massachusetts. The information provided to document the existing conditions within the Town of Nantucket was obtained from existing resource mapping, including MassGIS, United States Geological Survey (USGS) topographic maps, and Soil Survey Report by the U.S. Department of Agriculture. Information was also provided by the Nantucket Planning and Economic Development Commission (NP&EDC), local planning officials, Assessors, Zoning, the Building and Public Works Departments, Conservation Commission, the Nantucket Board of Health, the Historic District Commission, Coastal Zone Management, the Natural Heritage Program, Wannacomet Water Company, Siasconset Water Company, and the Coastal and Marine Department. A majority of the natural resources and environmentally sensitive areas is presented on Figure 2A-1 (pocket).

B. GEOLOGY, SOILS AND TOPOGRAPHY

This section provides a description of the geology, soils, and topography that are characteristic of the Island. The discussion of geology, soils, and topography presented below focuses on the general characteristics of these resources and their location within the Town, rather than site specific soil testing data.

Geology and Soils

Nantucket is a product of the late Wisconsinan glacial period and the rise in sea level that followed glaciation. The glacial and post-glacial deposits on the Island were derived from the bedrock of southern New England which was eroded and transported by moving ice mass. This rock debris, called drift, was carried southward by the ice and deposited along the ice front. These first order glacial landforms have been modified by marine erosion, deposition and wind action to form shoals, beaches, spits and dunes.

There have been numerous geologic studies conducted on Nantucket. The earliest work was done by Shaler in 1889 and Woodworth and Wigglesworth in 1934. More recently Oldale has published surficial geologic maps and comprehensive text on the subject (1982, 1985, 1986, 1992).

The fluctuating late Wisconsinan ice margin formed several deposition features on the Island. A discontinuous east trending end moraine runs from Nantucket Village to Sankaty Head. The moraine consists of mostly stratified sand and gravel with cobbles and numerous scattered boulders. Ice-contact deposits form a greatly collapsed area north of the moraine. These deposits consist of sand and gravel with some cobble and scattered boulders and abundant silt and clay. To the south, sand and gravel outwash deposits slope off the hilly moraine southward to the sea.

Two deep borings conducted on the Island reveal that these glacial sediments extend to depths of approximately 150 feet at Great Point (located at the northern portion of the island and east of the downtown area of the Island) to approximately 250 feet near the center of the Island. Beds of sand, silt and clay of Tertiary age underlie these sediments to a depth of approximately 330 feet. Next, Cretaceous varicolored silty clay with some sand and several thin layers of linite from approximately 330 to approximately 1,145 feet overlies Cretaceous white to gray clayey sand with three beds of clay between approximately 1,145 and approximately 1,500 feet. From approximately 1,500 to approximately 1,540 feet, a red-brown layer of weathered rock overlies hard igneous basalt of probable Triassic age (Walker, 1980).

Glacial drift deposits are the parent material forming Nantucket's soils. Soils on the glacial drift, the late glacial windblown sand and silt and dune sand, are called mineral soils. The mineral soils on Nantucket are classified as podzols. A podzol forms in regions where the climate is sufficiently cold to restrict chemical and biological activity and where trees are the natural vegetative ground cover. Nantucket soils have been mapped by the U.S. Department of Agriculture's Soil Conservation Service.

Soils are rated for suitability for engineering purposes. The key parameters for this project are suitability for (1) support of wastewater facility structures and (2) the disposal or recharge of treated wastewater effluent. It is expected that the soils on Nantucket will be able to support infrastructure and other structures such as a wastewater treatment facility based on a cursory review of the soils mapped by the Soil Conservation Service and their suitability for engineering purposes. Suitability for disposal of treated wastewater effluent, whether treatment is achieved with an on-site wastewater disposal system or a full-scale wastewater treatment facility, is typically the parameter causing the most concern when evaluating wastewater management alternatives. Favorable soil properties and site features are needed for proper functioning of effluent disposal sites. The soil properties and features that affect absorption of the effluent are: permeability, depth to bedrock, and susceptibility to flooding. Stones, boulders and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Soil erosion and soil slippage are hazards if soil absorption systems (leaching fields) are installed on sloping soils. In soils where the water table is seasonally high, seepage of groundwater into the effluent beds can seriously reduce their capacity for liquid waste disposal.

In addition to classifying soils according to suitability for engineering purposes, soil types have been classified according to their suitability for septic effluent disposal in the Soil Survey Reports generated by the U.S. Department of Agriculture. The classifications are slight limitations, moderate limitations, and severe limitations for on-site disposal of sewage. These classifications are based on the general characteristics of a particular soil association, and therefore, based on the broad performance of that soil association rather than individual soil tests performed within a specific area. This CWMP/EIR Phase I Document utilized the Soil Survey Report for Nantucket to determine the general percentages of soils with severe limitations, moderate limitations, and slight limitations and also to identify in general where these soils are located on the Island. The U.S. Department of Agriculture has classified all soil types on the Island for their suitability for septic effluent disposal.

In general, it can be said that the soils labeled as having slight and moderate limitations will have little problem supporting an on-site wastewater disposal system. Typically, these soils are characterized as well-drained to excessively well-drained, made up of sand and gravel materials with few stones, and generally do not have impermeable layers within 5 feet of the ground surface which would retard the downward movement of water. Soils classified as having severe limitations typically have the following characteristics: (1) bedrock within 5-1/2 feet of the ground surface; (2) slow or moderately slow permeability in the substratum; (3) a high water table, at or near the ground surface, for periods ranging in duration from 4 months to 9 months or longer each year; (4) slope gradients greater than 15 percent; (5) subject to flooding from stream overflow; and (6) extremely rocky surface. House lots that are one-half acre or smaller in size and having soils classified with severe limitations usually require intensive site preparation to rectify unsuitable soil conditions when subsurface sewage disposal systems are used.

Of the six severe limitations characteristics given above, the most difficult limitation to overcome is shallow bedrock. Title 5 requires at least 4 feet of naturally occurring pervious material below the bottom of a soil absorption system when the percolation rate is greater than 2 minutes per inch and at least 5 feet when the percolation rate is 2 minutes per inch or less. Thus, a conventional Title 5 on-site wastewater disposal system cannot be constructed in areas where bedrock is located 4 feet or less from the bottom of the leaching field.

Installing a conventional Title 5 system in areas with slow or moderately slow permeability in the substratum will require larger leaching areas. This is a problem for property owners whose lot size is not sufficient for the larger area required for an adequate soil absorption system. The problem may be further complicated if the area is also characterized with excessive slopes. Installing a conventional Title 5 system in areas with slopes greater than 15 percent proves to be difficult due to the possibility of effluent breakout along the sloped area of the soil absorption system. Title 5 permits the installation of conventional Title 5 systems on sloped areas; however, more stringent requirements for leaching field construction are established for these situations.

Hardpan soils limit the percolation rate of effluent to such a long period of time that a leaching field cannot function. The soils found on Nantucket that are associated with slow percolation rates consist of Nantucket, Woodbridge-Mattawan, Ridgebury, Chilmark, and Galeston.

Soils with excessive slope pose engineering problems in the design of wastewater disposal systems. The Plymouth-Evesboro soil complex mapped in the Shawkemo Hills, Trots Hills and Sauls Hills is identified as having slope conditions of greater than 15 percent. As was previously identified, soils with slopes of greater than 15 percent are classified as having severe soil limitations with respect to siting on-site wastewater disposal systems. Although when present in lower slopes, these excessively drained sandy soils have few limitations for their use. For instance, the Evesboro association formed in the outwash plains is described as nearly level and gently sloping, excessively drained, sandy soils. The permeability of this soil is rapid in the surface layer and subsoil and very rapid in the substratum. Hence this soil readily lends itself to on-site wastewater disposal systems.

Soils with a high water table (within 3 feet of ground surface) do not provide adequate filtration of wastewater. Seven of Nantucket's soil types fall into this category: Berryland Variant, Klej, Pompton, Pawtucket, Ridgebury Variant, Tisbury, and Woodbridge Variant.

Soils that drain poorly and/or have a high water table may restrict future development options for a parcel of land due to an inability to provide on-site wastewater disposal or support structures, or due to other environmental constraints such as wetland resources. Soils will continue to be a development constraint for those areas of Nantucket without suitable soils for a conventional Title 5 system.

Soil types with restraints on their use for on-site subsurface wastewater disposal systems are generally limited to isolated patches across the northern part of the Island. The bulk of the soils on Nantucket are very conducive for on-site wastewater disposal. This is due to the prevalence of sandy loams over thick subsurface layers of sand that can absorb large amounts of effluent. Rapid percolation rates are common across the Island.

Leaching fields are designed to take advantage of the ability of soil to absorb contaminants in wastewater. The wastewater that flows out of the effluent beds and into the leaching facility contains many fecal microorganisms (coliform) and chemical constituents such as ammonia and nitrate/nitrites. The effluent percolates into the soil beneath the bed and through the substratum to the groundwater. As it moves through the soil column, absorption, filtration and microbiological decompositions purify the effluent.

The highly porous, granular sand found on Nantucket filters out the fecal microorganisms very quickly. However, such a high hydraulic conductivity (soil permeability) provides little filtering action for chemical contaminants such as ammonia or nitrates. These chemical constituents form a plume of contaminants that flow down through the soil column and into the groundwater. A plume of contaminants introduced into the groundwater then travels with the hydraulic gradient in the direction of groundwater flow. Such a plume can extend a long distance, although it is generally narrow and self-contained. Areas with soils that are conducive to septic system leaching fields would be advantageous for disposal of treated effluent from a wastewater treatment facility.

It was determined from the Soil Survey Report by the U.S. Department of Agriculture that approximately 14.2 percent of the soils across the Island are classified as having severe soil limitations. Similarly, it was determined that approximately 18.3 percent of the soils across the Island are classified as having severe groundwater limitations. Although these percentages do not represent a majority of the Island, they do represent the areas on the Island that potentially lack acceptable soils to support on-site subsurface wastewater disposal systems and may warrant alternative means of wastewater disposal.

Topography

The topography on the Island is comprised of small hills and low lying areas associated with the outwash plains, waterbodies and wetland areas. Elevations range from 0 feet (sea level) to approximately 100 feet National Geodetic Vertical Datum (NGVD). In general, the ground elevations on the Island increase from the coastline to the interior of the Island and from the southern half to the northern half of the Island. The northern half of the Island has a greater concentration of prominent hills than the southern half of the Island. The low-lying areas on the Island are associated with wetland areas, coastal areas, and water bodies. These areas are spread throughout the Island, mostly located at the outer edges of the Island.

C. ORGANIZATIONAL CONTEXT OF TOWN

According to the 1997 Community Profile, "there are 84 elected and appointed boards, commissions, committees, departments and offices," all of which play an important role in guiding various activities in the Town. The Department of Public Works is responsible for the Town's wastewater collection, transmission, and treatment facilities. At present, the Town of Nantucket, Massachusetts acting through its Department of Public Works, is the local planning entity for wastewater facilities. Planning, operation, and financing of existing on-site wastewater disposal systems within Nantucket are currently the property owner's responsibility. The Nantucket Board of Health is the regulatory authority for on-site wastewater disposal systems within the Town.

D. LAND USE, DEMOGRAPHICS AND POPULATION

Earth Tech, Inc. has coordinated planning efforts with the NP&EDC in order to obtain as much information as possible on the existing and projected land use, demographic conditions and population of the Island. The goals and objectives developed by the NP&EDC for the community, coupled with "The Nantucket Comprehensive Plan," are used as the basis for the evaluations and analyses presented in this CWMP/EIR Phase I Document. Other agencies utilized for information and considered herein are local planning officials, Assessors, Zoning, Building and Public Works Department records and reports, Conservation Commission, Board of Health, Historic District Commission and the Natural Heritage Program. Earth Tech, Inc. has previously completed the comprehensive analysis for the Siasconset Planning Area, which utilized NP&EDC statistical data reports on population, housing, land use, and the seasonal economy. The methodology used in this CWMP/EIR for the Island-wide evaluation and analysis is similar to that used in the Siasconset Facilities Plan.

Developed and Undeveloped Areas

The Town of Nantucket, which encompasses the entire island of Nantucket, has a total land area of approximately 30,580 acres. Currently approximately 13,000 acres or 42 percent of the Island has been conserved. The State of Massachusetts, Office of Environmental Affairs estimated in 1996 that 11.5 percent of the land area was residential use, 0.3 percent was commercial use, 0.1 percent was industrial use, 1.1 percent was transportation use, 0.9 percent was agricultural use, 0.9 percent was urban open land, 4.7 percent was recreation, 3.4 percent was water, and 77.2 percent was designated as other, which includes conservation land. The above acres and percentages sited have been extrapolated from data provided by the Assessors Department and the Department of Housing and Community Development. These figures are significantly different than the land use profile presented by the NP & EDC in 1994, which attributed 16 percent of the land area to residential use, 4 percent of the land area to commercial use, 3 percent of the land area to agricultural use, 40 percent of the land area to open development, and 37 percent of the land area to conservation. Despite that these figures are inconsistent and were compiled during different years, one statistic stands out: that a significant amount of acres on Nantucket are yet to be developed.

The 1997 Build-Out Analysis also provided land use based on the parcel use rather than the areas of use. The data is as follows: 60 percent residential use, 2 percent open space, 4 percent agricultural/commercial, 0 percent industrial, and 34 percent conservation. Today 13,223 acres or 44 percent of the Island has been conserved.

Land Ownership (Public vs. Private)

To date, more than 42 percent of the land on the Island has been acquired for conservation. The remaining portion of the Island is either private or public. As defined here, public land supports facilities that serve the public, such as, town offices, public schools, libraries, fire stations, etc.

Development Density and Lot Size

The Island has developed into very distinct villages, such as Siasconset and Tom Nevers, with scattered development connecting the various villages on the Island. Increasing development in the areas between the villages has blurred the line between these villages. As such, the development density has risen between village areas and within the villages themselves. The NP&EDC is currently developing a plan to aid in guiding future development into a structured scheme on the Island. The Island-wide population density of Nantucket is calculated to be approximately 180 persons per square mile based on 1998 year round population data (8,587 persons/30,580 acres). Similar 1993 statistics showed the density per square mile to be 126. This is less than the average population density of 767.6 persons per square mile for Massachusetts as reported in the 1990 U.S. Census. The seasonal population density is 4 or 5 times greater than the year round population density, depending on which data is used. The population density for the individual villages has not been compiled to date, as the NP&EDC is currently establishing neighborhood boundaries.

Zoning Classifications

The Town of Nantucket is comprised of eleven zoning districts as described in Table 2D-1. In addition, the Town has established overlay districts for the purpose of protecting environmentally sensitive land by enforcing more restrictive provisions for development within these districts. The Nantucket Harbor Watershed District, the Public Wellhead Recharge District, the Multi-Family District and Flood District serve to reduce the environmental impacts of development on the Island. Zoning districts LUG 1, 2, and 3 is zoned strictly for residential development. Zoning districts ROH, R 1, R 10, and R 2 are zoned for residential development, but do allow commercial development by permit. Zoning districts RC and RC 2 are zoned for both residential and commercial development. The Moorlands Management district is being purchased by the Nantucket Land Bank for conservation. For further explanation of the zoning districts, including dimensions, setbacks and restrictions refer to the Nantucket Zoning Bylaw and the zoning maps for the Island.

TABLE 2D-1
TOWN OF NANTUCKET
CWMP / EIR
ZONING DISTRICTS

Zoning Code	Zoning District	Minimum Lot Size
LUG 1	Limited Use General 1	40,000 sq.ft.
LUG 2	Limited Use General 2	80,000 sq.ft.
LUG 3	Limited Use General 3	120,000 sq.ft.
R 1	Residential 1	5,000 sq.ft.
R 10	Residential 10	10,000 sq.ft.
R 2	Residential 2	20,000 sq.ft.
ROH	Residential Old Historic	5,000 sq.ft.
RC	Residential Commercial	5,000 sq.ft.
RC 2	Residential Commercial 2	5,000 sq.ft.
LC	Limited Commercial	5,000 sq.ft.
MM	Moorlands Management	10 acres

Public Facilities

The island of Nantucket offers many public facilities to support the community, including public schools, a Town Hall, a Town Library, long-term care facilities, a hospital, museums, parks and recreational land, a police station, and a fire station to name a few. The Island has an elementary school, middle school, high school and a community school. Most of the public facilities are located in the Town area of the Island. The Nantucket Elementary School had 617 students enrolled during the 1998 academic year. The Cyrus Peirce Middle School had 272 students enrolled during the 1998 academic year. The Nantucket High School had 328 students enrolled during the 1998 academic year. The community school operates year round and offers community based programs to all ages.

Year Round and Seasonal Housing Units

A majority of Nantucket's developed land is residential. The total number of housing units in 1998 was approximately 8,400, which represents both year round and seasonal housing units. The number of year round housing units, those units occupied by year round residents, has steadily increased in recent years. In addition, the number of seasonal housing units has also been steadily increasing in recent years. As a whole, the Island has supported increasing numbers of year round and seasonal populations. Historical data on the growth of year round and seasonal housing units can be utilized to approximate the 1998 year round and seasonal housing units.

In 1990, 2,597 of the existing 7,021 housing units were occupied by year round residents, or approximately 37 percent (1990 Census). The remaining 4,424 housing units were assumed to be seasonal housing units. In 1997, 3,818 of the existing 8,396 (1997 Nantucket Build-Out Analysis) housing units were occupied by year round residents, or approximately 45.5 percent (RKG Associates, Inc., 1998). During this time period, seasonal housing units grew at a rate of 5.8 percent. In August of 1999, the Massachusetts Institute for Social and Economic Research (MISER) reported the counties with the highest projected growth rates since 1990. Nantucket was at the top at 34.6 percent. MISER projected this percent change to be 30.1 percent between 2000-2010.

In 1997, 246 building permits were issued for new dwelling units, 13 permits were issued for duplex units, and 5 permits were issued for triplex units. A building cap of 225 dwelling units per year was established and became effective January 1, 1997. In the 1996 fiscal year, the planning board approved 86 secondary dwellings.

Nantucket's year-round population has increased from approximately 4,000 in 1970 to more than 7,000 in 1996. In the last few years, nearly a decade (1990-98), the Island has seen a 43 percent increase in population. The 1996 population was 7,267 persons. The Nantucket census reported a total resident population of 7,570 persons as of January 1998. The 1998 population was 8,587 persons, which has surpassed the MISER population projection for the year 2000 of 8,091 persons and also surpasses the 1999 Census Bureau estimates of 8,206 persons. This trend is likely to continue given the strong economy. RKG Associates, Inc. reported the annual visitation to the Island to be approximately 400,000 in 1996 using transportation statistics, an increase of 29 percent since 1992. It is expected that annual visitation has risen each year since 1996. This is evidenced by the fact that more and faster ferries are being used to transport passengers to and from Nantucket, thereby bringing more people onto the Island each day. The "Nantucket Comprehensive Community Plan", November 2000, states the number of passengers traveling to Nantucket by sea and air from 515,604 in 1990 to 779,330 in 1999-a 51 percent increase. During this same time period, the passengers alone coming by air increased 2½ times faster than the total travelers. The relative availability and affordability of air travel accounts for the shift. Due to the number of tourists and seasonal visitors to Nantucket, the peak season population is estimated to surpass40,000. The rate of growth has been increasing in Nantucket as evidenced by the increase in building permits, sewer connection permits, airport enplanements and ferry passengers.

Average Household Size and Income

The statewide average household size is 2.6. It is estimated that the off-peak season household size (year round housing units) is 2.48 persons per household (PPH) for owner occupied housing units and 1.97 PPH for renter occupied housing units based on 1990 data according to the 1997 Nantucket Build-Out Analysis. Of the 37 percent year round housing units in 1990, 23 percent were owner occupied and 14 percent were renter occupied. Based on information gathered for the Siasconset Facilities Plan, the off-peak season household size was determined to be 2.5 PPH and the peak season household size was determined to be 4.5 PPH. Note, the "Fiscal and Economic Impact Analysis of Development at Variable Growth Rates, Island of Nantucket, Final Report" prepared for the Nantucket Land Council by RKG Associates, Inc. in June 1998 estimated that there are 1.98 persons per household for year-round residents based on the annual town census and voter registration database, updated through 01/01/98. The total population used to develop the 1.98 PPH was 7,570 persons (01/01/98) and 8,396 existing dwelling units (1997 Build-Out Analysis).

According to 1997 Community Profile, the median household income in 1989 was $40,331, which is a 112 percent increase over the 1979 median household income. RKG Associates, Inc. reports the 1997 average household income on Nantucket to exceed $87,400, which is 17.1 percent above the statewide average.

Average Home and Land Prices

The average home price in 1999 was over $800,000, a 60 percent increase since 1989. The average single family home price in 1996 was $509,232. The average land price in 1999 was over $330,000, a 47 percent increase since 1989. The average land price in 1996 was $280,264. The Members of the Nantucket Association of Real Estate Brokers reported in July 2000 the average home price on the Island at over $1,000,000 and land prices averaging around $600,000. On July 20, 2000, the lowest priced house on the market was $290,000 with only twelve houses between that and $500,000.

Infrastructure

The Island's infrastructure consists of two wastewater treatment facilities (the Surfside WWTF and the currently under design and construction Siasconset WWTF) and associated disposal facilities; wastewater collection systems including pumping stations; privately owned wastewater collection systems; two water companies; one private water system; and private and Town owned drainage systems and roadways. The Town maintains drainage systems for its roadways. In addition to the Town owned and maintained wastewater collection system, there are several privately owned collection systems that connect into the Town's system. The two water companies supplying public water to the Island are the Siasconset water company and the Wannacomet water company. The Siasconset Water Company serves the Siasconset area of the Island. The Siasconset Water Co.'s distribution system extends from Sankaty Head Lighthouse south to the U.S. Coast Guard Loran Tower and west to the Siasconset Water Co.'s land off Milestone Road. The Wannacomet Water Company serves almost all of the Town area of the Island, all of the Warren's Landing area of the Island, and portions of the Monomoy, Town WPZ, and other portions of the countryside. According to Nantucket DPW records, the Island has approximately 134 miles of roadway connecting the 15 mile long and 5 mile wide Island.

E. NATURAL RESOURCES AND ENVIRONMENTALLY SENSITIVE AREAS

The following is a description of the existing environmental conditions including air quality; waterbodies; wetlands; floodplain areas; rare species and sensitive habitats; historical and archaeological resources; park lands and recreational resources; and conservation land. These resources are discussed in terms of the type and location of the resources within the Town. Most of these natural resources are presented on Figure 2A-1 (pocket).

Air Quality

Air quality is an important natural resource to consider for any Town when planning any type of improvement project. Air quality has the potential to have the largest impact on the greatest number of people within Nantucket, especially since Nantucket is a highly regarded tourist destination with mostly residential development. It is important for the Island to maintain its historic character and charm, and adverse air quality would change that for the islanders. At this point, Nantucket has very good air quality, with only the Town area of the Island seeing the most vehicular traffic. As with any project, air quality should be considered to reduce the negative impacts that may be caused during construction and after construction due to operation of the facility. Hence, the CWMP/EIR will consider potential impact to air quality at all points during the three phase planning process.

Waterbodies – Harbors, Ponds, Wetlands, Floodplains, Dunes, Beaches and Moors

Nantucket's environmentally sensitive areas include its ponds, wetlands, floodplains, dunes, beaches, and moors, as well as, it's harbors. Nantucket is surrounded by the Atlantic Ocean and is associated with several harbors: Nantucket Harbor, Madaket Harbor, and Polpis Harbor, as well as, several large tidal surface waterbodies. Major ponds, streams, swamps and wetlands include: Tom Nevers Pond, Sesachacha Pond, The Creeks, Miacomet Pond, Shimmo Creek, Hither Creek, Long Pond, No Bottom Pond, Reed Pond, Pocomo Meadow, Squam Swamp, Rolgers Marsh, Millbrook Swamp, Brunt Swamp, and Madaket Ditch. Nantucket's wetlands include freshwater and coastal tidal marshes. Inland floodplain areas are minimal due to the absence of large streams. However, Nantucket's entire coastline is subject to flooding. Beaches and dunes are significant both scenically and as a barrier between the ocean and low lying inland areas. Nantucket's moors are extensive areas or low scrubby vegetation reflecting the relatively barren soils resulting in a heath plant population. They are scenically unique and contain significant wildlife nesting areas.

Both islanders and tourists use the harbors and most of the ponds for recreational purposes alike. The entire coastline, especially the beaches, are used for swimming, boating, and other recreational activities. Over the years, the harbors and beaches have been closed to shellfishing and swimming due to poor water quality associated with fecal bacteria. In addition, failing septic systems from the homes and summer cottages surrounding Madaket harbor are threatening the water quality of the harbor with bacterial contamination and eutrophication.

Rare Species and Sensitive Habitats

Rare species and sensitive habitats within the Town of Nantucket include Estimated Habitats of Rare Wildlife, Certified Vernal Pools, and Priority Sites of Rare Species Habitat and Exemplary Natural Communities. These resources are mapped by the Massachusetts Natural Heritage & Endangered Species Program (MANHESP) Atlas (1997-1998 Edition).

Many of the plants found on Nantucket are listed on the Massachusetts rare and endangered plants list including Mattamuskeet panic grass (Dichanthelium mattamuskeetense), Nantucket shadbush (Amelanchier nantucketensis), bushy rockrose (Helianthemum dumosum), subulate bladderwort (Utricularia subulata), and Torrey's beak-rush (Rhynchospora torreyana). The Island is also home to the spotted turtle (Clemmys guttata), common barn-owl (Tyto alba), water-willow borer (Papaipema sulphurata), and the regal fritillary (Speyeria idalia), all of which are listed as protected wildlife in Massachusetts.

The U.S. Department of the Interior lists Muskeget Island on it's Natural Registry of Natural Landmarks. Muskeget Island is located approximately 5 miles northwest of Nantucket Island. Muskeget Island is the only known location where the Muskeget vole is found and the southernmost area where the grey seal breeds. The Island is also nesting grounds for large populations of herring gulls and black-backed gulls. Although Muskeget Island is not populated, and as such is not considered as part of this CWMP/EIR Phase I Document, it is a noteworthy natural resource for the island of Nantucket.

Historic and Archaeological Resources

The entire island of Nantucket is classified as a historic resource, as such the entire island of Nantucket is designated as the Nantucket Historic District and any permit to build must be approved by the Nantucket Historic District Commission. In addition, many archaeologically significant sites have been identified on the Island, but their locations are not mapped.

The following is a list of the historic places in Nantucket, as they appeared in the Massachusetts Historical Commission's "State Register of Historic Places, 1997:"

- African Meeting House, 29 York Street
- Brant Point Light Station, Brant Point
- Jethro Coffin House, Sunset Hill
- Friends Meeting House, Fair Street
- Richard Gardner House, 32R West Chester Street
- Hawden House, 96 Main Street
- 37 Hulbert Avenue, Hulbert Avenue
- Lighthouses of Massachusetts
- Nathaniel Macy House, Liberty Street
- Thomas Macy Warehouse, Straight Warf
- Nantucket Historic District, Nantucket Island
- Old Mill, South Mill Street, and
- Sankaty Head Light, Sankaty Head.

The following is a list of the historic places in Nantucket, as they appeared in the National Register of Historic Places 1966-1988:

- Brant Point Light Station, Brant Point
- Jethro Coffin House, Sunset Hill
- Nantucket Historic District, Nantucket Island, and
- Sankaty Head Light, Sankaty Head.

F. GROUNDWATER SUPPLY AND QUALITY

The following discussion provides a description, including location, of the present water supplies, the water distribution system, water quality, aquifers, and aquifer protection zones within Nantucket. These resources are discussed in terms of the location of existing public water supply wells and DEP approved Zone II protection areas.

Groundwater Supply and Quality

The entire island of Nantucket relies on public and private water supply wells, which draw water from a groundwater supply or aquifer. An aquifer is a naturally occurring geologic formation. Typically, these formations consist of deposits of rock, sand, and gravel that contain significant amounts of water. The U.S. Department of Environmental Protection has designated Nantucket's water supply aquifer as a Sole Source Aquifer. As a sole source aquifer, Nantucket's aquifer is the "principal source of drinking water" for the Island and if contaminated, would create a "significant hazard to public health."

The source of this groundwater is precipitation. Average annual precipitation reported by the National Weather Service from 1941-70 was 43.7 inches. On average, 24.6 inches are returned to the atmosphere through evapotranspiration. Surface runoff is estimated on the order of one inch or less per year due to the nature of the porous soils (Walker, 1980). Hence, an average recharge rate of the aquifer is 18.1 inches per year. The groundwater reservoir forms a freshwater lens approximately 500 feet thick at the center of the Island and thins out towards the shores. The groundwater floats above the seawater due to its lower density.

There are two public water supply companies on the Island, Wannacomet Water Company and Siasconset Water Company. There is also a small community drinking water supply well serving approximately 15 homes in the Wauwinet area of the Island. The Wannacomet Water System consists of wells and a storage tank. In 1999 it was recorded that approximately 500.3 million gallons were pumped from the Wannacomet Water Co. wells. The Siasconset Water System consists of five large diameter dug wells with a total capacity of 240 gallons per minute (GPM) and one 12-inch gravel packed well with a capacity of 800 GPM. These wells result in a total capacity of approximately 1.5 million gallons per day (MGD). The average yearly water consumption in Siasconset between 1990 and 1994 was approximately

51.2 million gallons. The average yearly water consumption in Siasconset between 1993 and 1997 was approximately 63.0 million gallons.

The 1990 Water Resources Management Plan stated that the water quality at the Siasconset well fields is excellent. All of the relevant drinking water standards are being met consistently. However, there were indications of water quality degradation within the zones of contribution to these wells (Zone I and IIs). The plan stated that this degradation has possibly occurred from overlaying land uses such as an abandoned dump in the Siasconset Area, on-site sewage disposal systems, salt storage, and underground storage tanks, fertilizers, pesticides, etc. One indication of degradation is nitrate-nitrogen concentrations. Although the concentrations are well below the maximum contaminant levels, the presence of nitrates represents possible contamination from on-site septic systems, fertilizers, road runoff and precipitation.

Both the Wannacomet and Siasconset Water Departments monitor the water quality of its source water in accordance with DEP regulations. The water companies are not required to monitor additional water quality parameters, nor are they required to monitor supply sources more frequently than the minimum requirements as stated in 310 CMR 22.00: Drinking Water.

Aquifer Protection Zones

In accordance with Massachusetts Drinking Water Regulations each public water supply well has a Zone I Protection Area which, as a minimum is a land use control area designated as a protective radius around each well of 400 feet. Each well also has a Zone II, which is an additional protective area which is established by determining the aquifer area which may contribute water to a given well under severe pumping and recharge conditions. The Zone II areas within Nantucket are described hereinafter. The Wannacomet and Siasconset Water Companies serves almost all of the Village of Siasconset and the Downtown area of Nantucket, as well as, the Warren's Landing area of the Island.

In addition, a Public Wellhead Recharge District has been established for the Wannacomet water supply wells located off Milestone Road. The delineation of the Public Wellhead

Recharge District serves to regulate land use and limit lot coverage in the district to protect the wells from development in the contribution area.

G. ON-SITE WASTEWATER DISPOSAL SYSTEMS

The Town of Nantucket is currently utilizing on-site wastewater disposal systems for approximately 48.2 percent of its wastewater treatment and disposal (based on 1998 Assessor's data). The 3,952 properties use either a conventional Title 5 septic system, Title 5 with variance, innovative/alternative system, cesspool or combination. In 1996, 267 permits were issued for septic systems. Of these permits, over 25 percent (62) were issued for the repair of non-code compliant systems. Of the systems repaired, 18 required variances to Title 5 and in most cases, nitrate reduction or "innovative/alternative" systems were utilized. In 1997, 342 septic system permits were issued.

The Department of Public Works manages septage for the Town of Nantucket. Currently the only location for the disposal of septage is the existing Surfside Wastewater Treatment Facility. The new Siasconset Wastewater Treatment Facility will not have provisions for a septage receiving station, and thus, the Surfside Wastewater Treatment Facility will remain the only facility on the Island that is capable of processing septage.

Since the new Title 5 regulations have been in effect (March 31, 1995), septage haulers are required to supply the Nantucket Board of Health with a record of all septage pumped. These records include information on the property address, type of system, location of system, amount pumped, date of service, disposal location, condition, and pumper license number. These records are filed with the Nantucket Board of Health.

The average daily septage pumped in Nantucket is approximately 1,600 gpd with the annual pumping volume being about 587,400 gallons on average based on 1996 and 1997 records. This septage is typical of residential wastewater but with a BOD of 5,000 mg/L and TSS of

15,000 mg/L. The areas of the Island relying on on-site wastewater disposal systems are outside of the downtown area, and therefore, not subject to industrial use with only minimal commercial use. Hence, the septage generated in Nantucket is consistent with medium strength residential septage.

The on-going septage management process in Nantucket is adequate but can be improved. A more proactive philosophy is being considered which would develop an education program to inform property owners about the function of their on-site septic system, how often to pump their septic tank or cesspool and what other maintenance can be provided to extend the life of their systems. A pumping incentive program should be discussed with the Board of Health and further discussions will be forth coming to develop a cost effective program that will benefit all properties utilizing on-site septic systems in Nantucket.

H. WASTEWATER CONVEYANCE AND TREATMENT SYSTEMS

The publicly collected wastewater on the island of Nantucket is directed to two facilities for treatment, the Surfside Wastewater Treatment Facility and the Siasconset Wastewater Treatment Facility. The Surfside Facility receives its wastewater from two pump stations, one located on Sea Street and the other located in Surfside. The Surfside Facility is a conventional wastewater treatment plant consisting of screening, grit removal, primary treatment, rapid infiltration basins, sludge holding tanks, and solids processing systems. The facility has been in full operation since 1991 and has a design capacity of 2.24 MGD (average daily flow). However, the facility is only permitted for a maximum discharge of 1.8 MGD and it has reached its discharge limit during average day conditions. The DEP has refused the Town's application to increase its discharge permit limits to its capacity of 2.24 MGD. The wastewater collection system serving the Town area of the Island consists of approximately thirty-four (34) miles of sewer.

The Surfside WWTF, which commenced operation in April 1991, consists of wastewater screening, grit removal, primary treatment rapid infiltration basins and composting (no longer in use). In the summer of 1992 various improvements were made at the facility to reduce odors, including, design and construction of a chemically enhanced primary treatment system that included a chemical storage and feed building, addition of chlorine to the facility's influent, and addition of chemicals to the primary clarifier effluent. The upgraded facility commenced operation in the summer of 1995.

The Siasconset sewerage system currently discharges via a screen chamber and dosing tank to a set of four sand filter beds. A new Siasconset Wastewater Treatment Facility is currently being designed and constructed. The new facility will produce a highly treated wastewater effluent that will discharge to the upgraded rapid infiltration beds. The wastewater collection system serving the Siasconset area of the Island coincides with the Siasconset Water Company's water distribution system. The Siasconset sewer system consists of approximately 4.89 miles of sewer. The new Siasconset Wastewater Treatment Facility with infiltration beds will treat only the wastewater collected by the Siasconset sewer system.

The CWMP/EIR Phase III Document will provide an evaluation of Nantucket's existing wastewater conveyance and treatment systems relative to (1) the existing wastewater system (Town and Siasconset); (2) infiltration/inflow rehabilitation; and (3) the existing Surfside Wastewater Treatment Facility.

Existing Wastewater System

The evaluation of the existing wastewater system will include information relative to each system's age, capacity, performance, condition, etc. based on existing reports. The existing wastewater collection systems will be mapped and an evaluation of any proposed future expansion of the collection system, including effects on future growth and its impact on capacity at the treatment facilities and collection systems.

Infiltration/Inflow Rehabilitation

In 1991, the Town of Nantucket completed an "Infiltration/Inflow (I/I) Analysis Report and Sewer System Evaluation Survey (SSES)" to determine the amount of I/I entering the sewer system and manholes in the Town and Siasconset service areas. These studies concluded that the infiltration and inflow found in the Siasconset sewer collection system was not significant and did not warrant corrective action. However, it was determined that approximately 157,000 GPD of infiltration could be cost-effectively removed from the Town sewer collection system. The recommended rehabilitation consisted of: pipe testing and sealing;

pipe replacement; rerouting of catch basin leads from the sewer system to the drain system; and removal of private inflow sources such as downspouts, floor drains, sump pumps and cleanouts. Many of the study recommendations have been implemented by the Department of Public Works, including: notifying property owners with illegal connections to remove such connections; developing a flushing program of the entire sewer system to minimize buildup of debris and maintain hydraulic capacity; and requiring restaurants to install grease traps. The fieldwork for the I/I Analysis and Sewer System Evaluation Survey indicated that the existing conveyance system in Nantucket was in poor condition and is in need of a major overhaul. Problematic conditions include: sewers at less than minimum slope; collapsed pipe, broken inverts, root intrusion; manhole spacing as much as 1,000 feet; and persistent sewer backups.

Surfside Wastewater Treatment Facility

An evaluation of the existing Surfside WWTF condition and performance and an inventory of the existing equipment and its existing capabilities will be developed as part of the CWMP/EIR Phase II Document. The WWTF will be evaluated with regards to the capabilities of the equipment throughout the planning period and a summary of recommendations and/or required equipment and operational improvements, including facility expansion and additional personnel requirements will be developed.

3.0 FUTURE CONDITIONS AND WASTEWATER NEEDS

A. LAND USE AND POPULATION PROJECTIONS

Land Use

The NP&EDC's Comprehensive Plan delineates the Island into two distinct areas: "Town" and "Countryside." A "Greenbelt" area divides the Town and Countryside areas. The Town and Town neighborhoods are defined by the NP&EDC as "areas were compact development is the predominant land use, some commercial use already exists or has the potential to develop, public water supply and sewer system can be used efficiently and/or expanded cost-effectively, and the majority of the year round island population lives." The Countryside and Countryside neighborhoods are defined by the NP&EDC as "areas where the natural landscape predominates, open space has been acquired or targeted for protection, sensitive habitats remain intact or can be re-established, scenic vistas and public recreation resources are valued by islanders and visitors alike, there are prime or important agricultural lands, and small hamlets and low-density rural subdivisions are nestled into the landscape." The "Greenbelt" is defined by the NP&EDC as "a band of open space that defines the limits of Nantucket town and the edge of the countryside." The Greenbelt area acts as a dividing line between the Town and Countryside, consisting of protected open space where no development occurs. The extents of the Greenbelt bounding the Town and Countryside are not definitive, as the boundaries have not been agreed upon as of yet. The basic idea of the Town and Countryside concept is to encourage development within the Town and Town neighborhood defined areas of the Island and discourage development within the Countryside and Countryside neighborhood defined areas. The Nantucket Comprehensive Plan provides more information regarding the Town, Countryside, and Greenbelt concept. Once the Town has accepted "Charting the Future, The Nantucket Comprehensive Plan," the NP&EDC will be developing Neighborhood Area Plans in the near future. It is our understanding from the NP&EDC that the Town has accepted the overall concepts presented in this plan but has not adopted all of its recommendations as of this writing. The NP&EDC has stated that it will continue to move forward with the residents and voters of Nantucket with the plan's recommendations in the future.

The CWMP/EIR will keep the NP&EDC's goals for future development in mind when considering future growth patterns for the entire Island. It is expected that this information will be available for use during the preparation of the CWMP/EIR Phase II Document, in which more quantitative wastewater flow estimates will be developed for the areas with wastewater disposal needs as identified herein.

The CWMP/EIR Phase I Document has also taken into consideration the goals of the Harbor Watershed Work Group, charged by the 2000 Annual Town Meeting with the responsibility of developing a strategy to manage nutrients in the harbor area. This Phase I also took into consideration the Madaket Harbor area, defining systems located within 3,600 feet of the harbor area border. By defining severe soil and groundwater constraints in these sensitive areas and with recommendations of long-term wastewater disposal, we work toward a common goal of cleaning and preserving Nantucket harbor areas.

Population Projections

As discussed previously, the existing population, both year-round and seasonal, has been cited by many sources. The importance of quantifying the existing population in terms of year-round and seasonal numbers is that these numbers play an important role in the design of treatment systems. Furthermore, there is also a sewered population and an unsewered population to consider. The sewered and unsewered populations also have a year-round and seasonal population component. Future population trends for the Island and the 20-year planning period have been projected based on existing information from regional, state, and Town data.

According to the most recent population data provided by the Town Clerk's Office, February 2001's population was determined to be 9,521. This represents the current year round population on the Island. The 1998 year round population was determined to be 8,587, a 10.9 percent increase over the past two years.

The impacts on the existing wastewater infrastructure (wastewater treatment facility, interceptor sewers and pump stations) from the increase in population and resultant wastewater flows from the existing and future service areas will be evaluated. Within this CWMP, Earth Tech will evaluate future sewering needs and limitations utilizing the NP&EDC land use and build out analysis. Based on this information, outlying areas which may require alternative wastewater treatment/disposal options will be identified. The implications of future development to the extent of full build out will also be evaluated.

B. ON-SITE WASTEWATER DISPOSAL PROBLEMS

The Town of Nantucket is about 47.8 square miles (30,580 acres) in geographic area with 11,393 residential, commercial and industrial parcels of which 8,194 have been developed (1998 Assessor's data). The Soil Survey Report by the U.S. Department of Agriculture states that about 14.2 percent (4,350 acres) of the Town has severe soil conditions and 18.3 percent (5,590 acres) of the Town has severe groundwater conditions that are not optimal for installation and use of conventional Title 5 wastewater disposal systems.

The current Title 5 failure rate for the Town of Nantucket is approximately 45 percent. There have been 289 reported failures and/or repairs of the 638 property re-sales between March 31, 1995 and January 1999. This failure rate is based on the number of system failures or upgrades for re-sales compared to the total number of re-sales in Nantucket since the implementation of the Title 5 regulations on March 31, 1995. The data used to develop this failure rate was compiled from Board of Health records and included information from disposal works construction permit applications and certificates, official Title 5 inspection reports and the actual property record files. This data documents actual on-site wastewater disposal system failures from Title 5 inspection reports, as well as, upgraded systems that would have received a certificate of compliance upon upgrade completion.

On-site wastewater disposal system upgrades and/or repairs dating from 1972 through March 31, 1995 were also compiled. These upgrades exclude simple repairs such as a septic tank or distribution-box replacement. This research documents 482 failures during the 23-year study period and represents about 12.2 percent of the approximately 3,953 unsewered developed properties in Nantucket (1998 Assessor's data). These consist of several types of failure modes that include: (1) sewage breakout; (2) high groundwater; (3) poor soils; (4)

continuous back-ups; (5) excessive pumping; and (6) failed inspections. Approximately 22 percent of the developed lots on the Island were developed prior to 1978, the year that Title 5 first went into effect. Refer to Table 3B-1.

C. DEVELOPMENT OF THE STUDY AREAS

The Town of Nantucket was divided into 18 study areas based on geographic location. All of the study areas (entire Town) were analyzed for the need for wastewater disposal beyond the use of conventional Title 5 septic systems. A brief description of the 18 geographic study areas in the Town of Nantucket is given in the following paragraphs. A summary of the characteristics of each study area is discussed below.

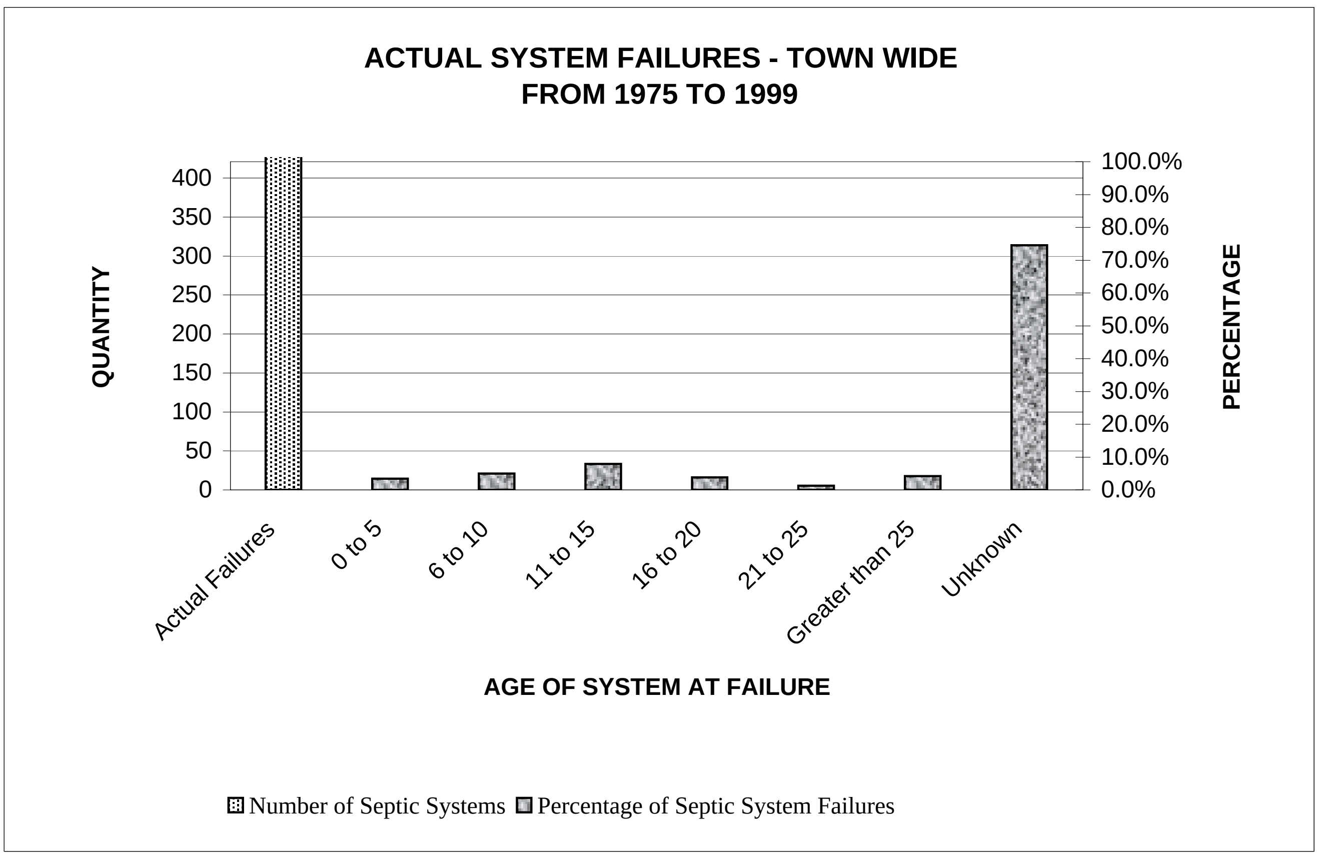
1. Madaket

The Madaket study area is bordered on the southwest by the Atlantic Ocean, on the southeast by Long Pond, to the north by Salt Pond and Madaket ditch and bordered on the northwest by Hither Creek and Madaket Harbor. Madaket is a relatively densely populated area that is located on the western side of the Island. There are many small pre-existing lots that are still being built upon in the study area. However, many of these lots have become unbuildable due to the location of wells on adjacent lots. In addition, there has also been subdivisions proposed for the Madaket study area. This area is served by on-site wastewater disposal systems and individual water wells. Municipal water ends at the bridge leading into Madaket. This study area is zoned for Residential 2, with some Residential Commercial and Limited Use General 2. The Madaket study area is designated by the NP&EDC as a "countryside neighborhood" and is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country".

Surface waters located in Madaket have suffered from poor surface water quality over the years and the designated shellfish beds have been closed numerous times. Two areas of high concern are the Millis Bridge and the Hither Creek area. Over the years, the Millis Bridge area has exhibited poor water quality and has had several algae blooms. Hither Creek has been closed to shellfish harvesting for many years.

TABLE 3B-1
CWMP/EIR
TOWN OF NANTUCKET, MASSACHUSETTS
ACTUAL SYSTEM FAILURES - TOWN WIDE

DESCRIPTION	TOTAL FOR TOWN	
	Number	Percentage
Total Number of Developed Lots	8,071	
Total Number of Unsewered Developed Lots	4,260	52.8%
Systems Built before 1978 (Title 5) and Lot Size less than or equal to 1/2 acre	2,584	60.7%
Systems Built before 1978 (Title 5)	4,081	50.6%
Age of System at Failure		
Actual Failures	771	
0 to 5	26	3.4%
6 to 10	38	4.9%
11 to 15	61	7.9%
16 to 20	29	3.8%
21 to 25	10	1.3%
Greater than 25	32	4.2%
Unknown	575	74.6%



It is believed that adjacent septic systems are causing the problems in Hither Creek, although there is no proof of this at this time. It is a goal, as outlined in "The Nantucket Comprehensive Plan" to "further study the sources of coliform bacteria in Madaket Harbor to determine if septic systems are the source of contamination."

The majority of the study area's soils consist of Riverhead-Katama, mostly loamy soils, Evesboro sands which are highly sandy soils and Udipsamments Beaches-Pawcatuck. The combination of these could also be the cause of the high groundwater contamination in the surface waters. The high percolation rate of the sand does not allow for adequate treatment of the septic tank effluent from the septic disposal systems.

Roadways in this study area include: A Street, Alabama Avenue, Ames Avenue, Arkansas Avenue, Baltimore Street, C Street, California Avenue, Cambridge Street, Chicago Street, Columbus Avenue, D Street, Delaware Avenue, E Street, F Street, Florida Avenue, Goose Cove Avenue, H Street, I Street, K Street, Long Pond Drive, M Street, Macy Road, Madaket Road, Maine Avenue, Massachusetts Avenue, Midland Avenue, Mississippi Avenue, North Cambridge Street, North Carolina Avenue, New Hampshire Avenue, New Jersey Avenue, Oakland Street, Oklahoma Avenue, Rhode Island Avenue, South Cambridge Street, South Carolina Avenue, Starbuck Road, Tennessee Avenue, Utah Avenue, Vermont Avenue, and Washington Avenue.

2. Warren's Landing

This study area is located north of the Madaket study area in the western portion of the Island. It consists of a small subdivision of homes located of off Warren's Landing Road. This area is serviced entirely by on-site wastewater disposal systems. A portion of this study area is served by Town water. This entire area is zoned Limited Use General 2. Currently, the Warren's Landing study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country". Warren's Landing has been designated by the NP&EDC as a countryside neighborhood.

The majority of the study area's soils consist of Evesboro sands. These soils are adequate for locating a septic system, but do have a problem with high permeability, leading to possible groundwater contamination due to inadequate treatment of septic tank effluent. The northern portion of the study area has a mixture of many different types of soils, some of which have severe limitations to locating functional septic systems.

Roadways in this study area include: Creek Lane, Fisher's Landing Road, North Point, Ridge Lane, Warren's Landing Road, and West Way.

3. Cisco

The Cisco study area is located on the southern coast of Nantucket between the Madaket and Miacomet study areas. The majority of the study area abuts Hummock Pond. There is a relatively high density of housing in the area, as well as, an increased demand to build over recent years. This area is served entirely by private water wells and on-site wastewater disposal systems. There are three main zoning types in this study area, which include: Residential/Commercial 2, Limited Use General 2, and Residential 2. Currently, the Cisco study area, a countryside neighborhood as designated by the NP&EDC, is not being considered in the island's growth plan.

The majority of the study area's soils consist of Evesboro sands. These soils are adequate for locating a septic system, but do have a problem with high permeability, leading to possible groundwater contamination due to inadequate treatment of septic tank effluent. The northern portion of the area has a mixture of many different types of soils, some of which have severe limitations to locating functioning on-site wastewater disposal systems.

Roadways in this study area include: Ahab Drive, Austine Locke Way, Caroline Way, Davis Lane, Falmouth Avenue, Heller Way, Hummock Pond Road, Ishmael Road, Marion Avenue, Mattapoisett Avenue, Melville Court, Moby Way, Moth Ball Way, Osprey Way, QueQueg Drive, South Miacomet Avenue, Saccacha Avenue, Tautemo Way, Trinity Avenue, Walbang Avenue, Wall Street, and Westerwyck Way.

4. Somerset

This study area is located in the southwest outskirts of the Town area. The majority of this study area is bounded by open space, which is not included in any of the study areas discussed here. The northeast portion of this study area borders the Town study area. This study area is served by on-site wastewater disposal systems and mainly by private individual water wells. The majority of this study area is zoned either Residential 2 or Limited Use General 2 based on the most recent Town and County of Nantucket, Massachusetts Official Zoning Map. The Somerset study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country". The NP&EDC have designated Somerset as a countryside neighborhood.

The soils in this study area are a combination of Riverhead-Nantucket-Woodbridge Variant and Evesboro sands. The Evesboro sands are adequate for locating a septic system, but do have a problem with high permeability, leading to possible groundwater contamination due to inadequate treatment of septic tank effluent in the soil profile.

Roadways in this study area include: Austin Farm Road, Bartlett Road, Burnt Swamp Road, Catherine Lane, Clara Drive, Doc Ryder Drive, Farmview Drive, Golfview Drive, Hatch Circle, Henderson's Drive, High Brush Path, Marble Way, Raceway Drive, Somerset Lane, Somerset Road, Swayze's Drive, Todd Circle, and West Miacomet Road.

5. Miacomet

The Miacomet study area is located on the southern coast of the Island between the Surfside and Cisco study areas. The Surfside Wastewater Treatment Facility, which is located in the southern portion of this study area, is relatively close to the eastern side of Miacomet Pond. The pond has not shown any repeated coliform outbreaks, which is a main indicator of poor water quality. The study area is primarily Limited Use General 2.

The Miacomet study area almost entirely consists of Evesboro sands. This soil category has no problems with seasonal high groundwater and is suitable to sustain a working on-site wastewater disposal system. However, as was previously mentioned, these extremely sandy soils do not always provide adequate treatment of the septic tank effluent due to their high permeability. This may lead to groundwater contamination.

This area is not densely populated. The majority of this study area is served by individual water wells and its wastewater is treated by on-site wastewater disposal systems, however, municipal water and sewer serves the northern portion of this area. The area has three zoning regions. West of Miacomet Pond, it is zoned as Residential/Commercial 2 and also Limited Use General 2. East of Miacomet Pond, there is a small patch of Residential 2. The Miacomet study area is being considered in the island's growth plan, as it is located inside the necklace separating the "Town" and "Country". Although the NP&EDC considers Miacomet as a town neighborhood, neighborhood plans have yet to be developed for this area.

Roadways in this study area include: Beach Plum Avenue, Blueberry Lane, Correia Lane, Field Avenue, Folger Avenue, Miacomet Road, Morgan Square, Pond View Drive, Rachel Drive, South Pasture Lane, South Shore Road, Tripp Drive, and Western Avenue.

6. Surfside

This study area is located on the south coast of the Island of Nantucket. It is bordered to the west by the Miacomet study area, to the north mainly by the Town-WPZ study area, and to the East by the Nantucket Memorial Airport. The majority of this study area is served by individual water wells and its wastewater is treated by on-site wastewater disposal systems. The zoning for the entire Surfside study area is Limited Use General 3.

Much of the coastal area in this study area consists of Riverhead-Katama sandy loams away from the Beach line and Udipsamments Beaches-Pawcatuck. These sandy loams are suitable for subsurface sewage disposal, but the fast seepage of the septic tank effluent through the soil leads to inadequate treatment and possible groundwater contamination. There is also some Evesboro sands in this study area that has the same general characteristics with regards to on-site wastewater disposal systems. There is also a large area of Riverhead sandy loams in this study area. These soils are also suitable for disposal systems, but provide the same problems with regards to high seepage through the soil layers to the groundwater. The Surfside study area is being considered in the island's growth plan, as it is located inside the necklace separating the "Town" and "Country". Although the NP&EDC considers Surfside as a town neighborhood, neighborhood plans have yet to be developed for this area.

Roadways in this study area include: Adams Street, Atlantic Avenue, Auriga Street, Boulevarde, Clifford Street, Cononicus Street, Dunham Street, Eagle's Wing Way, Gladlands Avenue, Hawthorne Street, Holly Street, Irving Street, Lovers Lane, Masaquet Avenue, Mequash Avenue, Monohansett Road, Myles Standish Street, Naushon Way, Nobadeer Avenue, Nonantum Avenue, Okorwaw Avenue, Pequot Street, Plum Street, Pochick Avenue, Poplar Street, Skyline Drive, Station Street, Surfside Road, Uncatena Street, Webster Street, Western Avenue, Weweeder Avenue, White Street, and Woodbine Street.

7. Tom Nevers – High Density

The Tom Nevers-High Density study area consists of the group of multiple 5,000 square feet lots west of the Siasconset study area, as well as, the area immediately surrounding these lots. There have been 20 to 30 homes that have been built in the last three years on these lots. This area also currently has no Town water or Town sewer. Due to the lot size and close proximity of the lots to each other, many of the other lots in the area are now unbuildable due to well and septic system setback requirements. The area is zoned entirely Limited Use General 3. The Tom Nevers – High Density study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country".

The entire study area consists of sandy Evesboro soils, which have only slight limitations to locating fully compliant, functional Title 5 septic systems. The slight limitations in these soils deal with the high permeability of the septic tank effluent through them, sometimes leading to inadequate treatment. There are also some small pockets of unsuitable soils on the eastern side of this area, located close to Tom Nevers Pond.

Roadways in this study area include: Arlington Street, Berkley Street, Clarendon Street, Cornwall Street, Dartmouth Street, Devon Street, Exeter Street, Fairfield Street, Gloucester Street, Huntington Street, Ipswich Street, Kendrick Street, Marion Street, Norwood Street, and Tom Nevers Road.

8. Tom Nevers – Low Density

The Tom Nevers-Low Density study area is located on the opposite side of Tom Nevers Road from the High Density Area. This study area consists of the developed land between Tom Nevers Road, Old Tom Nevers Road, and Milestone Road, west of the Siasconset Study Area. This study area is served exclusively by individual water wells and on-site wastewater disposal systems. The area is zoned entirely Limited Use General 3. The Tom Nevers – Low Density study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country".

A majority of the study area consists of sandy Evesboro soils, which have only slight limitations to locating fully compliant, functional Title 5 septic systems. The slight limitations in these soils deal with the high permeability of the septic tank effluent through them, sometimes leading to inadequate treatment. There are also some small pockets of Medisaprists-Berryland Variant soils located close to Tom Nevers Pond.

Roadways in this study area include: Arlington Street, Berkley Street, Bosworth Road, Cheshire Road, Chuck Hollow Road, Crestwood Circle, Dorset Road, Driscoll Way, Elliot’s Way, Flintlock Road, Green Hollow Road, Hampshire Road, Heath Lane, Hollister Road, Hulbert Avenue, Jonathan Way, Longwood Drive, Low Beach Road, Lyford Road, Lyons Lane, Mane Street, Marcus Way, Mayhew Road, Nichols Road, Old Tom Nevers Road, Parsons Lane, Sandpiper Way, Sandsbury Road, Surrey Avenue, Sussex Road, Tom Nevers Road, Walsh Street, Wanoma Way, Whitetail Circle, and Wood Hollow Road.

9. Siasconset

The Siasconset study area is located on the eastern coast of Nantucket. It is a densely populated area that is currently serviced by both Town water and sewer. The Siasconset Water Company supplies water to the majority of the area, but there are properties with private water wells. Siasconset also has an existing sewer system that serves approximately 77 percent of the summer population and 100 percent of the winter population in the study area. The raw wastewater collected by the existing sewer system is discharged to a set of four sand beds located on the beach in the southern part of the study area.

The Siasconset study area is made up of four different zoning areas: Limited Use General 3, Residential 1, Residential 2, and Residential Old Historic, with the majority being Residential 2. Residential 2 lots have a minimum size of 20,000 square feet with a minimum frontage of 75 feet. The Siasconset study area is being considered in the island’s growth plan, as it is located inside the necklace separating the “Town” and “Country”. Although the NP&EDC considers Siasconset as a town neighborhood, neighborhood plans have yet to be developed for this area.

The soils in this study area are a combination of Riverhead-Nantucket-Woodbridge Variant, Evesboro sands, Medisaprists-Berryland Variant soils and Udipsamments Beaches-Pawcatuck. The Evesboro sands are adequate for locating a septic system, but do have a problem with high permeability, leading to possible groundwater contamination due to inadequate treatment of septic tank effluent in the soil profile. The small pockets of Medisaprists-Berryland Variant soils have severe limitations for subsurface sewage disposal systems. In general, the main problem with these areas is the seasonal high groundwater issues that arise with these types of soils.

Roadways in this study area include: Ann Lane, Bank Street, Bass Lane, Baxter Road, Bayberry Lane, Beach Street, Beechcroft Way, Black Walnut Lane, Bluefish Lane, Broadway, Bunker Hill Road, Burnell Street, Butterfly Lane, Cannonbury Lane, Carew Lane, Center Street, Chapel Street, Clifton Street, Codfish Park Road, Coffin Street, Comeau Lane, Cottage Avenue, Elbow Lane, Eldridge Lane, Emily Street, Evelyn Street, Fawcett Way, Folgers Court, Front Street, Grand Avenue, Gully Road, Hawks Circle, Hoicks Hollow Road, Jackson Street, Jennifer Lane, King Street, Lily Street, Lincoln Street, Lindbergh Avenue, Low Beach Road, Magnolia Avenue, Main Street, McKinley Avenue, Meetinghouse Lane, Milestone Road, Morey Lane, North Gully Road, New Street, North Gully Road, North Road, Nosegay Lane, Ocean Avenue, Packet Drive, Park Lane, Pitman Road, Plumfield Road, Pochick Street, Quahog Court, Reaper Circle, Rosaly Lane, Sankaty Head Road, Scallop Court, Sconset Avenue, Shell Street, Sleet Wing Circle, South Gully Road, South Road, Stone Post Way, Towaddy Lane, Underhill Lane, West Sankaty Road, Wanoma Way, and Westerwyck Road.

10. Quidnet

The Quidnet study area is located north and adjacent to Sesachacha Pond and consists of approximately 50 developed lots on individual water wells. Sesachacha Pond is considered a brackish pond. This study area is not connected to any municipal sewer system, hence the houses are all served by on-site wastewater disposal systems. In recent years, the Sesachacha Pond water quality has been declining and it is possible that the on-site wastewater disposal systems in this study area have been contributing to this degradation. Recently, the Sesachacha Pond has been opened to the ocean in the spring and fall. Flushing the pond has improved the water quality in the pond, but the contaminant levels are still considered high.

The Quidnet study area is a sparsely populated area that is not included in the Town's plans for growth. The majority of the study area is zoned as Residential 2, with some Limited Use General 3 zoning.

Much of the Quidnet study area is covered by sandy soils, which may be suitable for subsurface disposal systems. Once again, the high percolation rate through these sands may not allow adequate treatment of the septic tank effluent prior to it reaching the groundwater. In the areas located around Sesachacha Pond, there are also some limitations to subsurface disposal systems due to the slope of the land. There are also some major pockets of soils in the area that would have severe limitations for locating on-site wastewater disposal systems. These soils are known for having high seasonal groundwater and this makes it extremely difficult to locate a functional, compliant Title 5 system.

Roadways in this study area include: Beacon Lane, Naauma Lane, Quidnet Road, Sakedan Lane, Sesachacha Road, and Squam Road.

11. Wauwinet

The Wauwinet study area is located north of the Quidnet study area. It consists of a hotel and a small village of homes, as well as, a restaurant on a small community water supply system. There is no municipal water or sewer that services this area. This area is zoned mainly Residential 1, with a small area of Limited Use General 1 and Limited Use General 3 to the South. The Wauwinet study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country". Wauwinet is considered to be a countryside neighborhood by the NP&EDC.

Medisaprists-Berryland Variant, Evesboro sands and Udipsamments Beaches-Pawcatuck make-up this study area and the effect on septic systems is dependent on which portion of the study area the properties are located in. Many of the soil types have severe limitations to locating functioning, compliant septic systems due to the high seasonal groundwater that occurs in them. However, there are some good pockets of soils in this area, which are made up of mainly sands. There are slight problems with these sandy soils due to their ineffectiveness in providing adequate treatment prior to the septic tank effluent reaching the groundwater.

Roadways in this study area include: Crows Nest Way, Squam Road, and Wauwinet Road.

12. Pocomo

The Pocomo study area is located on the peninsula that jets out into the northern portion of Nantucket Harbor, called Head of the Harbor. This peninsula helps to form Polpis Harbor. It is not very densely populated when compared to some of the other regions on the Island and is served entirely by private individual water wells and private on-site wastewater disposal systems. This study area is zoned entirely Limited Use General 3. The Pocomo study area is considered to be a countryside neighborhood, and as such is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country".

Much of the Pocomo study area consists of Medisaprists-Berryland Variant and Evesboro soils with some Udipsamments Beaches-Pawcatuck most of which are severely unsuitable for locating subsurface sewage disposal systems. In these soils high groundwater occurs very close to the surface and flooding and ponding is not an uncommon occurrence. The areas of Medisaprist soils have a severe problem with high groundwater.

Roadways in this study area include: Coskata Course Way, Fargo Way, Lauretta Lane, Medouie Creek Road, Pocomo Road, Village Way, and Wauwinet Road.

13. Polpis

The Polpis study area is not very densely populated, when compared with some of the other regions of the Island. This study area borders Polpis Harbor to the south, which has had many outbreaks in the past of fecal coliform above allowable limits.

Polpis Harbor is an inlet in Nantucket Harbor, and one of the possible reasons for high coliform counts could be that the Harbor does not get adequately flushed with the changing tides. This area is served entirely by private individual water wells and on-site wastewater disposal systems and is zoned entirely Limited Use General 3. The Polpis study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country".

There is a mixture of suitable and poor soils throughout the Polpis study area with some Udipsamments Beaches-Pawcatuck soils. There are some large areas of Evesboro sands that are suitable for septic disposal systems, but there are also some large pockets of Medisaprists that are poorly drained mucky soils. These soils are unsuitable for locating septic systems.

Roadways in this study area include: Almanack Pond Road, Bassett Road, Medouie Creek Road, Polpis Harbor Road, Polpis Road, Quaise Pastures Road, Quaise Road, and Wauwinet Road.

14. Town

The Town study area is a very densely populated area with the majority of its properties already connected to Town sewer and water. The wastewater generated in this study area is currently treated and disposed of at the Surfside Wastewater Treatment Facility located in the southern portion of the Island. This area consists of the highly congested downtown area located near the docks where the ferries arrive and depart from each day. It consists of three main zoning categories: Residential Old Historic, Residential 1, and Residential/Commercial 2. Currently, the Town study area is being considered in the island's growth plan, as it is located inside the necklace separating the "Town" and "Country".

The Nantucket Harbor area that directly abuts the downtown area has shown repetitive high counts of coliform bacteria. The Town believes that failing on-site wastewater disposal systems from properties not connected to the Town sewer could be contributing to this. It is also possible that improper discharges from boats in the harbor could also be a contributing factor.

The "Town Area" consists of mainly sandy soils. These soils do not have any major limitations to locating a conventional Title 5 septic system, however there are some moderate problems with the slopes associated with these soils in the area. With these very sandy, Evesboro soils, there may also be a problem with inadequate treatment of the septic tank effluent prior to it reaching groundwater. There are also some small pockets of loamy sand and other soils that have problems with seasonal high groundwater. In these areas, it would be very difficult to easily locate a functional, compliant Title 5 septic system.

Roadways in this study area include: Academy Lane, Alexandia Drive, Allen's Lane, Altheas Lane, Amelia Drive, Angola Street, Anna Drive, Appleton Road, Ash Lane, Ash Street, Atlantic Avenue, Autopscot Circle, Back Street, Bailey Road, Barnabas Lane, Bartlett Road, Bathing Beach Road, Bayberry Court, Bayberry Lane, Bear Street, Beaver Street, Benjamin Drive, Bloom Street, Boyer Alley Way, Boynton Lane, Brant Point Road, Brinda Lane, Broad Street, Brooks Farm Road, Burnt Swamp Lane, Cabot Lane, Cambridge Street, Camelia Lane, Candle House Lane, Candle Street, Capaum Road, Cartwright Place, Cash's Court, Cato Lane, Cedar Circle, Celtic Drive, Center Street, Charles Street, Cherry Street, Chester Street, Chestnut Street, Chins Way, Church Court, Cliff Road, Cobble Court, Coffin Street, Commercial Street, Coon Street, Copper Lane, Cornish Street, Cottage Court, Crooked Lane, Crown Court, Cynthia Lane, Daley Court, Darling Street, Dave's Street, Deer Pond Road, Delaney Road, Dennis Drive, Derry Lane, Derrymore Road, Dooley Court, Dukes Road, East Chestnut Street, East Creek Road, East Dover Street, East Hallowell Lane, East Lincoln Avenue, Eagle Lane, Easton Street, Easy Street, Enterprise Circle, Equator Drive Essex Road, Fair Street, Fairgrounds Road, Farmer Street, Fayette Street, Federal Street, Fifth Way, and First Way.

Also included in this study area are: Flora Street, Folger Lane, Forrest Avenue, Francis Street, Franklin Street, Freedom Square, Friendship Lane, Galen Avenue, Gardner Perry Lane, Gardner Street, Gay Street, Gifford Street, Gold Star Drive, Goose Pond Lane, Gorhams Court, Gosnold Road, Grant Avenue, Gray Avenue, Green Lane, Grove Lane, Gull Island Lane, Hallowell Lane, Halyard Lane, Hamblin Road, Harbor View Way, Hawthorne Lane, Helen's Drive, Highland Avenue, Hinckley Lane, Hooper Farm Road, Howard Court, Hulbert Avenue, Hull Lane, Hummock Pond Road, Hussey Farm Road, Hussey Street, India Street, Jefferson Avenue, Joy Street, Judith Chase Lane, Keel Lane, Kimball Avenue, King's Way, Kite Hill Lane, Lewis Court, Liberty Street, Lily Street, Lincoln Avenue, Lowell Place, Luff Road, Lyon Street, Maclean Lane, Madaket Road, Main Street, Mamack Lane, Manta Drive, Marsh Hawk Lane, Martins Lane, Mayhew Lane, Meader Street, Meadow Lane, Meadow View Drive, Miacomet Avenue, Milk Street, Mill Hill Lane, Mill Street, Mooers Avenue, Mount Vernon Street, Mulberry Street, N Beach Street, N Liberty Street, N Star Lane, N Union Street, N Water Street, Nantucket Avenue, Netowa Lane, New Dollar Lane, New Lane and New Mill Street.

These roadways are also included in this study area: New Street, New Whale Street, Newtown Road, Nickanoose Way, Nobska Way, Norquarta Drive, North Avenue, Oak Street, Old South Road, Orange Street, Otokomi Road, Pakanoket Lane, Parker Lane, Paupamo Way, Pawguvet Lane, Perry Lane, Pheasant Drive, Pilgrim Road, Pilot Whale Drive, Pine Grove Lane, Pine Street, Pinkham Circle, Pleasant Street, Plumb Lane, Polliwog Pond Road, Pond Road, Powderhouse Lane, Priscilla Lane, Prospect Street, Quail Lane, Quaker Road, Quince Street, Ramos Court, Rays Court, Reacher Lane, Roberts Lane, Rose Lane, Rudder Lane, Rugged Road, Rusty's Way, S Beach Street, S Mill Street, S Water Street, Salem Street, Salros Road, Saltmarsh Way, Saratoga Lane, School Street, Scott's Way, Sea Fox Circle, Sea Street, Second Way, Seikinnow Place, Shady Lane, Sherburne Turnpike, Silver Street, Somerset Road, Sparks Avenue, Spinnaker Circle, Spring Street, Spruce Street, Starbuck Court, Stone Barn Way, Summer Street, Sunset Hill Lane, Surfside Drive, Swain Street, Tashama Lane, Thirty Acres Lane, Thurston's Court, Ticcoma Way, Toms Way, Toombs Court, Topaz Circle, Trotters Lane, Twin Street, Union Street, Valley View Drive, Vesper Lane, Vestal Street, W Chester Street, W Creek Road, W Dover Street, W York Lane, Walsh Street, Wamasquid Place, Warren Street, Washaman Avenue, Washington Street, Waydale Road, Wesco Place, Westmoor Lane, Weymouth Street, Willard Street, Williams Lane, Windy Way, Winn Street, Winter Street, Woodbury Lane, Wyers Way, Yampasham Lane, York Street, and Young's Way.

15. Town - WPZ

This study area is located on the outskirts of the Town study area. It is named WPZ because the Wellhead Protection Zone for the public drinking water supply wells that serve portions of the Island are located in this study area. This area is not very densely populated. Town water and Town sewer serve much of the study area. This study area is located inside of the "greenbelt" that designates the Town and Country areas of the Island; therefore, it is included in the Town's plans for growth. The zoning in this area varies from Limited Use 1, Residential 1, Residential Old Historic, Residential Commercial, Residential Commercial 2 to Residential 10 all under the overlay of the Wellhead Protection District.

The Town-WPZ study area almost entirely consists of Evesboro sands. The Evesboro sands are adequate for locating a septic system, but do have problems with high permeability, leading to possible groundwater contamination due to inadequate treatment of septic tank effluent in the soil profile. This is of particular concern in this Wellhead Overlay Protection District.

Roadways in this study area include: Arrowhead Drive, Bluebird Lane, Curlew Court, Daffodil Lane, Daisy Way, Davkim Lane, Dovekie Court, Evergreen Lane, Falcon Court, Goldfinch Drive, Greglen Avenue, Hinsdale Road, Kill Deer Lane, Kittiwake Lane, Lovers Lane, Macys Lane, Mary Ann Drive, Milestone Crossing, Milestone Road, Miller Lane, Nancy Ann Lane, Nobadeer Farm Road, Nobadeer Way, Old South Road, Pinetree Road, Sesapana Road, Skyline Drive, Sparrow Drive, Square Rigger Road, Sun Island Road, Tawpoot Road, Teasdale Circle, Webster Street and Woodland Drive.

16. Monomoy

The Monomoy study area directly abuts the Town study area to the east and north, and is immediately south of Nantucket Harbor. This area is located within the "Town" and "Country" necklace, which means it is included in the Town's growth plan. This is a densely populated region with continuing expansion, included a proposed subdivision in the near future. Town water and Town sewer service part of the Monomoy study area, but the majority of the region is on private individual water wells and on-site wastewater disposal systems. A portion of the Nantucket State

Forest is located in the southern portion of this study area. This area is zoned mainly Limited Use General 1, with some Residential/Commercial 2 and some Residential 10.

There is extensive water quality information that exists for Nantucket Harbor as numerous studies have been done. There have been repetitive high coliform counts at sample locations close to shore near the Monomoy study area. Failing on-site wastewater disposal systems within the Monomoy study area may be the cause of these high coliform counts.

Much of this study area consists of Evesboro sands in varying slope conditions. These sands are suitable for locating systems, but may not always provide the necessary treatment before the septic tank effluent reaches the groundwater. There are also some clays and silts within this region that may be the cause of the failing systems that are contributing to the degradation of the water quality in the harbor.

Roadways in this study area include: Berkeley Avenue, Boston Avenue, Brewster Road, Cathcart Road, Chatham Road, Gardner Road, Harborview Road, Middle Valley Road, Milestone Road, Monomoy Creek Road, Monomoy Road, North Road, Polpis Road, South Valley Road, Sandwich Road, Shawkemo Road, and Shimmo Pond Road.

17. Shimmo

The Shimmo study area is located along Nantucket Harbor between the Monomoy and Pocomo study areas. This area is serviced entirely by private individual water wells and on-site wastewater disposal systems. This study area is not densely populated, however any development that has and will occur in this area will directly effect the water quality of Nantucket Harbor. This entire study area is zoned Limited Use General 3, as shown on the Official Zoning Map of the Town and County of Nantucket. The Shimmo study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country".

Much of the Shimmo study area consists of Pawcatuck soils that are severely unsuitable for locating subsurface sewage disposal systems. In these soils high groundwater occurs very close to the surface and flooding and ponding is not an uncommon occurrence. There are also some areas of Medisaprist soils in this area, which also have a severe problem with high groundwater. Where there are not Pawcatuck or Medisaprist soils, there are some small pockets of sandy soils that would be suitable for subsurface sewage disposal.

Roadways in this study area include: Chadwick Court, Conservation Avenue, Drew Lane, Fulling Mill Road, Gardner Road, Hilltop Road, Kelley Road, Monomoy Road, Moors End Lane, North Pasture Lane, Pimny's Point, Polpis Road, Rabbit Run Road, Shawkemo Hills Lane, Shawkemo Road, Shimmo Pond Road, Top Gale Lane, and Wingspread Lane.

18. Remaining Island

The study area termed "Remaining Island" encompasses all areas of the Island that were not included in the previously described 17 study areas. The Remaining Island study area is not being considered in the island's growth plan, as it is located outside the necklace separating the "Town" and "Country". The NP&EDC considers the Remaining Island study area as the countryside.

Roadways in this study area include: Alliance Lane, Almanack Pond Road, Altar Rock Road, Amelia Drive, Appleton Road, Arlington Street, Austin Farm Drive, Barnard Valley Road, Barstow Road, Bartlett Farm Road, Bartlett Road, Bishop's Rise, Blue Heron Way, Braeburn Way, Brewster Road, Brier Patch Road, Burnt Swamp Lane, Capaum Pond Road, Chase Lane, Clark Cove Road, Cliff Road, Crooked Lane, Crows Nest Way, Cudweed Road, Cynthia Lane, Deacon's Way, Deer Run Road, Dionis Beach Road, Douglas Way, Dukes Road, E Creek Road, E Tristram Road, Eat Fire Spring Road, Eel Point Road, Fairgrounds Road, Fintry Lane, Green Leaf Road, Grove Lane, Hawthorne Lane, Head of Plains Road, High Brush Path, Hinsdale Road, Hoicks Hollow Road, Horn Beam Road, Huckleberry Lane, Hulbert Avenue, Hummock Pond Road, Illinois Avenue, Isobel's Way, Lauretta Lane, Lavendar Lane, Little Neck Way, Lyford Road, Macy's Lane, Madaket Road, Madequecham Valley Road, Marcus Way, Margaret's Way, Maryland Street, Massasoit Bridge Road, Maxey Pond Road, McGarvey's Way, Medouie Creek Road, Miacomet Avenue, Middle Tawpawshaw Road, Milestone Road, Millbrook Road, Mioxes Pond Road, and Missouri Avenue.

Also included in this study area are: Monomoy Road, N Cambridge Street, N Swift Rock Road, Nevada Street, New Hummock Circle, New South Road, New York Avenue, Old Harbor Road, Old Quidnet Milk Route, Old Smith Road, Old South Road, Orange Street, Otokomi Road, Phillip's Run Road, Pocomo Road, Polpis Road, Poor Richard's Way, Pout Pond Road, Primrose Lane, Quidnet Road, Ranger Road, Red Barn Road, Richard's Landing Road, Rugged Road, Russell's Way, S Shore Road, Salt Marsh Road, Salti Way, Sankaty Road, Scott's Way, Sesapana Road, Sheep Commons Lane, Sheep Pond Road, Smooth Hummocks Way, Somerset Lane, Somerset Road, Squam Road, Squidnet Way, Surfside Road, Swift Rock Road, Tawpoot Road, Tetawkimmo Drive, Texas Street, Tom Nevers Road, Trott's Hills Road, Upper Tawpawshaw Road, Van Fleet Circle, Virginia Avenue, W Chester Street, W Miacomet Road, Wannacomet Road, Waquoit Road, Warren's Landing Road, Washing Pond Road, Washington Street, Wauwinet Road, Weetamo Road, Western Avenue, Wherowhero Lane, Wigwam Road, Wisconsin Avenue, and Worth Road.

D. NEEDS ANALYSIS DISCUSSION

A Town wide needs analysis was performed to determine whether or not conventional Title 5 septic systems will be effective in disposing of wastewater within a given study area throughout and beyond the 20 year planning period. Data obtained from Board of Health records, Assessor's files, and soil surveys of Nantucket performed by the U.S. Department of Agriculture was used to ascertain current land uses, associated soil and groundwater conditions, and to identify wastewater disposal problem areas. The objective of the needs analysis was to determine the specific study areas where conventional Title 5 wastewater disposal systems are inadequate or conversely, where existing on-site wastewater disposal systems can remain and be effective for wastewater disposal.

A two-stage analytical approach was utilized in the need analysis evaluation. First, a rating criteria matrix was created to establish or eliminate a study area as a need area. Second, each study area was evaluated based on soil classification, groundwater levels, and a combination of system age and lot size to confirm or eliminate a study area as a need area. Both evaluation approaches were then compared to determine: (1) if a given area showed consistent need, i.e., both evaluations showed the study area to be a need area; (2) areas where there was a conflict in need (e.g. areas that showed a need in one evaluation approach and no need in the other were further evaluated in order to identify the real need); and (3) areas of no need, where both evaluations showed that there was no need and therefore the analyses showed that existing wastewater disposal systems are adequate for these study areas. A detailed description of the two analytical approaches used to determine a need area is given below.

First Stage Analytical Approach - Rating Criteria Matrix

A rating criteria matrix was developed to evaluate the 18 previously defined study areas. Four levels of criteria were developed for the rating criteria matrix and are defined as follows:

The first or highest rating was given to actual failures of septic systems. Four criteria points were assigned to each septic system repair that occurred between 1972 and 1999.

The second highest rating was given to imminent failures of on-site wastewater disposal systems. Three criteria points were assigned for each on-site wastewater disposal system that would categorically fail if a current Title 5 inspection were performed. This was based on (1) disposal systems located within a Zone I aquifer recharge area, (2) disposal systems located within 50 feet of private drinking water wells, and (3) disposal systems located within 100 feet of a public drinking water supply. Also, developed lots with a private water supply well that do not have 10,000 square feet of lot area per bedroom were also considered to fall into the imminent failure category.

The third highest rating was given to on-site wastewater disposal systems that have a high likelihood of imminent failure. Two criteria points were assigned for each on-site wastewater disposal system that: (1) had severe groundwater limitations; (2) had severe soil limitations; (3) had on-site wastewater disposal systems that were built before 1978; (4) had a lot size of one-half acre or less, and (5) disposals systems pumped out more than two times per year.

The fourth highest rating was given to on-site wastewater disposal systems that have health/water quality issues. One criteria point was assigned for each on-site wastewater disposal system that: (1) was located in a study area with a density of on-site wastewater disposal systems greater than two per acre; (2) was located within 100 feet of a surface water body, wetland, or stream; (3) was located within a 100 year flood plain; (4) was located within a Zone II aquifer recharge area; and (5) was located within 3,600 feet of Madaket Harbor or within the Town-recognized Nantucket Harbor Watershed Buffer Line.

Need Determination

The rating criteria matrix was applied to each of the study areas and the criteria points for each study area was developed. For each study area, the total criteria points were divided by the number of unsewered developed lots. This in effect “normalized” the criteria points on a per lot basis for each study area.

The average rating for the entire Town was determined to be 7.33 points per developed lot, and thus, represents average conditions within the Town. Study areas which were determined to have higher than average points per developed lot (greater than 7.33) represent areas with less than average conditions with respect to on-site wastewater disposal. The converse is true for study areas determined to have less than average points per developed lot (less than 7.33).

Study areas were determined to be "need areas" based on the difference between criteria points per study area when arranged in the lowest to highest points per developed lots. Refer to Table 3D-1, Rating Criteria Points per Developed Lots. As the table shows, the largest difference in the points per developed lots were determined to occur between Monomoy and Quidnet. This "largest difference" in points per developed lots represent a break in which one study area ranks significantly higher than it's neighboring study areas. This break, was determined to be significant in that, for example, the Quidnet Study Area has more constraints in utilizing Conventional Title 5 Systems for on-site wastewater disposal than the Monomoy Study Area. Study areas with criteria points per developed lot greater than the break line between Monomoy and Quidnet were determined to be "Need Areas". This "largest difference" break line was used to delineate the study areas into "No Need Areas" and "Need Areas" was confirmed utilizing a second stage analytical approach to validate the break line assumptions. The second stage analytical approach to study area evaluation was used to confirm or correct this assumption.

After performing an analysis of the difference in criteria points per developed lot for each study area, it can be seen that there is a distinct break in the criteria points per developed lot for each study area right at the average. This helps to confirm the use of this threshold as the breaking point in the determination of whether or not there is a need in a particular study area. This method of ranking study areas represents an unbiased and objective method to determine the areas within the Town where conventional Title 5 septic systems would not function properly in order to protect public health and water quality.

Refer to Table 3D-2 for the rating criteria matrix for the entire Town.

TABLE 3D-1
TOWN OF NANTUCKET
CWMP / EIR
RATING CRITERIA POINTS PER DEVELOPED LOT

Study Area	Points per Developed Lot	Difference in Points per Developed Lot
Miacomet	1.990	---
Surfside	2.263	0.273
Tom Nevers Low-Density	3.238	0.974
Other	3.720	0.482
Shimmo	4.168	0.448
Tom Nevers High-Density	4.475	0.307
Siasconset	4.519	0.044
Town - WPZ	4.597	0.078
Town	5.077	0.480
Pocomo	5.111	0.034
Cisco	5.161	0.050
Monomoy	6.170	1.009
Quidnet	7.333	1.163
Somerset	7.404	0.070
Warren's Landing	8.088	0.685
Polpis	8.186	0.098
Madaket	8.400	0.214
Wauwinet	9.260	0.860

TABLE 3D-2
CWMP/EIR
TOWN OF NANTUCKET, MASSACHUSETTS
RATING CRITERIA

CRITERIA NAME	DESCRIPTION	Madaket Number	Madaket Points	Warren's Landing Number	Warren's Landing Points	Cisco Number	Cisco Points	Somerset Number	Somerset Points	Miacomet Number	Miacomet Points	Surfside Number	Surfside Points	Tom Nevers Hi-Density Number	Tom Nevers Hi-Density Points
CRITERIA POINTS	Total Number of Lots	864		99		204		206		127		419		350	
Actual Failure 4	Total Number of Developed Lots	435		68		143		161		101		281		255	
Imminent Failure 3	Total Number of Unsewered Developed Lots	435		68		143		161		101		281		255	
High Likelihood of Imminent Failure 2	Number of Resales since 3/31/95	70		19		27		30		15		44		26	
Health / Water Quality Issue 1	Number of Acres per Study Area	394		49		355		151		296		685		129	
	Number of Net Acres for Developed Lots	232		26		143		103		197		363		63	
	No. of Acres of Severe Groundwater Limitation	117		10		27		7		8		49		28	
	Number of Acres of Severe Soil Limitation	86		26		178		96		149		112		61	
Actual Failure	3/31/95 to 1999	31	124	4	16	8	32	21	84	8	32	21	84	2	8
	1972 to 3/31/95	74	296	2	8	10	40	8	32	6	24	27	108		0
		105	420	6	24	18	72	29	116	14	56	48	192	2	8
	Adjusted Total based on Developed/Unsewered Developed Ratio		420		24		72		116		56		192		8
Imminent Failure	System within Zone I Aquifer Recharge Area	9	27		0	6	18	1	3		0	11	33		0
	System within 50 feet of Private Drinking Water Well		0		0		0		0		0		0		0
	System within 100 feet of Public Drinking Water Supply		0		0		0		0		0		0		0
	Developed Lots with Less than 10,000 sq. ft. of area per Bedro	260	780	66	198	105	315	152	456		0		0	110	330
		269	807	66	198	111	333	153	459	0	0	11	33	110	330
High Likelihood of Imminent Failure	Lots with Severe Groundwater Limitation	130	260	14	28	11	22	8	16	3	6	20	40	54	108
	Systems Built before 1978 (Title 5)	281	562	1	2	43	86	13	26	15	30	72	144	2	4
	Lot Size less than or equal to 1/2 acre	246	492	62	124	34	68	100	200	2	4	52	104	97	194
	Lots with Severe Soil Limitation	95	190	36	72	72	144	103	206	51	102	46	92	121	242
	Pumpouts Greater than 2 times per year		0		0		0		0		0		0		0
		752	1,504	113	226	160	320	224	448	71	142	190	380	274	548
Health / Water Quality Issue	Density of Systems Greater Than 2 per Acre	435	435	68	68	0	0	161	161	0	0	0	0	255	255
	System within 100 feet of Surface Water Body, Wetlands or Streams		0		0	7	7	8	8	3	3	3	3		0
	System located within 100 Year Flood Plain	53	53		0	6	6		0		0		0		0
	System within Zone II Aquifer Recharge Area		0		0		0		0		0	28	28		0
	System within Harbor Watershed Line or 3,600' of Madaket Ha	435	435	34	34		0		0		0		0		0
		923	923	102	102	13	13	169	169	3	3	31	31	255	255
	Total Criteria Points for Study Area		3,654		550		738		1,192		201		636		1,141
	Rating Criteria Points Per Developed Lot		8.40		8.09		5.16		7.40		1.99		2.26		4.47
	RECOMMENDED AS A NEED AREA		**YES**		**YES**		**NO**		**YES**		**NO**		**NO**		**NO**

(Conventional Title 5 System Not Feasible for Majority of Study Area)

TABLE 3D-2 (Continued)
CWMP/EIR

TOWN OF NANTUCKET, MASSACHUSETTS
RATING CRITERIA

CRITERIA POINTS	
Actual Failure	4
Imminent Failure	3
High Likelihood of Imminent Failure	2
Health / Water Quality Issue	1

CRITERIA NAME	DESCRIPTION	om Nevers Lo-Density Number	om Nevers Lo-Density Points	Siasconset Number	Siasconset Points	Quidnet Number	Quidnet Points	Wauwinet Number	Wauwinet Points	Pocomo Number	Pocomo Points	Polpis Number	Polpis Points	Town Number	Town Points
	Total Number of Lots	195		1,049		77		68		140		100		4,741	
	Total Number of Developed Lots	122		664		45		50		81		59		3,943	
	Total Number of Unsewered Developed Lots	122		127		45		50		81		59		890	
	Number of Resales since 3/31/95	48		27		9		3		11		10		108	
	Number of Acres per Study Area	653		1,012		68		61		457		583		1,922	
	Number of Net Acres for Developed Lots	374		349		45		51		297		395		1,333	
	No. of Acres of Severe Groundwater Limitation	31		291		22		29		162		324		419	
	Number of Acres of Severe Soil Limitation	286		479		19		9		163		371		1,076	
Actual Failure	3/31/95 to 1999	13	52	3	12	7	28	3	12	6	24	10	40	43	172
	1972 to 3/31/95	15	60	15	60	13	52	11	44	9	36	12	48	99	396
		28	112	18	72	20	80	14	56	15	60	22	88	142	568
	Adjusted Total based on Developed/Unsewered Developed Ratio		112		376		80		56		60		88		2,516
Imminent Failure	System within Zone I Aquifer Recharge Area		0	2	6		0	28	84		0		0		0
	System within 50 feet of Private Drinking Water Well		0		0		0		0		0		0		0
	System within 100 feet of Public Drinking Water Supply		0		0		0		0		0		0		0
	Developed Lots with Less than 10,000 sq. ft. of area per Bedroom		0		0	21	63	21	63	8	24	6	18	60	180
		0	0	2	6	21	63	49	147	8	24	6	18	60	180
High Likelihood of Imminent Failure	Lots with Severe Groundwater Limitation	6	12	191	382	15	30	24	48	29	58	33	66	859	1,718
	Systems Built before 1978 (Title 5)	42	84	461	922	30	60	42	84	41	82	40	80	2,439	4,878
	Lot Size less than or equal to 1/2 acre	37	74	512	1,024	22	44	8	16	8	16	10	20	3,098	6,196
	Lots with Severe Soil Limitation	53	106	60	120	12	24	8	16	29	58	38	76	498	996
	Pumpouts Greater than 2 times per year		0		0		0		0		0		0		0
		138	276	1,224	2,448	79	158	82	164	107	214	121	242	6,894	13,788
Health / Water Quality Issue	Density of Systems Greater Than 2 per Acre	0	0	127	127	0	0	0	0	0	0	0	0	890	890
	System within 100 feet of Surface Water Body, Wetlands or Str	5	5	29	29	28	28	33	33	27	27	60	60	447	447
	System located within 100 Year Flood Plain	2	2	1	1	1	1	13	13	8	8	16	16	65	65
	System within Zone II Aquifer Recharge Area		0	13	13		0		0		0		0	161	161
	System within Harbor Watershed Line or 3,600' of Madaket Harbor		0		0		0	50	50	81	81	59	59	1,972	1,972
		7	7	170	170	29	29	96	96	116	116	135	135	3,535	3,535
	Total Criteria Points for Study Area		395		3,000		330		463		414		483		20,019
	Rating Criteria Points Per Developed Lot		3.24		4.52		7.33		9.26		5.11		8.19		5.08
	RECOMMENDED AS A NEED AREA		**NO**		**NO**		**YES**		**YES**		**NO**		**YES**		**NO**

(Conventional Title 5 System Not Feasible for Majority of Study Area)

TABLE 3D-2 (Continued)
CWMP/EIR
TOWN OF NANTUCKET, MASSACHUSETTS
RATING CRITERIA

CRITERIA NAME	DESCRIPTION	Town - WPZ	Shimmo	Monomoy	Other			

			Number	Points	Number	Points	Number	Points	Number	Points	Number	Points	Number	Points	Number	Points
CRITERIA POINTS		Total Number of Lots	743		284		263		2,539		0		0		0	
Actual Failure	4	Total Number of Developed Lots	524		137		184		818		0		0		0	
Imminent Failure	3	Total Number of Unsewered Developed Lots	315		137		178		812		0		0		0	
High Likelihood of Imminent Failure	2	Number of Resales since 3/31/95	37		21		19		114							
Health / Water Quality Issue	1	Number of Acres per Study Area	744		881		276		21,863		0		0		0	
		Number of Net Acres for Developed Lots	313		380		218		5,422		0		0		0	
		No. of Acres of Severe Groundwater Limitation	7		171		44		5,263		0		0		0	
		Number of Acres of Severe Soil Limitation	321		230		150		7,538		0		0		0	
Actual Failure		3/31/95 to 1999	23	92	9	36	17	68	60	240		0		0		0
		1972 to 3/31/95	24	96	17	68	30	120	110	440		0		0		0
			47	188	26	104	47	188	170	680	0	0	0	0	0	0
		Adjusted Total based on Developed/Unsewered Developed Ratio		313		104		194		685		0		0		0
Imminent Failure		System within Zone I Aquifer Recharge Area		0		0		0	10	30		0		0		0
		System within 50 feet of Private Drinking Water Well		0		0		0		0		0		0		0
		System within 100 feet of Public Drinking Water Supply		0		0		0		0		0		0		0
		Developed Lots with Less than 10,000 sq. ft. of area per Bedro	137	411	33	99	37	111		0		0		0		0
			137	411	33	99	37	111	10	30	0	0	0	0	0	0
High Likelihood of Imminent Failure		Lots with Severe Groundwater Limitation	5	10	27	54	29	58	197	394	0	0	0	0	0	0
		Systems Built before 1978 (Title 5)	74	148	40	80	108	216	337	674		0		0		0
		Lot Size less than or equal to 1/2 acre	229	458	4	8	29	58	73	146		0		0		0
		Lots with Severe Soil Limitation	136	272	36	72	97	194	280	560	0	0	0	0	0	0
		Pumpouts Greater than 2 times per year		0		0		0		0		0		0		0
			444	888	107	214	263	526	887	1,774	0	0	0	0	0	0
Health / Water Quality Issue		Density of Systems Greater Than 2 per Acre	315	315	0	0	0	0	0	0	0	0	0	0	0	0
		System within 100 feet of Surface Water Body, Wetlands or Str	9	9	43	43		0	204	204		0		0		0
		System located within 100 Year Flood Plain		0	5	5	4	4	72	72		0		0		0
		System within Zone II Aquifer Recharge Area	473	473	3	3	116	116	117	117		0		0		0
		System within Harbor Watershed Line or 3,600' of Madaket Harbor		0	103	103	184	184	161	161		0		0		0
			797	797	154	154	304	304	554	554	0	0	0	0	0	0
		Total Criteria Points for Study Area		2,409		571		1,135		3,043		0		0		0
		Rating Criteria Points Per Developed Lot		4.60		4.17		6.17		3.72		0.00		0.00		0.00
		RECOMMENDED AS A NEED AREA		**NO**		**NO**		**NO**		**NO**		**NO**		**NO**		**NO**

(Conventional Title 5 System Not Feasible for Majority of Study Area)

Second Stage Analytical Approach - Soils, Groundwater, and Age/Lot Evaluation

During the second stage of the analysis, each study area was evaluated based on soil classification, groundwater levels, and a combination of system age and lot size. The three criteria are: (1) having 50 percent or more of the properties within the study area meeting the age/lot size criteria (built before 1978 and a lot size of one-half acre or less); (2) having 30 percent or more of the study area with severe soils limitations (hardpan, bedrock, slope, high permeability sands, flooding and wetness); and (3) having 20 percent or more of the study area with severe groundwater (seasonally high water table at the surface to 2 feet deep). If two of the three criteria were met, then the study area was confirmed as a need area.

On-Site Wastewater Disposal System Age

On-site wastewater disposal systems built before 1978 have a very high likelihood of failure due to the lack of design and construction controls placed on these systems prior to this date. If a developed lot had an on-site wastewater disposal system that was built before 1978, the system today would most likely fail a current Title 5 inspection. In 1978, Title 5 Regulations were promulgated by DEP and the local Boards of Health were required to enforce these regulations. The significance of this date is that prior to 1978 there were rules pertaining to the design and construction monitoring of on-site wastewater disposal systems, but these requirements were significantly less stringent and enforcement by the State Department of Public Health was ineffective.

Lot size

Lot size will have a direct affect on whether or not a failed on-site wastewater disposal system can be repaired to meet current Title 5 criteria. It is a reasonable assumption that under less than ideal soil and groundwater conditions, all lots of one-half acre or less in an area would, as a minimum, require a variance to Title 5 in order to repair the on-site wastewater disposal system.

To better describe how lot size will affect the ability to repair an existing failed on-site wastewater disposal system, consider the following scenario: a one-half acre lot with typical dwelling, property line and structure setbacks along with Title 5 setbacks is shown in Figure 3D-1. If the soils and groundwater levels are not problematic there is about 9,150 square feet available for a soil absorption system. A typical soil absorption system servicing a four-bedroom single family residence generating 440 gallon per day of wastewater being disposed into the ground with a percolation rate of 10 minutes per inch will require about 2,500 square feet. If an on-site wastewater disposal system under the same general conditions has to be mounded, due to high groundwater, the land area required to build this system is about 4,400 square feet

(1) If 30 percent of the one-half acre lot has severe soil limitations (hardpan, bedrock, etc.) the useable land for a new septic system is reduced to less than 2,500 square feet.

(2) If 20 percent of the one-half acre lot has severe groundwater limitations (seasonally high groundwater level at the surface to 2 feet below grade) the useable land for a new septic system is reduced to less than 4,400 square feet.

Combination Age and Lot Size Criteria

If 50 percent or more of the properties within a study area have a septic system that was built before 1978 and a lot of one-half acre or less, then the age/lot size criteria has been met. The percentage was chosen as it represents that the majority of the study area has a small lot size and an outdated on-site wastewater disposal system.

Severe Soils Criteria

If 30 percent or more of the soils within a study area classified as having severe limitations (hardpan, bedrock, slope, high permeability sands, flooding and wetness) the severe soils criteria has been met. The percentage represents the minimum amount of severe soils that can be present on a lot and still construct a conventional Title 5 system. Soil types were obtained from the Soil Survey Report by the U.S. Department of Agriculture.

Figure 3D-1

Severe Groundwater Criteria

If 20 percent or more of a study area is classified as having a moderately shallow to shallow (high water table at the surface to 2 feet deep) seasonally high groundwater level the severe groundwater criteria has been met. The percentage represents the minimum amount of severe soils that can be present on a lot and still construct a conventional Title 5 system. High groundwater levels were obtained from the Soil Survey Report by the U.S. Department of Agriculture.

Need Determination

If two of the three criteria are met then the study area qualifies as a need area. As previously discussed, the three criteria are: (1) having 50 percent or more of the properties within the study area meeting the age/lot size criteria (built before 1978 and a lot size of one-half acre or less); (2) having 30 percent or more of the study area with severe soils limitations (hardpan, bedrock, slope, high permeability sands, flooding and wetness); and (3) having 20 percent or more of the study area with severe groundwater limitations (seasonally high water table at the surface to 2 feet below grade).

If this hypothetical one-half acre lot had an on-site wastewater disposal system that failed and the property was developed before 1978 and the lot has either 30 percent severe soils or 20 percent high groundwater, the existing system could not be repaired using a conventional Title 5 system. The options for a solution for this system would be either: (1) allowing variances to the conventional Title 5 system; (2) on-site innovative-alternative systems; (3) communal wastewater treatment and disposal; and (4) local wastewater treatment. Of these alternatives, the recommended solution for each study area with wastewater disposal needs will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

If this same hypothetical one-half acre lot had both soils and groundwater characteristics at or above the percentages mentioned, the property would need to have the wastewater collected, treated and disposed of off-site utilizing communal, or local wastewater treatment and disposal.

Results of Needs Analysis Assessment

The results of the two needs analyses are summarized below for each study area.

Madaket

This study area is comprised of 394 acres of which approximately 232 acres are currently developed. There are 435 developed lots located in this study area. The average age of the residential units is 30 years. This study area is about 50 percent developed. About 22 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 30 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 435 systems fall within 3,600 feet of Madaket Harbor.

Between 1972 and 1999, there were 105 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 44 percent, based on 70 resales.

This study area has a criteria point rating of 8.40 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 46 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 22 percent have poor soils; and approximately 30 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Warren's Landing

This study area is comprised of 49 acres of which approximately 26 acres are currently developed. There are 68 developed lots located in this study area. The average age of the residential units is 10 years. This study area is about 69 percent developed. Approximately 53 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and 221 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 34 systems fall within 3,600 feet of Madaket Harbor.

Between 1973 and 1999, there were 6 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 21 percent, based on 19 resales.

This study area has a criteria point rating of 8.08 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: no properties were developed before 1978 and had a lot size of one-half acre or less; approximately 53 percent have poor soils; and approximately 21 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Cisco

This study area is comprised of 355 acres of which approximately 143 acres are currently developed. There are 143 developed lots located in this study area. The average age of the residential units is 19 years. This study area is about 70 percent developed. About 50 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 8 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 18 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 30 percent, based on 27 unsewered resales.

This study area has a criteria point rating of 5.16 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 9 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 50 percent have poor soils; and approximately 8 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's septage management plan.

Somerset

This study area is comprised of 151 acres of which approximately 103 acres are currently developed. There are 161 developed lots located in this study area. The average age of the residential units is 12 years. This study area is about 78 percent developed. About 64 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 5 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 29 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 73 percent, based on 30 resales.

This study area has a criteria point rating of 7.40 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 64 percent have poor soils; and approximately 5 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Miacomet

This study area is comprised of 296 acres of which approximately 197 acres are currently developed. There are 101 developed lots located in this study area. The average age of the residential units is 14 years. This study area is about 79 percent developed. About 51 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 3 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 14 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 53 percent, based on 15 resales.

This study area has a criteria point rating of 1.99 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 51 percent have poor soils; and approximately 3 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's septage management plan.

Surfside

This study area is comprised of 685 acres of which approximately 363 acres are currently developed. There are 281 developed lots located in this study area. The average age of the residential units is 19 years. This study area is about 67 percent developed. About 16 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 7 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 48 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 48 percent, based on 44 resales.

This study area has a criteria point rating of 2.26 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 9 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 16 percent have poor soils; and approximately 7 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's septage management plan.

Tom Nevers – High Density

This study area is comprised of 129 acres of which approximately 63 acres are currently developed. There are 255 developed lots located in this study area. The average age of the residential units is 8 years. This study area is about 73 percent developed. About 47 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 21 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 2 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 8 percent, based on 26 resales.

This study area has a criteria point rating of 4.48 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 47 percent have poor soils; and approximately 21 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's septage management plan.

Tom Nevers – Low Density

This study area is comprised of 653 acres of which approximately 374 acres are currently developed. There are 122 developed lots located in this study area. The average age of the residential units is 15 years. This study area is about 63percent developed. About 44 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 5 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 28 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 27 percent, based on 48 resales.

This study area has a criteria point rating of 3.24 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 3 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 44 percent have poor soils; and approximately 5 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's septage management plan.

Siasconset

This study area is comprised of 1,012 acres of which approximately 349 acres are currently developed. There are 664 developed lots located in this study area of which 127 are currently unsewered. The average age of the residential units is 56 years. This study area is about 63 percent developed with approximately 81 percent of the developed lots connected to the existing wastewater collection system. About 47 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 29 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 18 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 11 percent, based on 27 resales of unsewered developed lots.

This study area has a criteria point rating of 4.52 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 53 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 47 percent have poor soils; and approximately 29 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since a majority of the study area is currently provided with wastewater collection, treatment and disposal.

Quidnet

This study area is comprised of 68 acres of which approximately 45 acres are currently developed. There are 45 developed lots located in this study area. The average age of the residential units is 47 years. This study area is about 58 percent developed. About 28 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 32 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 20 reported on-site wastewater disposal system upgrades or repairs in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 78 percent, based on 9 resales.

This study area has a criteria point rating of 7.33 per developed lot, which is at he threshold of 7.33. The properties within this study area have the following characteristics: approximately 36 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 28 percent have poor soils; and approximately 32 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Wauwinet

This study area is comprised of 61 acres of which approximately 51 acres are currently developed. There are 50 developed lots located in this study area. The average age of the residential units is 46 years. This study area is about 74 percent developed. About 15 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 47 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 50 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 14 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 Regulations came into effect on March 31, 1995, the failure rate in this study area is 100 percent, based on 3 resales.

This study area has a criteria point rating of 9.26 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 10 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 15 percent have poor soils; and approximately 47 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Pocomo

This study area is comprised of 457 acres of which approximately 297 acres are currently developed. There are 81 developed lots located in this study area. The average age of the residential units is 24 years. This study area is about 58 percent developed. About 36 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 35 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 81 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 15 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 55 percent, based on 11 resales.

This study area has a criteria point rating of 5.11 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 6 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 36 percent have poor soils; and approximately 35 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since the study area abuts the Town Harbor and is entirely located within the Harbor Watershed Area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Polpis

This study area is comprised of 583 acres of which approximately 395 acres are currently developed. There are 59 developed lots located in this study area. The average age of the residential units is 44 years. This study area is about 59 percent developed. About 64 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 56 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 59 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 22 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area is 100 percent, based on 10 resales.

This study area has a criteria point rating of 8.19 per developed lot, which is above the threshold of 7.33. The properties within this study area have the following characteristics: approximately 15 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 64 percent have poor soils; and approximately 56 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Town

This study area is comprised of 1,922 acres of which approximately 1,333 acres are currently developed. There are 3,943 developed lots located in this study area of which 890 are currently unsewered. The average age of the residential units is 64 years. This study area is about 83 percent developed with approximately 77 percent of the developed lots connected to the existing wastewater collection system. About 56 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 22 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade). Approximately 1972 systems are within the Harbor Watershed Line.

Between 1972 and 1999, there were 142 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 40 percent, based on 108 resales of unsewered developed lots.

This study area has a criteria point rating of 5.08 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 47 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 56 percent have poor soils; and approximately 22 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since a majority of the study area is currently provided with wastewater collection, treatment and disposal.

Town - WPZ

This study area is comprised of 744 acres of which approximately 313 acres are currently developed. This area encompasses the Wellhead Protection Overlay Zone. There are 524 developed lots located in this study area of which 315 are currently unsewered. The average age of the residential units is 15 years. This study area is about 71 percent developed with approximately 40 percent of the developed lots connected to the existing wastewater collection system. About 43 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 1 percent of this study area is classified as having moderate to severe groundwater levels (i.e. water table varies from the ground surface to two feet below grade).

Between 1972 and 1999, there were 47 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 62 percent, based on 37 resales of unsewered developed lots.

This study area has a criteria point rating of 4.60 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 6 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 43 percent have poor soils; and approximately 1 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since this study area is located within the Wellhead Protection Overlay Zone and approximately 40 percent is of the study area is currently provided with wastewater collection, treatment and disposal. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Shimmo

This study area is comprised of 881 acres of which approximately 380 acres are currently developed. There are 137 developed lots located in this study area. The average age of the residential units is 21 years. This study area is about 48 percent developed. About 26 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 19 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 103 systems are located within the Harbor Watershed Line.

Between 1972 and 1999, there were 26 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 43 percent, based on 21 resales.

This study area has a criteria point rating of 4.17 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 1 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 26 percent have poor soils; and approximately 19 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since the study area abuts the Town Harbor and approximately 75 percent is located within the Harbor Watershed Area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Monomoy

This study area is comprised of 276 acres of which approximately 218 acres are currently developed. There are 184 developed lots located in this study area of which 178 are currently unsewered. The average age of the residential units is 29 years. This study area is about 70 percent developed with approximately 3 percent of the developed lots connected to the existing wastewater collection system. About 54 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 16 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 184 systems are located within the Harbor Watershed Line.

Between 1972 and 1999, there were 47 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 90 percent, based on 19 resales of unsewered developed lots.

This study area has a criteria point rating of 6.17 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 14 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 54 percent have poor soils; and approximately 16 percent have high groundwater.

Conventional Title 5 septic systems are not the recommended long-term wastewater disposal solution for this study area since the study area abuts the Town Harbor and is entirely located within the Harbor Watershed Area. On-site innovative alternative systems, local or satellite wastewater disposal systems are all presently viable alternatives for effectively addressing the wastewater disposal needs in this study area. Of these alternatives, the recommended solution for this study area will be presented in Phase II of the CWMP/EIR, based on comprehensive technical, environmental, and financial considerations.

Remaining Island

This study area is comprised of 21,863 acres of which approximately 5,422 acres are currently developed. There are 818 developed lots located in this study area of which 812 are currently unsewered. The average age of the residential units is 26 years. This study area is about 32percent developed with approximately 1 percent of the developed lots connected to the existing wastewater collection system. About 35 percent of the soils in this study area are classified as severe (hardpan, bedrock, slope, high permeability sands, flooding and wetness) and about 24 percent of this study area is classified as having moderate to severe groundwater levels (i.e. seasonally high water table varies from the ground surface to two feet below grade). Approximately 161 systems are located within the Harbor Watershed Line.

Between 1972 and 1999, there were 170 reported on-site wastewater disposal system repairs or upgrades in this study area. Since the revised Title 5 regulations came into effect on March 31, 1995, the failure rate in this study area has been approximately 53 percent, based on 114 resales of unsewered developed lots.

This study area has a criteria point rating of 3.72 per developed lot, which is below the threshold of 7.33. The properties within this study area have the following characteristics: approximately 5 percent were developed before 1978 and have a lot size of one-half acre or less; approximately 35 percent have poor soils; and approximately 24 percent have high groundwater.

Conventional Title 5 septic systems are the recommended long-term wastewater disposal solution for this study area. This study area should be maintained in accordance with the Town's septage management plan.

E. FORECAST OF WASTEWATER FLOWS AND POLLUTANT LOADINGS

In order to assess the Town's wastewater disposal needs and recommend appropriate wastewater disposal solutions for each of the study areas determined to have wastewater disposal needs, it was necessary to estimate the daily wastewater flow and waste load that would be generated within these study areas. In a typical wastewater collection, transmission, and/or treatment system, the wastewater is composed of the following sources: residential, commercial, and industrial wastewater. Currently, there isn't any industrial development on the Island; therefore, only residential and commercial wastewater flows have been developed.

Baseline data was utilized for the detailed analysis, which forecast the wastewater flows and pollutant loads for each study. The baseline data consisted of assessor's information, water consumption data, undeveloped parcel and acreage data, and land utilization data. The Assessor's information consisted of an Island-wide database with parcel information, undeveloped parcel and acreage information, zoning, and maps. The assessor's maps and parcel identifications were used to delineate data, assess potential growth, and analyze wastewater production data within the study areas. An undeveloped parcel and acreage potential development analysis was performed for each study area in order to quantify future wastewater flows.

In order to predict the amount of wastewater that the Needs Areas will generate, current wastewater flows at the Surfside Wastewater Treatment Facility were analyzed. The Assessor's database was also reference in this analysis to determine the number of units connected to the Surfside Sewer system. Using the current flows at the treatment facility and the number of residential and commercial units connected to the system, unit wastewater flows per property could be determined.

This analysis was done for both the summer (June-September) and winter (December-March) seasons to determine a unit wastewater flow for both residential and commercial properties. Flow data from 1999 was used to complete this analysis.

The calculated summer season average daily wastewater flow per residential unit and commercial unit, expressed in gallons per day (GPD), is about 320 GPD and 345 GPD, respectively. The average number of people per residential year round household is approximately 2.5 and the average number of people per residential summer season household is approximately 4.5, as determined from population data. Based on 4.5 people per residence, the summer season average residential wastewater production in Nantucket is approximately 71.1 gallons per capita per day (GPCD). This is consistent with typical per capita wastewater production that is estimated to be between 60 and 80 GPCD. The calculated winter season average daily flow per residential unit and commercial property is about 185 GPD and 260 GPD, respectively. Similarly, based on 2.5 people per residence, the winter season average residential water consumption in Nantucket is approximately 74 GPCD. This is also consistent with typical per capita wastewater production.

The second type of baseline data which was analyzed to project design wastewater flows was undeveloped parcel and acreage data obtained from the Assessor's Department, which was analyzed in order to determine the amount of future growth which may occur within each study area. The design wastewater flow estimates were based on the future growth projections of the study areas.

The undeveloped parcel and acreage data, Assessor's maps, and zoning map of the Town were used for this analysis. The zoning map provided the minimum zoning requirements for the undeveloped parcels. Refer to Section 2.0 for a description of existing zoning within the Town.

The undeveloped parcel and acreage data was used to estimate the design residential within each study area. The maximum number of lots available for development on any given parcel was estimated by determining the minimum lot size in acres of the undeveloped parcel.

Wastewater Flow Analysis

Wastewater flows were estimated for each study area for both the initial and design years. The initial summer season wastewater flow for each study area was calculated by multiplying the summer season residential wastewater flow, as determined from wastewater flows seen at Surfside, by the number of developed residential lots within the study area and by multiplying the summer season commercial wastewater flow by the number of developed commercial lots within the study area. The number of developed lots and undeveloped parcels within each study area was tabulated from Assessor's information. The design wastewater flow for each study area was calculated from the undeveloped parcel and acreage data to determine the design number of developed lots. In this case, all development was assumed to be residential due to the strong pressure on the Island to build more residential and vacation homes. The design number of developed lots for each study area multiplied by the summer season residential wastewater flow resulted in the design summer season residential wastewater flow. Table 3E-1 presents the estimated wastewater flows that were forecast for the initial and design years for each Need Area.

A similar analysis was performed to determine the initial winter season wastewater flow and the design winter season wastewater flow, as was performed for the summer season wastewater flow analysis that was described above.

Peak and Minimum Flows

A determination of Peak and Minimum flows from the average daily flow (ADF) value is required to size gravity sewers, pump stations, and force mains. Once the ADF is determined, the peak daily flow (PDF) is computed by multiplying the ADF for residential and commercial and industrial flows by a peaking factor. The peaking factor is determined using Figure 5 - Ratio of extreme flows to average daily flow in New England, Chapter III of ASCE Manual No. 37." The Town's wastewater facilities will be designed using a peaking factor based on "Peak on Maximum Day".

TABLE 3E-1
TOWN OF NANTUCKET
CWMP / EIR
ESTIMATED WASTEWATER FLOWS

Need Area	Initial Flow Winter (gpd)	Initial Flow Summer (gpd)	Design Flow Winter (gpd)	Design Flow Summer (gpd)
Wauwinet	9,400	16,050	11,250	19,250
Madaket	86,545	149,490	101,715	175,730
Polpis	11,360	19,545	15,245	26,265
Warrens Landing	12,765	22,080	16,465	28,480
Somerset	30,085	51,620	38,225	65,700
Quidnet	8,325	14,400	9,620	16,640
Monomoy	34,340	58,980	42,295	72,740
Pocomo	15,245	26,265	20,980	36,185
Town	790,585	1,312,620	883,710	1,470,245
Town - WPZ	109,455	172,885	147,920	237,115
Siasconset (1)	97,250	166,495	122,505	210,175
Shimmo	25,235	43,545	34,300	59,225
Totals	1,230,590	2,053,975	1,444,230	2,417,750

Note:

(1) Siasconset Study Area flows adjusted based on the Facility Plan dated December 1997 which calculated the future summer season sewered population being 75 percent of the future summer season total population.

The “Peak on Maximum Day” is defined as a flow rate that occurs during the highest flow period on a given day. This value will be used to size the system which includes gravity sewers, force mains and pumping stations. Table 3E-2 presents the PDF for the initial and design years summer season and winter season.

TABLE 3E-2
TOWN OF NANTUCKET
CWMP / EIR
AVERAGE AND PEAK WASTEWATER FLOWS

Description	Average Daily Flow (gpd)	Peak Daily Flow (gpd)
Initial Wastewater Flow - Winter	1,230,590	3,556,400
Initial Wastewater Flow - Summer	2,053,975	5,422,500
Design Wastewater Flow - Winter	1,444,230	4,058,300
Design Wastewater Flow - Summer	2,417,750	6,213,600

Waste Strengths

Although the strength of the waste will be controlled by the Town's Sewer Use Rules and Regulations, it has been estimated that the strength of the waste will be in accordance with the New England Interstate Water Pollution Control Commission Guides for the Design of Wastewater Treatment Works (TR-16). Domestic waste load projections have been based on an average daily contribution of 0.22 pounds of five-day Biochemical Oxygen Demand (BOD_5) per capita and 0.25 pounds of Total Suspended Solids (TSS) per capita.

Commercial/Industrial waste load projections have been based on a medium strength domestic sewage consisting of a BOD_5 concentration of 250 mg/L and a TSS concentration of 300 mg/L. The projected wastewater flows and waste loads are presented in Table 3E-3.

TABLE 3E-3
TOWN OF NANTUCKET
CWMP / EIR
WASTELOAD ESTIMATES FOR BOD_5 AND TSS

Description	Initial (lbs/day)	Design (lbs/day)
BOD_5	2,450	2,775
TSS	2,875	3,270

Septage Management Plan

A Septage Management Plan needs to be developed with the local Board of Health and implemented for the areas of Town not included in the sewer service area. The purpose of a septage management plan is to maintain the operation of septic systems that will protect the groundwater and reduce the need of the system. Such a plan should include such items as recommended septage pumpout frequencies and maintenance of on-site wastewater disposal systems. Public education concerning the importance of proper maintenance of on-site wastewater disposal systems is an important means of prolonging the life of these systems.

Water Conservation Program

It is recommended that water conservation programs be implemented in order to reduce the amount of water consumed and discharged into both the existing on-site wastewater disposal systems and the proposed expansion of the existing wastewater infrastructure system. Not only will the implementation of water conservation devices and programs result in lower operational costs (assuming user charges are based on water consumption), but it will also result in reserve capacity at the receiving treatment facility for future areas of need in Town should they arise.

F. EXISTING WASTEWATER FLOWS AND POLLUTANT LOADINGS

The treated wastewater on the Island of Nantucket is directed to two facilities, the Surfside WWTF and the Siasconset WWTF. The Surfside WWTF receives its wastewater from two pump stations, one located on Sea Street and the other located in the Surfside area. The Surfside WWTF is a conventional wastewater treatment plant consisting of screening, grit removal, primary treatment, ten rapid infiltration basins, sludge holding tanks, solids processing systems and composting. The facility has been in full operation since 1991 and has a design capacity of 2.24 MGD (average daily flow). However, the facility is only permitted for a maximum discharge of 1.80 MGD and it has reached this discharge limit. The DEP has refused the Town's application to increase its discharge permit limits to its capacity of 2.24 MGD. The Siasconset sewerage system discharges via a screen chamber and dosing tank to a set of four sand filter beds.

Data was collected from the last 36 months for the four treatment operations previously mentioned from the Nantucket Department of Public Works. This information included daily flow rates, monthly flow averages, and influent and effluent characteristics where applicable. The influent and effluent characteristics were measured once a month. As the data shows, the wastewater flows and loadings for the Island of Nantucket are extremely variable. This is due to the high seasonal population that migrates to Nantucket every summer. Table 3F-1 shows the average, high and low monthly flows for each year for each facility.

For every month during the period, influent and effluent characteristics were determined for the two treatment facilities. The characteristics that were analyzed included BOD_5, total suspended solids, total solids, pH, and oil and grease. For the Siasconset facility, there was only one set of characteristics that needed to be analyzed, the influent to the sand beds. The effluent from these beds goes directly to the ground and is not analyzed. Table 3F-2 shows the existing pollutant loadings for the Surfside and Siasconset treatment facilities.

TABLE 3F-1
TOWN OF NANTUCKET
CWMP / EIR
EXISTING WASTEWATER FLOWS

Description	Wastewater Flows (Gals/Day)		
	Monthly Average	High Month	Low Month
Surfside Treatment Facility			
1995 (July – Dec)	1,249,453	1,545,419	968,935
1996 (Jan – Dec)	1,386,824	1,910,292	1,003,935
1997 (Jan – Dec)	1,399,749	1,882,129	1,076,393
1998 (Jan - Jun)	1,547,154	1,724,600	1,355,677
Sea Street Pump Station			
1995 (July – Dec)	1,159,350	1,424,410	908,949
1996 (Jan – Dec)	1,314,329	2,096,352	902,949
1997 (Jan – Dec)	1,245,559	1,708,077	938,597
1998 (Jan - Jun)	1,292,796	1,418,933	1,098,608
Surfside Pump Station			
1995 (July – Dec)	118,682	152,668	89,326
1996 (Jan – Dec)	114,226	181,471	80,193
1997 (Jan – Dec)	129,124	188,494	94,561
1998 (Jan - Jun)	136,765	182,607	113,913
Siasconset Treatment Facility			
1995 (July – Dec)	92,077	166,079	47,552
1996 (Jan – Dec)	72,911	131,952	23,863
1997 (Jan – Dec)	76,596	158,118	37,220
1998 (Jan - Jun)	46,021	57,700	40,343

TABLE 3F-2
TOWN OF NANTUCKET
CWMP / EIR
EXISTING POLLUTANT LOADINGS

Facility	Pollutant Loadings (mg/L)					
	Monthly Average		High Month		Low Month	
	BOD_5	TSS	BOD_5	TSS	BOD_5	TSS
Surfside Wastewater Treatment Facility						
1995 (July - Dec)	208	231	271	286	113	130
1996 (Jan - Dec)	109	110	149	190	83	70
1997 (Jan - Dec)	146	149	256	266	80	75
1998 (Jan - Jun)	130	124	165	162	97	80
Siasconset Wastewater Treatment Facility						
1995 (July - Dec)	208	136	329	317	92	35
1996 (Jan - Dec)	161	86	262	241	42	8
1997 (Jan - Dec)	150	70	225	216	30	7
1998 (Jan - Jun)	133	88	318	373	37	9

4.0 TREATMENT AND DISPOSAL SITES

A. DEVELOPMENT OF SCREENING CRITERIA

The screening criteria presented in this section were developed to assess the viability of potential wastewater treatment facility and/or wastewater disposal facility sites that will be identified within Nantucket in the CWMP/EIR Phase II Document. The screening criteria used to evaluate potential treatment and disposal sites consist of environmental factors. The environmental screening criteria were chosen based upon past experience with these types of projects. It was determined that by applying the screening criteria to the soon-to-be identified sites, a short list of selective potential sites would be established for additional evaluation through field testing. The screening criteria chosen to evaluate the potential project sites are:

- Wetlands;
- Soils;
- Floodplains;
- Waterbodies (distance from surface water);
- Drinking water supply - wellhead protection areas (Zone I and Zone II);
- Fisheries;
- Sensitive habitats;
- Parklands and recreational resources; and
- Historical interests.

A description of each screening criterion is given below and presented in Table 4A-1.

The criteria were also developed with respect to whether or not there was an existing "Opportunity" or environmental "Constraint" for the site to be utilized for a treatment facility and/or disposal facility for Nantucket's wastewater. The designation of an "Opportunity" within the screening criteria reflects the positive aspects of the site and environment that could be used in a beneficial manner in siting these facilities. Similarly, the designation of environmental "Constraints" within the screening criteria reflects aspects of the site and environment that would not be beneficial in siting the treatment and/or disposal facilities.

TABLE 4A-1
TOWN OF NANTUCKET
CWMP/EIR
ENVIRONMENTAL SITE SCREENING CRITERIA

Screening Criteria	Facility	Surface Water Discharge	Groundwater Discharge
Wetlands	**No opportunity/no minimal, moderate or severe constraint** based on proximity to wetlands (a)	**Opportunity** - if wetlands present adjacent to site **No constraint** - if within 200 feet of wetlands **Minimal constraint** - if between 200 and 400 feet from wetlands **Moderate constraint** - if between 400 and 1000 feet from wetlands **Severe constraint** - if greater than 1000 feet from wetlands	**Opportunity** - N/A **No constraint** - if greater than 1000 feet from wetlands **Minimal constraint** - if between 400 and 1000 feet from wetlands **Moderate constraint** - if between 100 and 400 feet from wetlands **Severe constraint** - if within 200 feet of wetlands
Soils	**No opportunity/no minimal, moderate or severe constraint** based on mapped soil type	**No opportunity/no minimal, or moderate constraint** based on mapped soil type **Severe constraint** - if within known hazardous area	**Opportunity** - N/A **No constraint** - if mapped within areas with slight limitations for sewage disposal systems **Minimal constraint** - if mapped within areas with moderate limitations for sewage disposal **Moderate constraint** - N/A **Severe constraint** - if mapped within known hazardous area or areas with severe limitations
Drinking Water Supply	**Opportunity** - N/A **No constraint** - if outside Zone II **Minimal constraint** - if within Zone II **Moderate constraint** - N/A **Severe constraint** - N/A	**Opportunity** - N/A **No constraint** - if greater than 1000 feet from Zone II **Minimal constraint** - N/A **Moderate constraint** - if within Zone II and greater than 1000 feet from public well **Severe constraint** - if within Zone II and within 1000 feet from public well	**Opportunity** - N/A **No constraint** - if greater than 1000 feet from Zone II **Minimal constraint** - N/A **Moderate constraint** - if within Zone II and greater than 1000 feet from public well **Severe constraint** - if within Zone II and within 1000 feet from public well
Fisheries	**No opportunity/no minimal, moderate or severe constraint** based on proximity to fish stocking area (a)	**Opportunity** - N/A **No constraint** - if discharge is downstream or greater than 1000 feet from fish stocking area **Minimal constraint** - if discharge is between 200 and 400 feet from fish stocking area **Moderate constraint** - if discharge is within 200 feet from fish stocking area **Severe constraint** - if discharge is directly into fish stocking area	**Opportunity** - N/A **No constraint** - if discharge is downstream or greater than 1000 feet from fish stocking area **Minimal constraint** - if discharge is between 200 and 400 feet from fish stocking area **Moderate constraint** - if discharge is within 200 feet from fish stocking area **Severe constraint** - if discharge is directly into fish stocking area
Waterbodies	**No opportunity/no minimal, moderate or severe constraint** based on proximity to waterbodies (a)	**Opportunity** - if adjacent waterbody is present **No constraint** - if within 200 feet of waterbody **Minimal constraint** - if between 200 and 400 feet from waterbody **Moderate constraint** - if greater than 400 feet from waterbody **Severe constraint** - if greater than 1000 feet from waterbody	**Opportunity** - N/A **No constraint** - if greater than 1000 feet from waterbody **Minimal constraint** - if between 200 and 1000 feet from waterbody **Moderate constraint** - if within 200 feet of waterbody **Severe constraint** - N/A
Floodplains	**Opportunity** - N/A **No constraint** - if outside floodplain **Minimal constraint** - N/A **Moderate constraint** - N/A **Severe constraint** - if within floodplain	**Opportunity** - N/A **No constraint** - if outside of floodplain **Minimal constraint** - N/A **Moderate constraint** - N/A **Severe constraint** - if within floodplain	**Opportunity** - N/A **No constraint** - if outside of floodplain **Minimal constraint** - N/A **Moderate constraint** - N/A **Severe constraint** - if within floodplain
Sensitive Habitats	**Opportunity** - N/A **No constraint** - if outside of sensitive habitat **Minimal constraint** - N/A **Moderate constraint** - if within sensitive habitat and greater than 100 feet from wetland **Severe constraint** - if within sensitive habitat and less than 100 feet from wetland	**Opportunity** - N/A **No constraint** - if greater than 200 feet from sensitive habitat **Minimal constraint** - if within 200 feet from sensitive habitat **Moderate constraint** - if within sensitive habitat and greater than 100 feet from wetland **Severe constraint** - if within sensitive habitat and within 100 feet of wetland	**Opportunity** - N/A **No constraint** - if greater than 200 feet from sensitive habitat **Minimal constraint** - if within 200 feet from sensitive habitat **Moderate constraint** - if within sensitive habitat and greater than 100 feet from wetland **Severe constraint** - if within sensitive habitat and within 100 feet of wetland
Parklands (a)	**Opportunity** - N/A **No constraint** - if greater than 200 feet from parklands **Minimal constraint** - if abutting parklands **Moderate constraint** - N/A **Severe constraint** - if within parklands	**Opportunity** - N/A **No constraint** - if greater than 200 feet from parklands **Minimal constraint** - if abutting parklands **Moderate constraint** - if within parklands **Severe constraint** - N/A	**Opportunity** - N/A **No constraint** - if greater than 200 feet from parklands **Minimal constraint** - if within 200 feet of parklands **Moderate constraint** - if within parklands **Severe constraint** - N/A
Recreation Resources	**Opportunity** - N/A **No constraint** - if greater than 200 feet from recreation resources **Minimal constraint** - if within 200 feet of recreation resources **Moderate constraint** - if within recreation resource area **Severe constraint** - N/A	**Opportunity** - N/A **No constraint** - if greater than 200 feet from recreation resources (b) **Minimal constraint** - if within 200 feet of recreation resources **Moderate constraint** - if within recreation resource area **Severe constraint** - N/A	**Opportunity** - N/A **No constraint** - if greater than 200 feet from recreation resources **Minimal constraint** - if within 200 feet of recreation resources **Moderate constraint** - if within recreation resource area **Severe constraint** - N/A
Historic Interests	**Opportunity** - N/A **No constraint** - if greater than 200 feet from historic interest **Minimal constraint** - if within 200 feet of historic interest **Moderate constraint** - if directly abutting historic interest **Severe constraint** - if within historic interest area	**Opportunity** - N/A **No constraint** - if greater than 200 feet from historic interest **Minimal constraint** - if within 200 feet of historic interest **Moderate constraint** - if directly abutting historic interest **Severe constraint** - if within historic interest area	**Opportunity** - N/A **No constraint** - if greater than 200 feet from historic interest **Minimal constraint** - if within 200 feet of historic interest **Moderate constraint** - if directly abutting historic interest **Severe constraint** - if within historic interest area

(a) Based on available information, potential sites will be located to avoid directly impacting wetlands, floodplains and waterbodies and are at least 100 feet removed.
(b) Assumes that receiving waters are not a recreational resource.

The “Constraints” are classified as “Minor”, “Moderate”, and “Severe” depending on the extent and nature of the obstacles to developing each site.

- “Opportunity”: the positive attributes associated with the criteria that could be a benefit to siting the facility (positive).
- “Constraint”: the nature of the obstacles associated with the criteria that could negatively affect the siting of the facility.

    1. “No Constraint”: the criterion does not have any positive attributes or impose any obstacles to siting of the facility (neutral).
    2. “Minimal Constraint”: the criterion imposes the lowest degree of obstacles in siting the facility.
    3. “Moderate Constraint”: the criterion imposes average obstacles to siting the facility.
    4. “Severe Constraint”: the criterion imposes extremely difficult obstacles to overcome in siting the facility.

For the purposes of this report, it is presumed that treated effluent from any proposed facilities will be discharged to land, as the Massachusetts Ocean Sanctuaries Act prohibits ocean discharge of municipal wastewater off Nantucket. Although the Ocean Sanctuaries Act permits municipalities to apply for a waiver from its requirements, the Department of Environmental Protection would most likely deny the consideration of ocean discharge as an option, as it did during the Siasconset Facilities Planning Process. The Island is designated a Sole Source Aquifer, by the Environmental Protection Agency under the auspices of the Safe Drinking Water Act (Section 1424e) and gives the EPA the authority to review and restrict federal funding for projects that represent threats to the aquifer. An additional discharge alternative that may be available is the discharge to a surface water body, such as a stream or wetland.

Wetlands

The wetlands screening criterion is considered an important factor in siting both the treatment facilities and effluent disposal facilities. It was determined that "No Opportunities" exist for constructing treatment facilities or effluent disposal facilities in wetlands. These facilities would need to be constructed in upland areas to avoid filling or alteration of wetlands. The wetland related "Constraints" are based on distances from the wetland. The wetland screening criteria is developed with the assumption that the potential facilities will be greater than 100 feet away from wetland areas.

The wetlands criteria for surface water discharge facilities is considered more constrained the further removed from the wetland, since the discharge of the treated effluent ideally should be directly into the receiving waterbody. Those sites located within 100 feet of a wetland are considered to present "Minor Development Constraints" because the proximity of the treatment facility and the length of the treated wastewater effluent discharge piping are minimized. Sites located distant (greater than 400 feet) from the wetland/surface water would pose "Moderate" and "Severe Constraints" since access to the discharge point is restricted.

Soils

The soil type criterion is considered to have a greater influence on the selection of an effluent disposal/groundwater discharge site than on the selection of a treatment facility site due to the variable infiltrative properties of soils. However, soil type is not as critical in selecting a treatment facility or surface water disposal site since construction is predominantly above ground. The only "Constraint" associated with soil type for the construction of treatment facilities or surface water discharge facilities is the presence of known hazardous materials on site. The soil properties and the presence of hazardous material on site are considered to be of utmost importance to the selection of potential groundwater discharge sites.

To ensure proper function of an effluent disposal facility, a suitable site must have soil permeability high enough to allow percolation of the effluent into the soil profile at a rate that will properly treat the effluent. Suitable soil types were determined by review of the Nantucket County Soil Survey Reports, developed by the U.S. Department of Agriculture's Soil Conservation Service. The soil suitability regarding sanitary facilities for each soil map unit is identified in Table 6 of the Soil Survey Report. Soil types with slight or moderate limitations for sewage disposal will be considered to present "No Constraint" (slight) or "Minimal Constraint" (moderate) with regards to locating a subsurface effluent disposal/groundwater discharge system. Soil types with severe limitations for sewage disposal or soils mapped within hazardous areas will be considered to present "Severe Constraints" with regards to locating a subsurface effluent disposal/groundwater discharge system.

Floodplains

Construction within 100-year floodplain is constrained by regulatory restrictions on development within floodplain areas for protection of flood storage and for protection of the constructed facility against flood hazards. This criteria was considered to present "Severe Developmental Constraints" with regard to siting of treatment facilities if located within a floodplain, and "No Constraint" if located outside of a floodplain.

Potential groundwater discharge sites located within the 100-year floodplain are restricted from being located in velocity zones and floodways in accordance with DEP regulations (310 CMR 15.213(2)). A facility in the 100-year flood plain would also be more susceptible to flooding during major storm events. Therefore, the floodplain site selection criterion was considered to present "Severe Developmental Constraints" for groundwater disposal facilities if the potential site is located within the floodplain. If the disposal site is outside the floodplain then "No Constraints" are present to development of a groundwater discharge facility. The 100-year flood plain was identified through review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps for Nantucket, Community-Panel Numbers 250230 0001-0020. Sites with insufficient buildable area outside the flood plain were deemed unacceptable and were eliminated from consideration.

Surface water discharge facilities located within a floodplain are a concern since the discharge flow would represent additional flow that would have to be accommodated during the 100-year flood event. Most of the primary streams in Nantucket are associated with a floodplain. Therefore, potential flooding impacts could be buffered by the capability of the stream to handle slight increases in flow. Therefore, surface water discharges within a floodplain are considered to present “Moderate Development Constraints”. If the disposal site is outside the floodplain then “No Constraints” are present to development of a discharge facility.

Waterbodies (Distance from Surface Water)

Proximity to waterbodies is a factor in siting surface water and groundwater discharge systems. The location and construction of treatment facilities should not impact waterbodies if the facility is located greater than 100 feet from the waterbodies. The screening criterion for waterbodies is not considered to present “Developmental Constraints” on treatment facility sites regardless of the location outside the resource.

Surface water discharge sites are required to be located proximate to a surface waterbody, such as a stream. Therefore, this site selection criterion is accorded substantial weight in the surface water discharge site selection process. Those sites located proximate to surface waterbodies are considered to present an “Opportunity” for development. Those sites that are not located proximate to a water body are considered to present extensive “Developmental Constraints” regarding the surface water discharge site selection process.

Groundwater discharge sites should be located a sufficient distance from a surface water to ensure the facility does not affect the water quality of the surface water. The proposed subsurface disposal of effluent may result in the creation of a groundwater “mound” beneath the disposal field. The system should be sited such that the outer edges of the mound do not significantly influence the hydrology or water quality of the adjacent surface water body.

Therefore, it was conservatively assumed that a groundwater discharge effluent bed should be at least 500 feet from a surface water body to provide an adequate margin of safety to ensure preservation of surface water quality. Potential groundwater discharge sites located at least 500 feet from a surface water body are considered to present an "Opportunity" for development. If within 500 feet, the site is considered to present "Moderate Constraints" for groundwater disposal.

Drinking Water Supply - Wellhead Protection Areas (Zone I and II)

The Town of Nantucket has an overlay district, the Public Wellhead Recharge District, designed to protect the Town's groundwater resource to ensure a safe and healthy public water supply (Nantucket Code Section 139-12B). Siting a wastewater treatment facility or an effluent disposal discharge in this overlay district is strictly prohibited. For this siting study, only sites with suitable area outside of the public wellhead protection district will be considered viable options.

Treatment facility sites, without an associated discharge on site, located in Zone II areas are not scrutinized the same as treatment facility sites with a groundwater discharge since the potential impacts to drinking water quality are minimal. Due to the importance of the Zone II resource areas, treatment facility sites located in Zone II areas are considered to present "Minor Developmental Constraints" while those located outside these areas are considered to present "No Constraints".

The proximity of surface water and groundwater discharge sites to public drinking water supplies is a significant criterion in the screening process due to the stringent regulatory restrictions which apply to siting these facilities within Zone I and II areas. This criterion is not given the same significance with respect to the siting of the treatment facilities since construction of a treatment facility does not necessarily include an effluent discharge. The screening criteria were developed to coincide with the requirements of the Nantucket Code (Zoning Overlay District), Massachusetts Drinking Water Regulations and the designation of Zone I (for wells with a yield of greater than 100,000 gpd, the Zone I is assumed to be 400 feet in radius) and Zone II (contributes to the well under severe pumping and recharge conditions).

Siting an effluent discharge is prohibited within a Zone I area. The location of a surface water or groundwater discharge within a Zone II area and greater than 1,000 feet from a public well is considered a "Moderate Constraint". In order to conservatively protect the Zone II areas, which are nitrogen sensitive, more stringent nitrogen discharge limitations have been established by DEP. Discussions with regulatory agencies regarding this matter suggest that an effluent discharge should not be considered unless all alternative options have been exhausted and a risk/benefit analysis has been performed. Current DEP policy allows for a wastewater discharge within Zone II's. Due to the higher levels of treatment and public concerns placed on siting wastewater discharge facilities within Zone II's, a "Severe Constraint" is identified for a discharge within 1,000 feet of a drinking water supply well within the Zone II. Location of a facility outside of the Zone II is viewed as having "No Constraint" for either a treatment facility or a discharge facility. Zone II areas were determined from the MASS GIS database and Town maps entitled "Public Wellhead District, Siasconset," prepared by Horsely, Witten and Heggemann, Inc. for the Siasconset Wellfield and "Public Wellhead Recharge District: Town" for the Wannacomet Wellfield.

Fisheries

The proximity of the potential facility site to fisheries resources and adjacent waterbodies is a factor in siting surface water and groundwater discharge facilities. It was assumed that the location and construction of treatment facilities would not impact fisheries, if the facility is located greater than 100 feet from the waterbodies supporting the fisheries. The screening criteria for fisheries is considered to present "No Constraints" to development on treatment facility sites regardless of the location outside the resource.

Surface water discharge facilities pose the greatest threat to the fishery resources since the discharge of treated wastewater is directly into the waterbodies that support the fisheries. Therefore, this criterion is considered to present "Moderate Developmental Constraints" for a facility if it is located within 100 feet of a fish stocking area. If a site is located downstream or greater than 1,000 feet from a fish stocking area, the site is considered to present "No Constraint" for the facility.

While groundwater discharges may impact fisheries, there is less risk of impact because the discharge is not directly into the surface waterbody that contains the fisheries. Therefore, the criterion is only considered to present a "Minor Constraint" for sites located within 400 feet of the fish stocking areas, and "No Constraint" for sites located greater than 1,000 feet from fish stocking areas. It was considered to be a "Moderate Constraint" if the facility site was located within 200 feet of the fisheries.

Sensitive Habitats

Sensitive habitats considered in the screening criteria include Estimated Habitats of Rare Wildlife, Certified Vernal Pools, Priority Sites of Rare Species Habitats and Exemplary Natural Communities, and Areas of Critical Environmental Concern. These habitats are sensitive to changes in the environment and are protected in both DEP Wetland Protection and Surface Water Quality Regulations. These regulations impose restrictions on development of any kind within the boundaries of these mapped habitats, and thus, for sites located within sensitive habitats, there is a "Severe Constraint" to development. Therefore, the "Constraints" to treatment facilities, surface water and groundwater disposal facilities are viewed to be equally restricted. The criterion identifies a "Severe Constraint" for those sites located within a sensitive habitat area, a "Minor Constraint" if outside of, but abutting a sensitive habitat area, and "No Constraint" for those sites are located a sufficient distance outside of a sensitive habitat area. Other sensitive habitats include parklands, recreational resources, and historical interests.

Parklands and Recreational Resources

Land developed for recreational use or as parklands should be avoided in siting treatment facilities. If the existing land use of the potential site involves park or conservation lands or other recreational resources, construction of a wastewater treatment facility would represent an incompatible use conflict. Therefore, the presence of a park, conservation, or recreation land poses a "Severe Constraint" to development of a treatment facility. If the potential treatment facility site is located on property directly abutting the resources, then a "Minor Development Constraint" exists on the site. If located greater than 200 feet from these resource areas, the criterion is considered to present "No Constraints" to development.

Groundwater and surface water discharge facilities do not impact these resources to the same extent the buildings any above ground structures associated with a treatment facility would. A sub-surface discharge could potentially be located within these resources. Therefore, these wastewater disposal facilities are only considered to present "Moderate Developmental Constraints" for sites located within the resource areas and "Minor Constraints" if the sites are located outside the resource areas and "No Constraints" to development if located greater than 200 feet from these resource areas.

Historical Interests

The proximity of the potential facilities (wastewater treatment facility and/or wastewater disposal facility) to historic resources is a factor that will be considered in siting the facilities. The Massachusetts Historical Commission State Register of Historic Places was consulted to determine the existence of historic resources within Nantucket. In addition to the presence of historic resources, the Massachusetts Historical Commission (MHC) has commented that there are many areas throughout the Island that could contain archaeological resources. The Massachusetts Historical Commission has noted that Nantucket has one of the highest densities of known archaeological sites in the Commonwealth.

In screening the potential project sites, it is considered desirable to select sites that do not impact these resources. The Massachusetts Historical Commission (MHC) must be notified of details regarding proposed projects in designated historic areas. The MHC will then determine whether State Register properties exist within a project's area of potential impact. If it is determined that the proposed project will have an adverse effect, the applicant will be required to present a comprehensive analysis of alternatives. By eliminating these sites, the project will preserve the resources and avoid potential administrative and regulatory burdens associated with development in these areas. Since the developmental regulatory "Constraints" associated with these resources apply with equal force to either treatment facilities or disposal facilities, independent of any specific characteristics associated with the facilities, this screening criterion is considered to present the same "Constraints" for each facility. The criterion presents a "Severe Constraint" for those sites located within a historic resource area, a "Moderate Constraint" if directly abutting the site, a "Minor Constraint" if within 200 feet a historic resource area and "No Constraint" for those sites located greater than 200 feet outside of these resource areas.

B. IDENTIFICATION OF SITES

Potential wastewater treatment facility and disposal sites will be presented and analyzed in the CWMP/EIR Phase II Document, which will be completed upon review and approval of this CWMP/EIR Phase I Document. It is expected that a number of sites will be identified as either having the potential to locate a centralized treatment facility and/or groundwater disposal system. Sites will also be identified based on their potential to locate smaller, neighborhood systems. These smaller systems would only treat the wastewater from a certain study area or limited number of study areas as opposed to a centralized system that would handle the wastewater from most of or all of the study areas.

In the CWMP/EIR Phase II Document, each site will be described in terms of its location, the primary land use associated with the site, and the significant site features and conditions. Existing conditions and site features for each site will be presented in a detailed table with respect to the screening criteria. Information used in the description of the sites will be obtained from MassGIS data layers, the Nantucket Planning and Economic Development Commission (NP & EDC) and USGS topographic maps. Most of the sites screened in this analysis will have been field investigated and information gathered during these inspections will be reflected in the detailed description of the site.

C. PRELIMINARY SITE SCREENING

The screening criteria previously presented will be applied to the potential sites that will be identified in the CWMP/EIR Phase II Document. The preliminary screening of sites will involve applying the environmental criteria: (1) wetlands; (2) soils; (3) floodplains; (4) waterbodies; (5) drinking water supply; (6) fisheries; (7) sensitive habitat; (8) park lands and recreational resources; and (9) historic interests to each site. Each site will be screened with respect to the potential for construction of a treatment facility, location of a surface water discharge and/or location of a groundwater discharge site.

As previously mentioned, the designation of an "Opportunity" within the screening criteria reflects the positive aspects of the environment that could be viewed as a benefit in siting these facilities. Similarly, the designation of environmental "Constraints" within the screening criteria reflects aspects of the site and environment that would impose limitations in siting the treatment and/or disposal facilities. The "Constraints" are identified as "Minor", "Moderate", and "Severe" depending on the extent and nature of the obstacles to developing each site.

The results of this preliminary screening will be presented in a detailed table in the CWMP/EIR Phase II Document. This table will present a rating of each site based on the application of the screening criteria. The sum of the "Opportunities" and various "Constraints" will be reflected in a rating of low, moderate or high potential for siting a facility or disposal site. The rationale for the ratings will be as follows:

- ○ High Potential = predominately "Opportunities" and "No Constraints"; may have a "Minimal" or "Moderate Constraint".

- ◒ Moderate Potential = characterized by more than 1 "Moderate" and 1 "Minimal Constraint".

- ● Low Potential = presence of a least one "Severe Constraint" plus a "Minimal", "Moderate" or additional "Severe Constraint".

This rating system only considers the environmental factors that influence the selection of sites. Other factors such as economical and technical consideration, as well as political decisions may also influence the selection of sites and will also be analyzed in the CWMP/EIR Phase II Document.

5.0 ALTERNATIVES FOR WASTEWATER DISPOSAL

A variety of wastewater alternatives were investigated to determine the appropriate wastewater facilities that will meet the needs of Nantucket. The wastewater alternatives that were investigated include: (a) the continued use of existing on-site wastewater disposal systems; (b) replacement of existing wastewater disposal systems with Title 5 systems; (c) replacement of existing wastewater disposal systems with on-site innovative/alternative options; (d) replacement of existing wastewater disposal systems with cluster systems consisting of a pressure system and communal subsurface disposal; and (e) replacement of existing wastewater disposal systems with a conventional sewer collection system, either: (1) connection into the existing collection system; (2) gravity sewers and pump station, (3) pressure sewers and grinder pumps, or (4) a combination thereof. Each wastewater alternative is evaluated based on environmental and technical design criteria and on site-specific data such as subsurface conditions, topography, and existing septic system performance. The CWMP/EIR Phase II document will evaluate the environmental, technical design and institutional cost associated with each alternative and recommend the appropriate solution to the wastewater disposal problems in the Town of Nantucket in order to reach a long term solution.

A. EXISTING DISPOSAL SYSTEMS AND CONVENTIONAL TITLE 5 SYSTEMS

Repair / Upgrade Existing On-Site Systems

One alternative for the areas of wastewater disposal need on the Island is continued use of existing systems with emphasis on optimizing the performance of the existing on-site wastewater disposal systems. This includes optimizing septage management, maintenance, and repair and upgrade of on-site systems.

If this alternative is pursued, all presently unsewered developed lots in Nantucket would remain dependent on their existing on-site wastewater disposal systems. In essence, this is a "no action" alternative. As previously discussed, there are a substantial number of documented problems and failures of the existing wastewater disposal systems on Nantucket, as well as, severe soils and severe groundwater limitations.

Evaluation of the existing information on the on-site disposal systems revealed that the Island-wide percentage of actual septic system failures versus number of resales since March 31, 1995 is approximately 45.3 percent. This is significantly higher than the Massachusetts statewide average of approximately 15 percent according to the New England Interstate Water Pollution Control Commission.

Failing on-site wastewater disposal systems contribute to the degradation of water quality of groundwater, wetlands and surface water. The surface waters bordered by areas of wastewater disposal need on the Island are: Tom Nevers Pond, Sesachacha Pond, The Creeks, Miacomet Pond, Shimmo Creek, Hither Creek, Long Pond, No Bottom Pond, and Reed Pond. The swamps and/or wetlands bordered by areas of wastewater disposal need are: Pocomo Meadow, Squam Swamp, Rolgers Marsh, Millbrook Swamp, Brunt Swamp, and Madaket Ditch. The harbors bordered by areas of wastewater disposal need on the Island are: Nantucket Harbor, Madaket Harbor, and Polpis Harbor. These water bodies and water ways are located adjacent, within, and downstream of the areas of wastewater disposal need and are threatened by existing on-site wastewater disposal systems (both properly operating as well as malfunctioning systems depending on the soils present and groundwater table) which will eventually contribute to water quality degradation due to contamination of groundwater.

As time passes, the non-conforming on-site wastewater disposal systems that do not meet current Title 5 rules and regulations will become less adequate and will contribute to the degradation of groundwater, wetlands and surface water. These sub-standard on-site wastewater disposal systems combined with soils with severe limitations for subsurface sewage disposal and high groundwater levels are a potential health hazard. With increased system age combined with these environmental issues, it is expected that property owners will experience future operating nuisances and eventually failures. If the water quality of surface water bodies continues to decline, Nantucket will potentially lose a very important recreational resource. Declining water quality of Miacomet Pond, Hither Creek, Long Pond, Nantucket Harbor, Madaket Harbor, and Polpis Harbor may reach such unacceptable levels that swimming could be prohibited.

As more on-site wastewater disposal systems fail, individual property owners will be required to upgrade their systems to a conventional or innovative/alternative Title 5 system. If this cannot be accomplished due to the physical site conditions, a tight tank would be required and would only be approved by the DEP to eliminate a failed system. The cost of frequently pumping these tight tanks will be a financial burden for the property owners. Property owners would not be able to expand their homes and/or even fully use their existing facilities. In this scenario, property values would decline.

With the increased potential of the degradation of both the water quality in the surface water bodies and the drinking water supply from the sole source aquifer, Nantucket is obligated to provide acceptable wastewater disposal for the areas of need. Continued use or repair/upgrade of the existing on-site disposal systems in the areas of need is not recommended as the wastewater disposal solution for the entire area of need due to the likelihood that not all existing systems could be repaired or upgraded to conform to Title 5. Continued operation of poor or substandard disposal systems poses public health hazards and environmental degradation.

If it is decided that the existing wastewater disposal systems will continue to be used, then, at a minimum, a septage management plan should be implemented. The purpose of a septage management plan is to maintain the operation of septic systems that will protect the groundwater and reduce the expansion of the areas of wastewater disposal need which require structural solutions (i.e., treatment facility and collection system). Such a plan should include such items as recommended septage pump-out frequencies and maintenance of on-site wastewater disposal systems. Public education concerning the importance of proper maintenance of on-site wastewater disposal systems is a beneficial means of prolonging the life of these systems, and should be included as part of the plan.

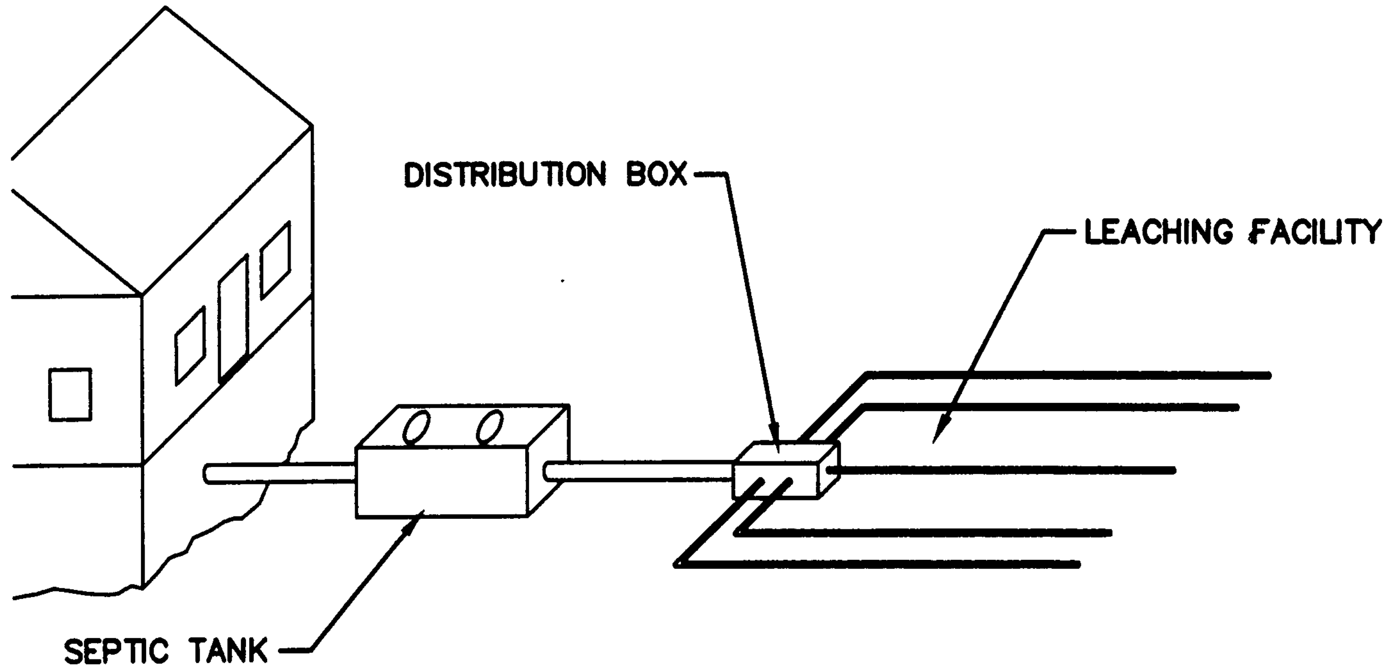
Conventional Title 5 System

This wastewater alternative entails replacing the existing on-site septic systems with Title 5 systems for wastewater management within the wastewater disposal need areas of the Island. Under this option, the systems that do not meet the requirements of Title 5 would be replaced with new Title 5 systems. The remaining septic systems would be upgraded or replaced when it becomes necessary such as when the system fails.

The Massachusetts Environmental Code, 310 CMR 15.000, effective March 31, 1995 govern Title 5 systems. The standard components of a Title 5 system are a building sewer, septic tank, distribution box, soil absorption system, and reserve area. Wastewater exits the building through its building sewer and enters the septic tank where solids are settled and retained. The septic tank effluent flows through the distribution box and to the soil absorption system where it is distributed and treated prior to discharge to appropriate subsurface soils. A schematic of this system is shown on Figure 5A-1.

The Title 5 state code dictates certain requirements for the soil absorption system. For instance, the minimum vertical separation distance from the bottom of the stone underlying the soil absorption system to the top of the seasonally high groundwater table is 4 feet in soils where the percolation rate is greater than 2 minutes per inch (mpi) and 5 feet in soils where the percolation rate is less than or equal to 2 mpi. In addition, there must be at least 4 feet of naturally occurring pervious soil below the entire area of the soil absorption system and the reserve area. Title 5 requires a reserve area to be located on the property such that it can be used in case the primary soil absorption system fails. No building, driveway or other physical improvement can be made to the reserve area; it must remain in its pristine state. Setback requirements are also given in the Title 5 code, which identifies the minimum horizontal separation required between the soil absorption system and items such as a drinking water well, property lines and wetlands.

In order to assess the suitability of replacing existing on-site wastewater disposal systems with new Title 5 systems, several critical criteria need to be addressed. The most common reasons that on-site septic systems fail (including Title 5 systems) is due to overloading, poor construction, and poor maintenance. Assuming the systems are properly constructed and



DISTRIBUTION BOX
LEACHING FACILITY
SEPTIC TANK

maintained, the remaining issue to address is overloading of the system. Several ways in which a soil absorption system can be overloaded are (1) hydraulically overloading the soil, (2) pollutants clogging within the soil, and (3) insufficient depth of naturally occurring pervious soil that results in improper treatment of the effluent. Standard design practices should deal with each of these issues. The most difficult condition to overcome is subsurface conditions including shallow depth to groundwater and insufficient depth of naturally occurring pervious soil.

Variances from Title 5 code may be granted for septic systems that are unable to meet the groundwater separation distance, depth to impervious layer, or other provisions of Title 5. These systems are referred to as Title 5 Systems with Variances. In these cases, a mounded system would be constructed. A mounded system is not a conventional Title 5 system. Mounded systems are sited in areas where there are slowly permeable soils, shallow permeable soils over creviced or porous bedrock, or permeable soils with high water tables.

B. INNOVATIVE/ALTERNATIVE (I/A) OPTIONS

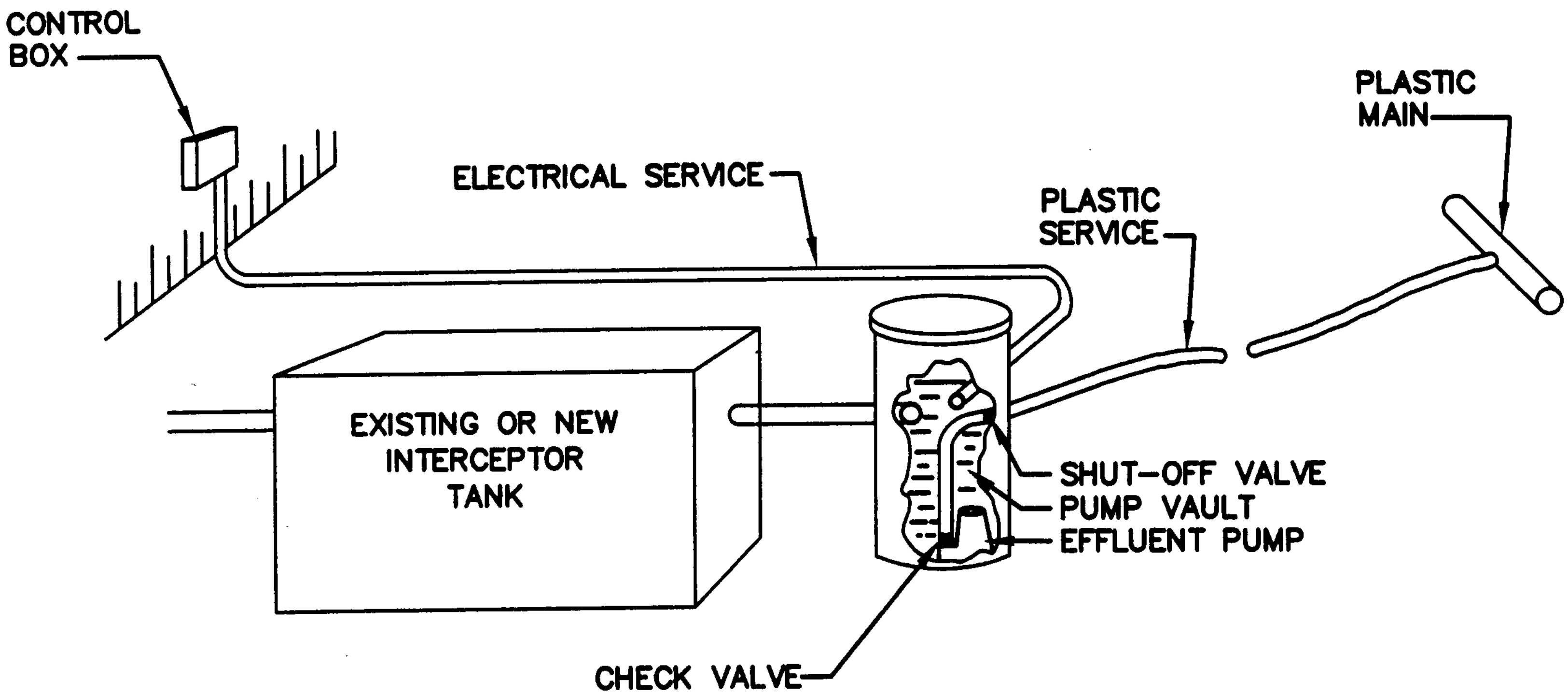
As previously stated, the areas of wastewater disposal need on the Island currently rely on individual on-site wastewater disposal systems for wastewater treatment and disposal. A majority of these systems are substandard, provide a low level of treatment, and do not comply with the requirements of Title 5. As discussed previously in Section 3.0, eleven study areas were determined to need some sort of upgraded wastewater disposal, whether it be a sewage collection system, cluster systems serving a limited number of homes, or on-site innovative/alternative disposal systems. This section will discuss the option of providing each property that has an existing on-site wastewater disposal system with an on-site or decentralized innovative/alternative wastewater disposal system. The systems considered include (1) STEP/Cluster Systems, (2) Small-scale Wastewater Treatment Plants and (3) On-Site Innovative/Alternative Systems.

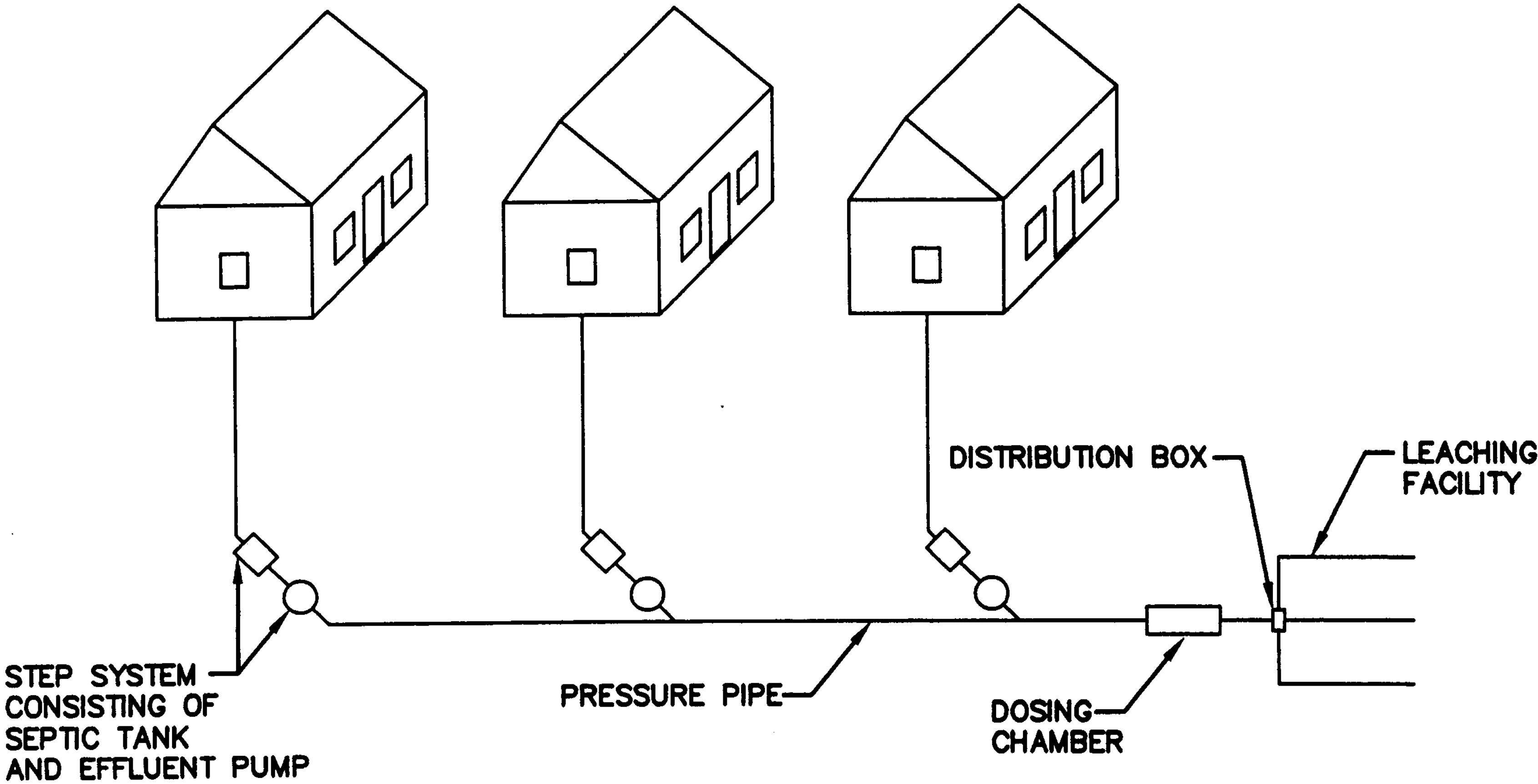
A Title 5 system achieves only a nominal level of treatment in terms of Biochemical Oxygen Demand (BOD_5) and Total Nitrogen removal. Based on the compilation of various studies and DEP data, typical effluent concentrations from a conventional Title 5 septic tank are as follows: the effluent BOD_5 concentration is 170 mg/L; the effluent Total Suspended Solids (TSS) concentration is 60 mg/L; and the effluent Total Nitrogen concentration is 42 mg/L with the majority of this total being ammonia nitrogen. Comparing these effluent concentrations with the influent concentrations noted during the evaluation of Title 5, (BOD_5 = 300 mg/L, TSS = 300 mg/L, and TN = 45 mg/L), the conventional system can achieve about 43 percent removal of BOD_5, about 80 percent removal of TSS and only 6 percent removal of Total Nitrogen. These influent concentrations to individual septic tanks were found to be higher than those of a medium strength wastewater. According to "Wastewater Engineering: Treatment, Disposal, Reuse" by Metcalf and Eddy, a medium strength wastewater has a Biochemical Oxygen Demand (BOD_5) of 220 milligrams per liter (mg/L), a Total Suspended Solids (TSS) of 220 mg/L, and a Total Nitrogen (TN) concentration of 40 mg/L. A typical wastewater treatment facility will remove 85 percent of the BOD_5 and TSS and 60 to 80 percent of the Total Nitrogen. These parameters are used in this section only to show the removal efficiency of the Title 5 system. Title 5 systems do not adequately remove nutrients from the wastewater before it enters the leaching field. From this it can be concluded that even a properly installed and operating Title 5 septic system will still discharge levels of pollutants which impact the quality of the receiving groundwater, in cases where the groundwater enters the bottom of the soil absorption area.

1. STEP/Cluster Systems

One decentralized treatment alternative to a Title 5 system to consider is the Septic Tank Effluent Pump (STEP) System which pumps septic tank effluent through a pressurized sewer to a small-scale, off-site subsurface disposal cluster system or treatment facility. This system consists of a septic tank that concentrates and collects the solids from the wastewater and a pump, which pumps the septic tank effluent to a cluster subsurface disposal system or treatment facility. Schematics of a typical STEP System and Subsurface Cluster System are shown on Figures 5B-1 and 5B-2, respectively.

Based on Title 5 requirements, a maximum flow of 10,000 gallons per day is allowed to be discharged to a subsurface trench disposal system before a sewage treatment plant is required. A treatment facility may or may not be required depending on the specific wastewater flow from each of the individual need areas. The land area


CONTROL
BOX
ELECTRICAL SERVICE
PLASTIC
SERVICE
PLASTIC
MAIN
EXISTING OR NEW
INTERCEPTOR
TANK
SHUT-OFF VALVE
PUMP VAULT
EFFLUENT PUMP
CHECK VALVE


DISTRIBUTION BOX
LEACHING FACILITY
STEP SYSTEM CONSISTING OF SEPTIC TANK AND EFFLUENT PUMP
PRESSURE PIPE
DOSING CHAMBER

required for a trench system for 10,000 gallons per day (about 45 residential/ commercial units) is about 17,800 square feet, assuming an optimal percolation rate of less than 5 minutes per inch with Class I soils (sands, loamy sands) equaling 0.74 GPD/SF (based on Title 5 requirements).

For the purpose of this calculation, it was assumed that each trench is 2 feet wide by 2 feet deep and 100 feet long, and that there is 6 feet between trenches. Title 5 also requires space to be set aside for a reserve area in the event of system failure; however, it allows the space between trenches to be used as the reserve. Therefore, the total area required for 10,000 gallons per day is 17,800 square feet (approximately 0.4 acres), which represents the minimum size of any one system based on the above assumptions. This area only includes the area needed for the subsurface disposal system itself, and does not include required setbacks from property lines, water bodies, buildings, slopes, etc. The land area required due to setback limitations can only be determined when an appropriate disposal area has been identified and designated, but an additional 50 percent would not be excessive. Hence 0.6 acres would be appropriate. Although the foregoing space requirements are needed to meet all of the setback limits of Title 5, it is quite common for septic systems to be sited within smaller spaces and still function well.

STEP systems can be used to pump the effluent from individual residences through a pressurized sewer to a small-scale treatment facility. As with a conventional Title 5 system, the septic tanks must be routinely pumped to remove solids.

2. Small-Scale Wastewater Treatment Plants

If more than 10,000 gallons per day is to be treated, a subsurface disposal system will no longer be adequate and a treatment plant will be required. A typical plant consists of an enclosed building which would include: anoxic pretreatment, primary settling and a sludge storage tank; a flow equalization and pump chamber in order to normalize flow over 24-hour periods; an aerobic biological process for organics reduction and nitrification; a secondary clarifier; an anoxic denitrification process; sand filtration and disinfection. The building would also typically include a laboratory, office and a utility and equipment room. The amount of land required for the plant itself and related site items varies with the capacity of the plant. The size of the disposal fields, however, is based directly upon the flow and according to the "Guidelines for the Design, Construction, Operation and Maintenance of Small Sewage Treatment Facilities with Land Disposal," January 1988 (as published by the Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control), a reserve area tested and shown to be sufficient to replace the capacity of the original leaching area would be required. Again, assuming an optimal percolation rate with good soils, open sand beds can treat 5.0 gallons per day/square feet and a subsurface trench system can treat 2.5 gallons per day/square feet (based upon "Guidelines for the Design, Construction, Operation and Maintenance of Small Sewage Treatment Facilities with Land Disposal"). For the open sand bed alternative, this would consequently result in a much smaller field of 2,000 square feet. Including 2,000 square feet for a reserve area, the total land area required for the open sand bed alternative would be 4,000 square feet (about 0.1 acre) for the equivalent wastewater flow of 10,000 gallons per day. Assuming trenches that are 2 feet wide by 2 feet deep by 100 feet long and a 6 foot wide area between trenches, a subsurface trench disposal system would occupy 5,000 square feet. The area between the trenches can be used as the reserve area. Therefore, the total area required for the equivalent 10,000 gallons per day flow utilizing a subsurface trench system would be 5,000 square feet to over 100,000 square feet depending upon the percolation rate of the soil.

3. On-Site Innovative/Alternative (I/A) Systems

Title 5 allows for the use of Innovative/Alternative (I/A) technologies with DEP approval. Periodically, the DEP issues an updated memorandum entitled: "Title 5 I/A Technologies Approved for use in 310 CMR 15.000 Massachusetts". This memorandum provides a description and status for a variety of innovative and alternative technologies. A number of these I/A technologies provide enhanced wastewater treatment with nitrogen reduction. Of these technologies, the on-site alternative systems that will be evaluated for use in each of the areas or wastewater disposal need are the Recirculating Sand Filter, Amphidrome™ Process, Bioclere™ System, Cromaglass®, RUCK® System, and the Single Home FAST®.

According to Title 5, "alternative systems, when properly designed, constructed, operated and maintained, may provide enhanced protection of public health, safety, welfare and the environment." I/A systems are recommended for use in areas where a conventional Title 5 system cannot be sited. Title 5 details an approval process which proponents of each respective innovative/alternative technology must adhere to in order to gain approval of their alternative system. DEP approves the I/A technologies under four main categories: Approval for Piloting; Provisional Approval; Certification for General Use; and Approval for Remedial Use. These categories are described in the following paragraphs:

1. Piloting Approval, which is addressed in 310 CMR 15.285, allows for controlled field testing and technical demonstration of I/A technologies. Pilot systems can only be built where the establishment to be serviced has access to a sewer system or a conventional Title 5 system to which it can be connected if the alternative system fails. If the I/A technology is approved for piloting it can be implemented at a maximum of fifteen locations. A minimum of 18 months of environmental monitoring must be performed at each facility. Piloting is considered successful when at least 75 percent of the systems perform satisfactorily over 12 months.

2. Provisional Approval, which is addressed in 310 CMR 15.286, provides for broader field testing of the I/A technologies which appear to be technically capable of providing equivalent levels of environmental protection as a conventional Title 5 system. Under the provisional approval testing, it will be determined if the technology is technically capable of providing this level of treatment over a broader use than the pilot, and whether any further conditions regarding operation, maintenance, or monitoring are necessary to ensure such environmental protection. Provisional approval is contingent on

successful completion of the piloting program. Systems that have completed two (2) years of general use in another state will also be considered for provisional approval. A three (3) year performance evaluation must be performed on the first fifty (50) systems. As with piloting, establishments to be serviced by provisional systems must be capable of connecting to a sewer system or a conventional Title 5 system, if the alternative should fail.

3. Certification for General Use, which is addressed in 310 CMR 15.288, facilitates the use of I/A technologies which have shown that they provide the level of environmental protection which is offered by a conventional Title 5 on-site system. In order for an I/A technology to be Certified for General Use, it must have a success rate during the provisional process of 90 percent. The DEP also establishes nutrient removal credits for I/A technologies that are more effective than a conventional Title 5 system in removing nitrates.

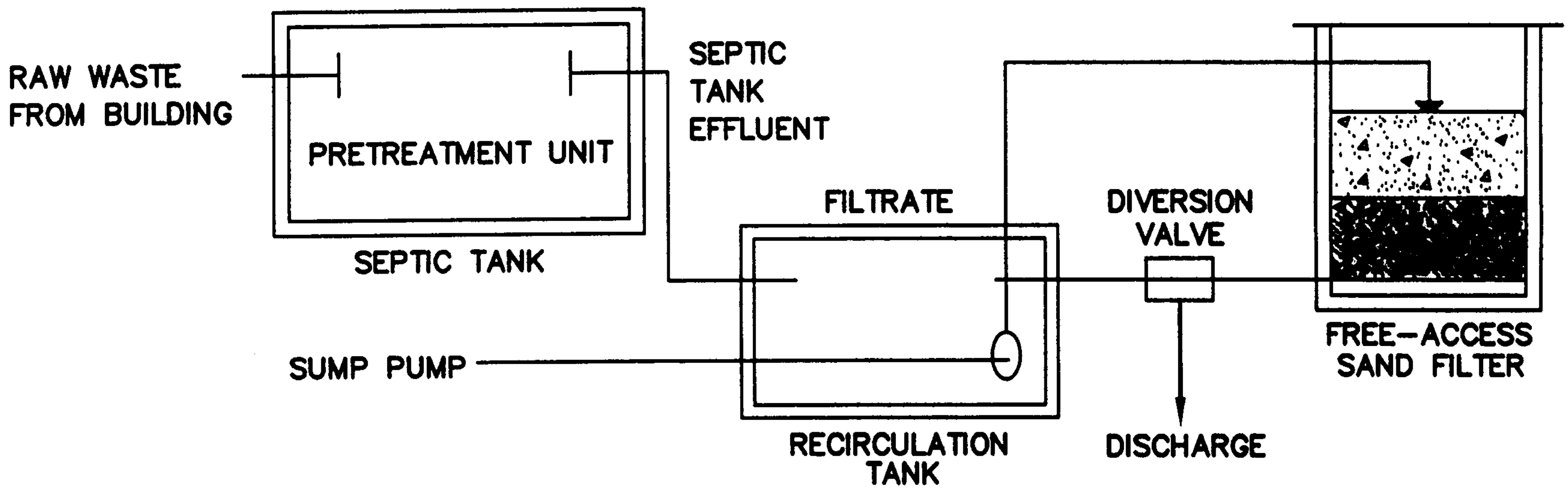
4. Remedial Approval, which is addressed in 310 CMR 15.284, provides for rapid approval of I/A technologies needed to upgrade currently failing or non-conforming systems. In order for the technology to be considered for remedial approval, it must have at least one year of general use in a state with climate conditions similar to Massachusetts. Remedial approval is a "stopgap measure". It is not intended that the data collected for a remedial use approval will be used to support an application for piloting, provisional or general certification.

Recirculating Sand Filter

The Recirculating Sand Filter (DEP approval March 1995) is an alternative treatment system which consists of a septic tank, a recirculation tank and pump, a sand filter with underdrains, and a soil absorption system. The wastewater flows from the building through its building sewer to a septic tank where solids are settled and retained. Effluent from the septic tank flows by gravity and is collected in the recirculation pump chamber. Within the recirculation pump chamber, the effluent from the septic tank and the effluent, which is returned from the sand filter, are mixed. This mixture is then periodically pumped and evenly distributed over the sand filter bed surface. After percolating through the sand filter, the effluent is collected by underdrains and either recirculated back by gravity flow to the recirculation pump chamber or, if the chamber is full, discharged to a soil absorption system. A typical schematic of this system is shown on Figure 5B-3.

The Recirculating Sand Filter was issued a Certification for General Use and Remedial Use Approval by DEP in March 1995. The Recirculating Sand Filter must meet secondary treatment standards of 30 mg/L BOD_5 and 30 mg/L TSS with a minimum removal of 85 percent of the influent BOD_5 and TSS. The effluent Total Nitrogen concentration must not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

Generally, the Recirculating Sand Filter achieves a higher level of treatment compared to a conventional Title 5 system. A variety of papers and studies have been written on Recirculating Sand Filters showing very high levels of treatment. Some of these studies show that typical BOD_5 and TSS removals are greater than 90 and 85 percent, respectively. Typical BOD_5 and TSS effluent concentrations have been less than 15 mg/L. These studies also show that the Recirculating Sand Filter is capable of obtaining high levels of Total Nitrogen removal of up to 75 percent. The effluent Total Nitrogen concentration has been recorded to be as low as 10 mg/L. The Recirculating Sand Filter is the I/A technology that is specifically covered in Title 5. The treatment capabilities of all I/A technologies are compared to the Recirculating Sand Filter. In discussions with DEP, the Recirculating Sand Filter does not always meet the effluent standards required, however, due to DEP's familiarity with the process and the majority of the data which they have reviewed, it is their opinion that the Recirculating Sand Filter is capable of enhanced wastewater treatment compared to a conventional Title 5 system. DEP is confident of the system's treatment capabilities and ability to protect public health and the environment.



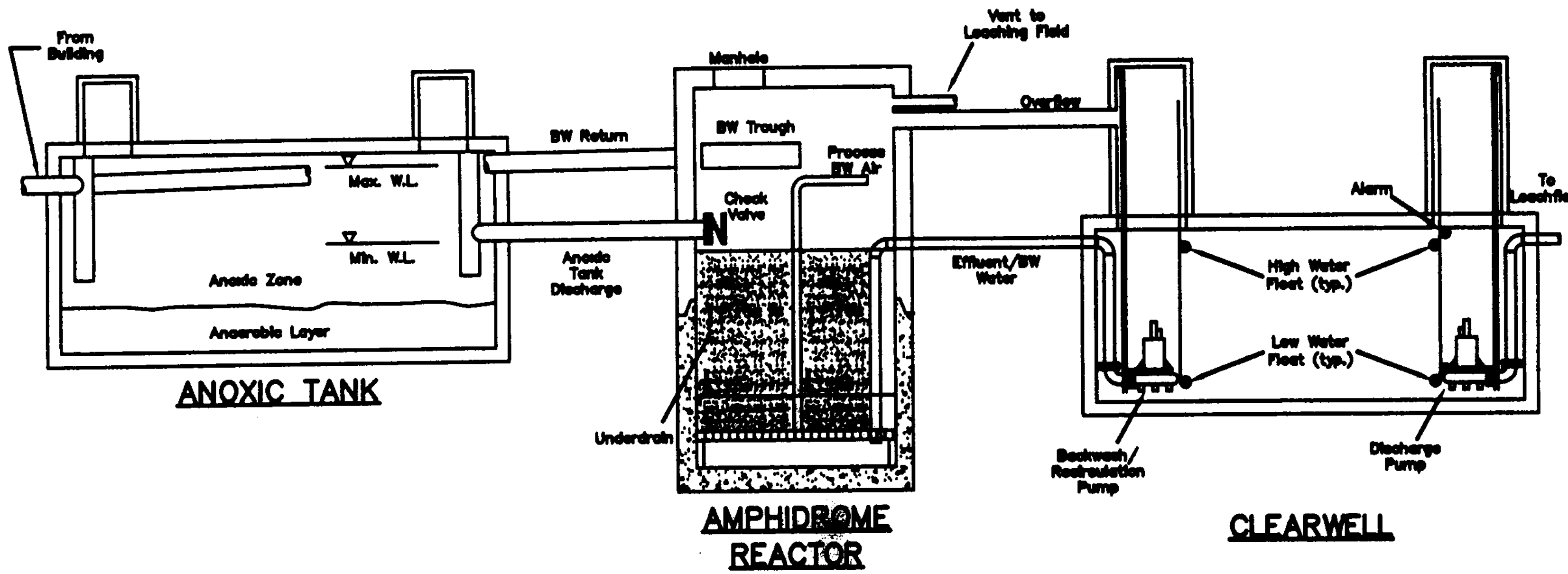
SOURCE: EPA MANUAL, WASTEWATER TREATMENT/DISPOSAL FOR SMALL COMMUNITIES

Amphidrome™ Process

The Amphidrome™ (DEP piloting approval June 1995) system is a fixed film, sequencing batch biological filter. The Amphidrome™ primarily consists of an anoxic equalization tank, the Amphidrome™ reactor/sand filter, and a clearwell. As with a conventional Title 5 system, a soil absorption system is also required. Wastewater flows from the building through its building sewer, combines with recycle flow from the clearwell and enters the anoxic equalization tank. From the equalization tank, the wastewater flows to the anoxic pretreatment/sludge storage area. The equalization tank stores flow prior to treatment through the biological filter. The anoxic pretreatment/sludge storage area settles solids, provides denitrification for the recycled flow using the new flow as the carbon source, and stores and digests sludge.

A batch of wastewater flow is sent by gravity from the anoxic equalization tank, down through the filter, to the clearwell. This flow of wastewater is then reversed by pumping from the clearwell, up through the filter, back to the equalization tank. This cycle is repeated several times until the required level of treatment is achieved. The cycles are alternated between aerobic and anoxic modes. The wastewater flows through the filter to the clearwell. The purpose of the clearwell is to provide storage for the flow to be recycled or to be used as backwash. Once the degree of treatment is obtained, the effluent is discharged to a soil absorption system. A schematic of this system is shown on Figure 5B-4.

The Amphidrome™ Process was issued Piloting Approval by DEP in June 1995. It is approved to be piloted as an equivalent technology to a Recirculating Sand Filter. The Amphidrome™ Process must meet secondary treatment standards of 30 mg/L BOD_5 and 30 mg/L TSS and a minimum of 85 percent of the influent BOD_5 and TSS must be removed. The system must also meet the nitrogen loading design standards as follows:



SOURCE: F.R. MAHONEY & ASSOCIATES, INC.

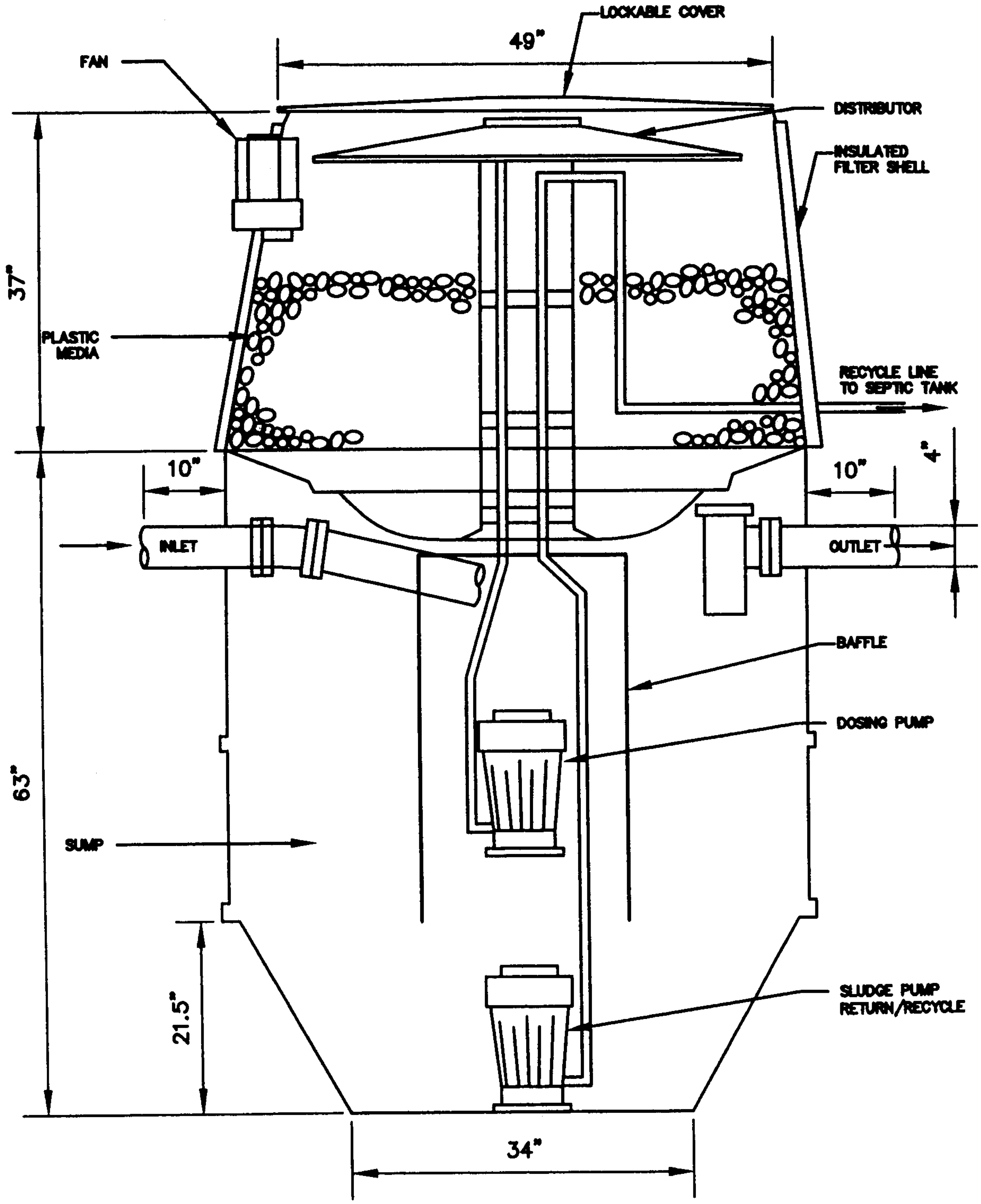
- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.

- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

DEP requires that the influent and effluent parameters for this technology be monitored monthly for the first year of operation. The proponent of this system is seeking to show that the effluent total nitrogen concentration does not exceed 10 mg/L and that the system removes a minimum of 76 percent of the influent Total Nitrogen. Therefore, the ultimate goal of the Amphidrome™ Process is to achieve an effluent with a Total Nitrogen concentration of less than 10 mg/L.

Bioclere™ System

The Bioclere™ (DEP general remedial and provisional approval March 1995) is essentially a modified tricking filter, which can be added to a Title 5 system between the septic tank and the soil absorption area. Wastewater flows from an establishment through its building sewer, into a standard Title 5 septic tank in which primary settling occurs. Effluent from the septic tank then flows by gravity to the baffled sump portion of the Bioclere™. A dosing pump within this sump intermittently pumps the effluent up to the top of the media bed for distribution. The wastewater trickles through this bed of highly permeable plastic media and then mixes with the wastewater in the bottom of the Bioclere™. This mixture is then recirculated to the top of the media bed in a continuous cycle. Sloughed biomass and particles not removed through the septic tank or the filter settle out in the base of the Bioclere™ unit from where a portion of the effluent sludge is pumped back to the septic tank. The remaining portion of the effluent from the Bioclere™ is discharged to a conventional leaching area. A schematic of this system is shown on Figure 5B-5.



SOURCE: BIOCLERE – RHODE ISLAND ON-SITE WASTEWATER TRAINING PROGRAM

The Bioclere™ was issued a Certification for General Use, Provisional Use Approval and Remedial Use Approval by DEP in March 1995. The Bioclere™ must meet secondary treatment standards of 30 mg/L BOD_5 and 30 mg/L TSS with a minimum removal of 85 percent of the influent BOD_5 and TSS. The system must also meet the nitrogen loading design standards as follows:

- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.
- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

A variety of papers and studies have been written on the Bioclere™ system showing high levels of treatment. Some of these studies show that typical BOD_5 and TSS removals are about 85 and 70 percent, respectively. Typical BOD_5 and TSS concentrations are about 50 and 70 mg/L, respectively. They also show that the Bioclere™ is capable of obtaining high levels of Total Nitrogen removal of up to 25 percent above that of a conventional Title 5 system. The effluent Total Nitrogen concentration has been recorded to be less than 30 mg/L.

Cromaglass®

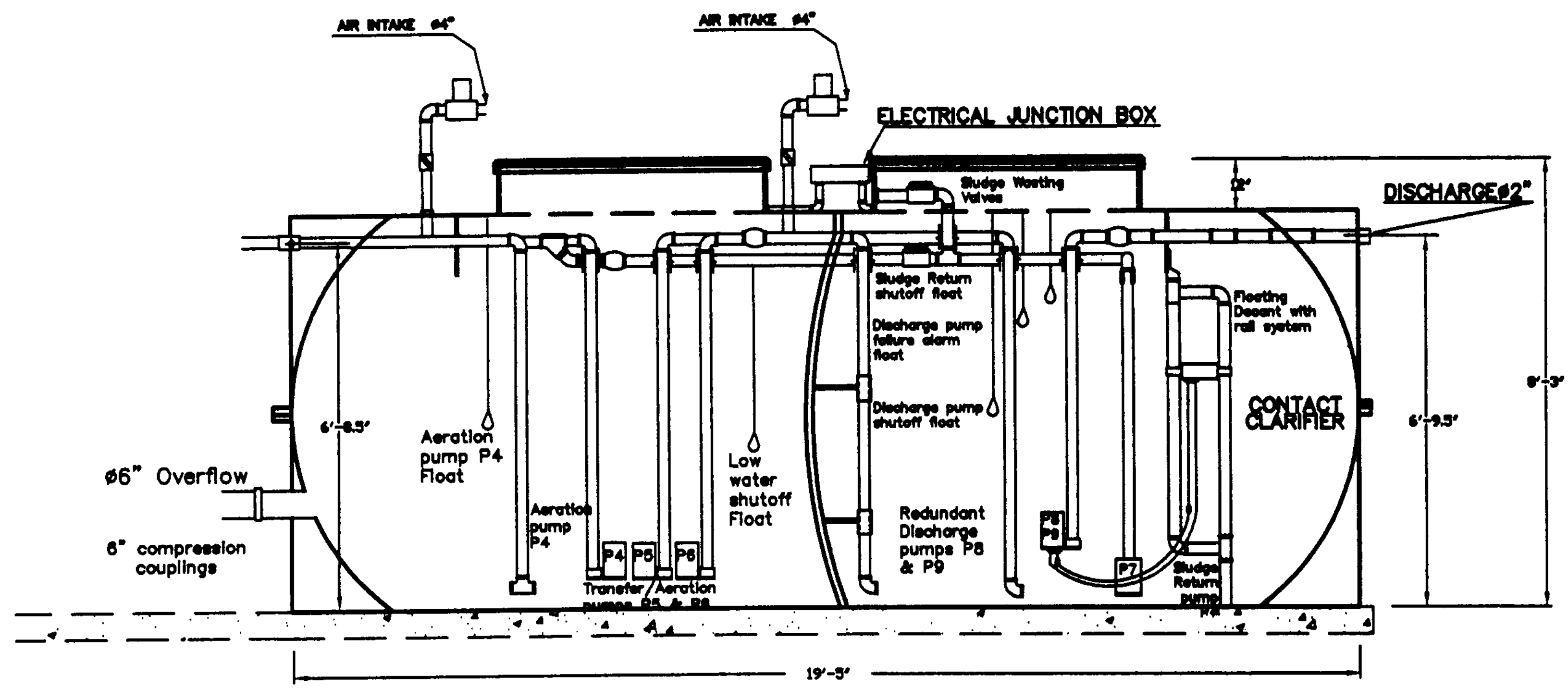
The Cromaglass® (DEP general piloting use approval September 1995) system is composed of a fiberglass tank, which is separated into three chambers and operates as a Sequencing Batch Reactor (SBR). Wastewater flows from the building through its building sewer and enters into the first chamber of the Cromaglass® unit. Within the first chamber, which is referred to as the “Solids Retention Section”, large inorganic particles are retained. Wastewater, with smaller particles and broken organic solids, flow through the grit screen into the second chamber. This chamber is referred to as the “Aeration Section” where biological treatment by aeration occurs. New inflow is continuously mixed with the existing activated sludge which is maintained in this chamber and aeration lasts for several hours. In this chamber, an anoxic period is also provided for denitrification. After the anoxic period, a batch of treated wastewater is transferred at preset intervals to the third chamber for clarification. This chamber is called the "Clarification Section," and is filled until the mixed liquor overflows the weir back into the Aeration Section.

The chamber is then isolated allowing solids separation to occur by settling under quiescent conditions for about one hour. The sludge, which collects at the bottom of the chamber, is either recycled by pump to the Aeration Section or transferred to a sludge collection tank. After clarification, a batch of treated wastewater effluent is discharged to the soil absorption system. A schematic of the Cromaglass® system is shown on Figure 5B-6.

The Cromaglass® system was issued a Certificate for General Use and Piloting Approval by DEP in September 1995. Under the General Use category, the Cromaglass® system must meet the environmental protection requirements of a conventional Title 5 system. It is also approved to be piloted as an equivalent technology to a Recirculating Sand Filter. The Cromaglass® must meet secondary treatment standards of 30 mg/L BOD_5 and 30 mg/L TSS and a minimum of 85 percent of the influent BOD_5 and TSS must be removed. The system must also meet the nitrogen loading design standards as follows:

- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.
- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.

DEP requires that the influent and effluent parameters for this technology be monitored monthly for the first year of operation. As with the Amphidrome™ Process, the proponent of the Cromaglass® is seeking to show that the effluent Total Nitrogen concentration does not exceed 10 mg/L and that the system removes a minimum of 76 percent of the influent Total Nitrogen.



SECTION VIEW

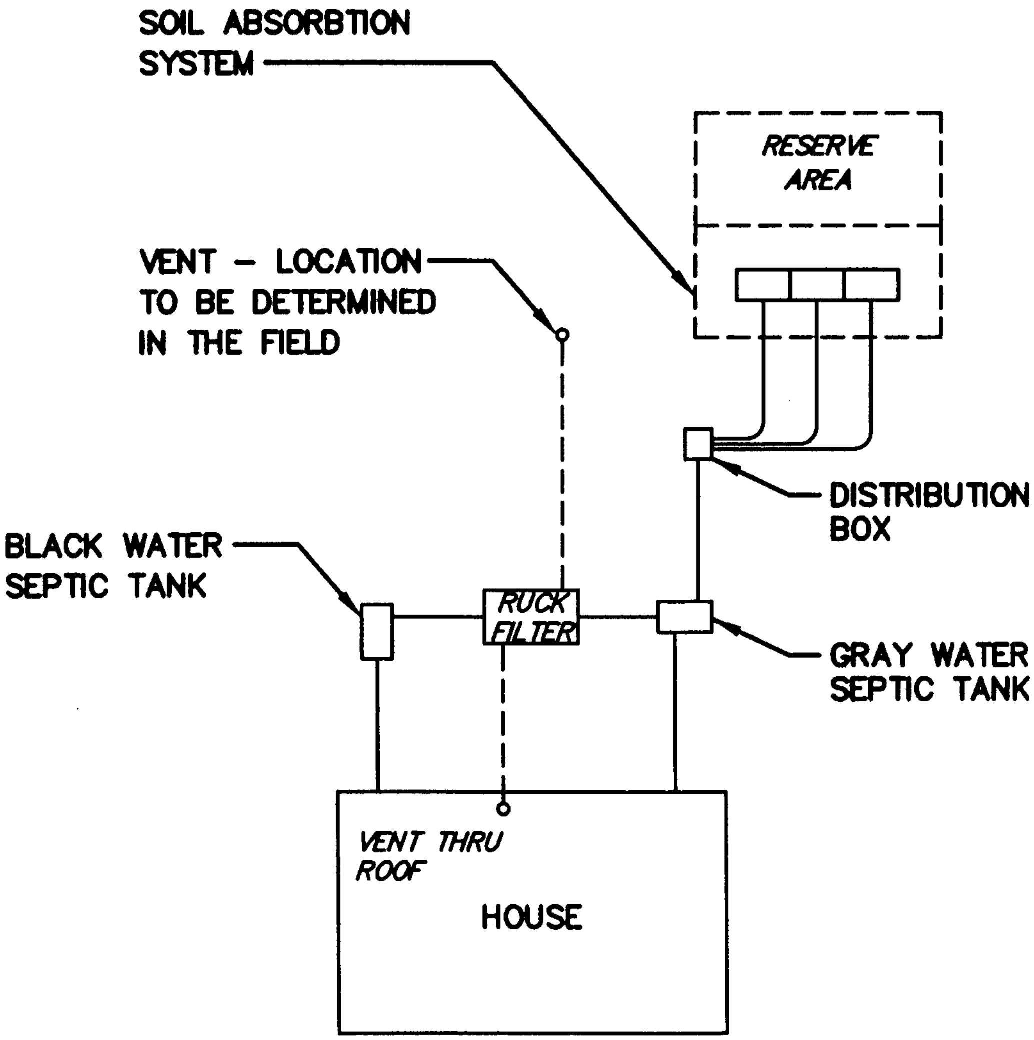
SOURCE: CROMAGLASS CORPORATION

RUCK® System

The RUCK® (DEP general use approval March 1995) system is referred to as a passive nitrogen removal system. The components of the RUCK® system consist of two parallel septic tanks, the nitrifying RUCK® filter, and a conventional subsurface leaching area. One septic tank receives blackwater, which is the waste from toilets and drains equipped with garbage grinders such as a kitchen sink; the other tank receives graywater, which is the waste from showers, washing machines, dishwashers and other sinks, also called washwater. These wastes must be separated at the source, therefore an establishment will need to have the appropriate dual plumbing system or make plumbing changes to make this possible. Blackwater flows from the establishment through the blackwater designated building sewer to the blackwater septic tank where solids settle. The effluent from this blackwater tank is then passed through the single pass aerobic RUCK® sand filter. After the wastewater passes through this filter, it is collected at the bottom of the filter, and is transferred to the graywater septic tank. Effluent from the RUCK® filter is combined with graywater from the establishment in the graywater septic tank. The denitrified effluent from this tank is then transferred to a conventional soil absorption system. A schematic of this system is shown on Figure 5B-7.

The RUCK® System was issued a Certification for General Use Approval by DEP in March 1995. The RUCK® must meet secondary treatment standards of 30 mg/L BOD_5 and 30 mg/L TSS with a minimum removal of 85 percent of the influent BOD_5 and TSS. The effluent Total Nitrogen (TN) concentration must not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent TN concentration. The proponent of the system has indicated that the RUCK® system has achieved between 60 to 85 percent removal of BOD_5 and TSS and has achieved better than 55 percent removal of Total Nitrogen. DEP requires sampling at three points in the process: the blackwater effluent (septic tank effluent); graywater influent; and the distribution box (final effluent) to the soil absorption system. The RUCK® System is just starting to be used in this area, and therefore, there is not much data available for these systems.

Figure 5B-7 (RUCK)



SOURCE: INNOVATIVE RUCK SYSTEMS, INC.

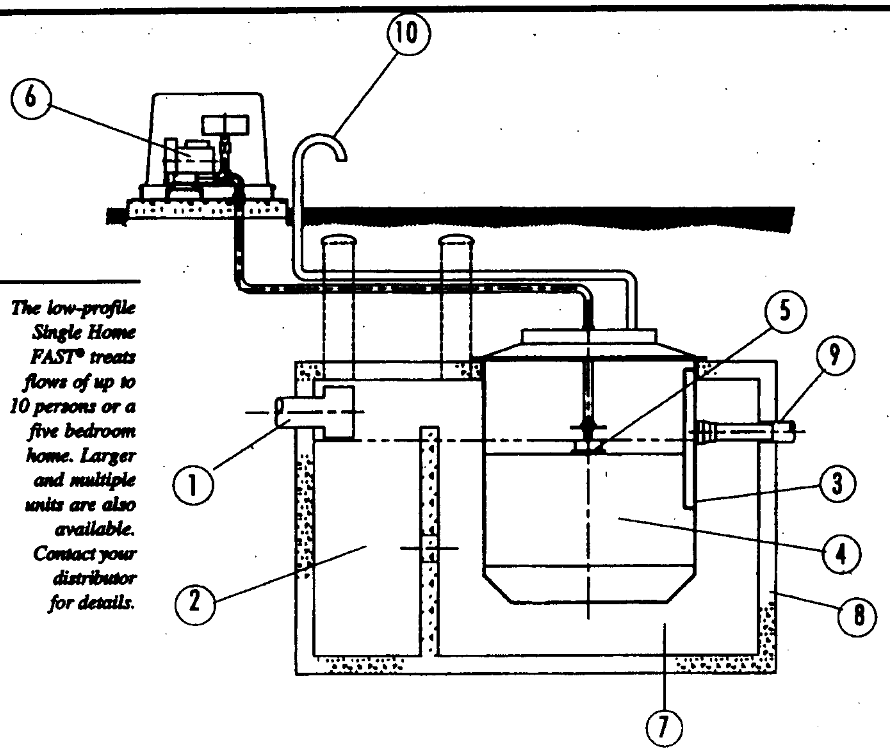
Single Home FAST®

The Single Home FAST® (DEP general, provisional and remedial use approval March 1995) system is a Fixed Activated Sludge Treatment (FAST) system. The FAST® Process consists of two zones -- a primary settling zone and an aerobic biological zone. The FAST® unit is essentially a fixed film media bed, which is inserted into a 1,500 to 2,000 gallon septic tank. A schematic of this system is shown on Figure 5B-8.

The FAST® System was issued a Certification for General Use, Provisional Use Approval and Remedial Use Approval by DEP in March 1995. The FAST® System must meet secondary treatment standards of 30 mg/L BOD_5 and 30 mg/L TSS with a minimum removal of 85 percent of the influent BOD_5 and TSS. The system must also meet the nitrogen loading design standards.

The proponent of this system is seeking to show that the effluent Total Nitrogen concentration does not exceed 15 mg/L and that the system removes a minimum of 64 percent of the influent Total Nitrogen. Therefore the ultimate goal of the FAST® System is to achieve an effluent with a Total Nitrogen concentration of less than 15 mg/L. DEP has recognized that the FAST® unit is capable of 90 to 95 percent reduction in BOD_5 and TSS. The effluent concentrations of BOD_5 and TSS are reported to be less than 30 mg/L. It is also recognized that the unit can reduce the Total Nitrogen entering the system to 19 mg/L.

- For residential systems, the effluent total nitrogen concentration shall not exceed 19 mg/L and the system shall remove a minimum of 55 percent of the influent total nitrogen concentration.
- For non-residential systems, the effluent total nitrogen concentration shall not exceed 25 mg/L and the system shall remove a minimum of 40 percent of the influent total nitrogen concentration.



The low-profile Single Home FAST® treats flows of up to 10 persons or a five bedroom home. Larger and multiple units are also available. Contact your distributor for details.

Standard Features:

1. **Influent from House Sewer Line** - connects directly from the house sewer line pipe and can handle the equivalent of 10 persons or a five bedroom home

2. **Primary Settling Zone** - encourages rapid settling of large solids entering the unit and away from the Fast® media

3. **Treatment Insert** - packed with bacteria-laden media, the liquid circulating through the insert is essentially clear and free of suspended solids, unlike those in conventional activated sludge systems

4. **FAST® Media** - houses the "friendly bacteria" in an environment ideal for rapid bacterial growth. The high surface area-to-volume ratio ensures a continuous level of treated effluent

5. **Draft Tube** - disperses the liquid evenly over the upper surface of the media, providing continuous circulation of the wastewater

6. **Totally Enclosed Blower** - supplies air which provides oxygen for the bacteria to grow and multiply

7. **Solids Collection Zone** - holds the solids which have settled. Occasional solids removal is required

8. **System Tank** - houses the system. Available in concrete or fiberglass configurations

9. **Odorless Liquid Effluent** - discharges into the leach field or disposal well after being disinfected

10. **Vent** - ventilates treatment section

SOURCE: SMITH & LOVELESS, INC.

Monitoring results for the six Innovative/Alternative (I/A) Technologies discussed above were compiled and are summarized in Table 5B-1. This Table shows the average effluent concentrations and percent removals for several systems in operation for each I/A technology. Also, shown on this Table is the DEP requirements and goals set for each system. The monitoring results are variable in that not all technologies were sampled and tested under the same conditions. Variable influent and effluent concentrations were recorded depending on the source, day and time of day each sample was taken. Also, different methods of sampling and testing were used for each technology. Although the monitoring methods and results were different for each system and cannot be used to rank the technologies, the results were helpful in evaluating the technologies in terms of whether or not the technology achieved the effluent requirements set by DEP.

In summary, the monitoring results show that all of the technologies have the capability of achieving enhanced treatment over that of a conventional Title 5 system. Of the systems and monitoring results analyzed, the Recirculating Sand Filter, the Amphidrome™ Process, the Cromaglass® and the FAST® system achieved their respective DEP effluent and removal requirements more frequently than the other technologies. These systems achieve a higher degree of wastewater treatment than can be achieved by a Conventional Title 5 system.

I/A technologies can potentially overcome site and environmental constraints but at a premium cost to the property owner. In remedial situations, I/A technologies with nitrogen reduction allow for either a 50 percent reduction in leaching area; a two foot reduction in the groundwater separation requirement; or a two foot reduction in the depth of naturally occurring soil under the leach field.

Since the treatment capabilities as well as the cost of the I/A technologies are similar, one technology was selected in order to evaluate the wastewater disposal alternatives for the areas of wastewater disposal needs. The Single Home FAST® System was chosen as the selected alternative. The costs of the I/A technologies are similar and all are capable of achieving enhanced treatment over that of a conventional Title 5 system.

TABLE 5B-1
TOWN OF NANTUCKET
CWMP / EIR
SUMMARY OF MONITORING RESULTS VERSUS TREATMENT REQUIREMENTS

I/A TECHNOLOGY	Average Monitoring Results						DEP Treatment Requirements					
	BOD$_5$		TSS		Total Nitrogen		BOD$_5$		TSS		Total Nitrogen	
	Effluent Concentration (mg/L)	Percent Removal (%)	Effluent Concentration (mg/L)	Percent Removal (%)	Effluent Concentration (mg/L)	Percent Removal (%)	Effluent Concentration (mg/L)	Percent Removal (%)	Effluent Concentration (mg/L)	Percent Removal (%)	Effluent Concentration (mg/L)	Percent Removal (%)
Recirculating Sand Filter							30	85	30	85	25	40
Colburn Street - Gloucester, MA	7.0	96.5	12.0	82.3	60.8	39.2						
Langsford Street - Gloucester, MA	11.0	93.3	15.0	77.0	78.6	44.6						
Anne Arudel County - Maryland												
System A	4.0	98.1	8.0	88.9	22.0	59.3						
System B	2.0	98.4	5.0	91.1	17.0	62.2						
System C	8.0	97.8	10.0	89.7	21.0	70.4						
Chart House Restaurant - Chester, CT	4.0	99.1	7.0	96.5	11.9	73.5						
Amphidrome Process							30	85	30	85	Residential -- 19	55
Stuart's Mall - Swansea, MA	9.2	95.0	9.9	68.5	14.5	67.5					Nonresidential -- 25	40
											Goal – 10	76
Bioclere							30	85	30	85	Residential -- 19	55
High Street - Gloucester, MA	29.0	78.4	33.0	62.3	26.9	39.8					Nonresidential -- 25	40
Vale Court - Gloucester, MA	51.0	83.6	42.0	66.3	29.3	47.4						
NSF Testing	13.0	82.4	17.0	63.8	22.3	20.5						
391 Atlantic Avenue - Cohasset. MA	7.3	87.6	8.9	64.0	12.3	11.1						
Stop & Shop - Yarmouth, MA	112.0	81.1	86.0	50.4	43.7	35.3						
Mercury Drive - S. Yarmouth, MA	50.0	63.9	79.0	63.5	24.0	21.7						
Cromaglass							30	85	30	85	Residential -- 19	55
Meadowbrook Christian School -- Milton, PA											Nonresidential -- 25	40
Phase I	11.1	92.1	19.2	86.2	12.9	29.7					Goal – 10	76
Phase II	7.5	95.8	11.9	93.1	4.7	78.7						
NSF Testing	42.0	82.3	39.0	84.2	--	--						
RUCK							30	85	30	85	Residential -- 19	55
Highway Inspection Facility -- Truckee, CA	9.7	80.9	--	--	60.3	57.0						
Porter's Orchard Lot No. 5 -- Colchester, VT	51.2	75.7	156.0	48.2	142.7	27.5						
Porter's Orchard 8 Home Composite	47.8	--	63.1	--	5.7	--						
Single Home FAST							30	85	30	85	Residential -- 19	55
NSF Testing	9.0	93.8	7.0	96.4	9.3	73.2					Nonresidential -- 25	40
Florida Keys -- Owners Demonstration	4.6	95.7	8.0	92.2	13.0	64.5					Goal – 15	64
140 Beach Street -- Cohasset, MA	20.1	--	6.2	--	12.2	--						
Coonamesett Inn -- Falmouth, MA	14.8	--	18.5	--	6.6	--						

Analysis of On-site Alternatives

A brief on-site alternatives analysis to determine the optimal wastewater treatment and disposal options for the areas of wastewater disposal needs is presented below. The analysis considers each of the need areas as a single entity. To determine the optimal wastewater treatment and disposal option for each need area, technical and environmental factors were considered. The purpose of this evaluation is to determine which of the on-site, cluster, and/or I/A options presented are feasible, if any, for the eleven (11) wastewater disposal need areas identified in Nantucket.

Conventional Title 5 Septic Systems

Conventional Title 5 septic systems would be a feasible option if all the existing developed properties within the need areas are capable of siting a soil absorption system according to Title 5 code. Without conducting site specific field investigations for each property in each of the need areas, and based solely on the subsurface soil and groundwater information gathered from BOH data, it is anticipated that some of the properties in each of the need areas will not be able to meet Title 5 regulations for the soil absorption system. Thus, continued use of existing and use of conventional Title 5 septic systems are not considered feasible for the need areas.

Variances to Conventional Title 5 Septic Systems

Conventional Title 5 septic systems with a variance would also be a feasible option if all of the existing developed properties within the need areas were capable of siting a soil absorption system with either a variance from the Title 5 regulations or Town By-law. The criteria used to determine whether variances to conventional Title 5 systems are feasible for a need area are: lot size, soils, and groundwater. If the need area has an average lot size of less than or equal to one-half acre but does not have either severe soil or groundwater limitations, the area could potentially use variances to conventional Title 5 systems. If a need area has an average lot size less than or equal to one-half acre with either severe soil or groundwater limitations, then variances to conventional Title 5 systems are not an option. Since all the properties within the need areas are not larger than one-half acre in size, Title 5 systems with variances are a potential option for a portion of each of the need areas, but not for all of each of the need areas. Hence, this is not a feasible option for an entire need area. Each property would need to be evaluated on a case-by-case basis in order to determine which properties could effectively utilize Title 5 systems with variances.

STEP/Cluster Systems

STEP/Cluster systems would be a feasible option if a soil absorption system can be sited within the area of wastewater disposal need or within close proximity to the need area. The STEP/Cluster System consists of a septic tank effluent pump on each property and a small scale, off-site subsurface cluster disposal system. The disposal system for this type of facility is similar to a conventional Title 5 soil absorption system, except that it is larger in scale and is located off-site from the wastewater source. As previously discussed, at a minimum, approximately 0.4 acres are required for the disposal system, assuming good soils and not including setback requirements from property lines, wells, etc. If reasonable setback limits are included, 0.6 acres is typically required for the disposal system.

The disposal system could be located either on an undeveloped parcel in the need area, on an undeveloped parcel just outside of the need area, or on a portion of an existing developed parcel in the need area. The property would need to be either purchased by the Town or an easement on the existing property would need to be obtained from the property owner by the Town. It is unlikely that a property owner would be willing to sell a portion of their property or grant an easement on their property to site a subsurface disposal system. In addition, there would need to be enough area on the property with adequate soils, depth to groundwater, depth of naturally occurring soil, and depth to ledge to accommodate such a system. It is doubtful that such an area exists in each of the need areas. Thus, STEP / Cluster systems are most likely not a viable option for wastewater treatment and disposal in the areas of wastewater disposal need.

On-site Innovative Alternative Wastewater Treatment and Disposal Systems

On-site Innovative/Alternative (I/A) systems would be a feasible option if the existing developed properties could accommodate innovative alternative systems (e.g. recirculating sand filter, Amphidrome™ Process, Bioclere™ System, Single Home FAST, etc.) to effectively treat and dispose of wastewater. Like a conventional Title 5 system, these I/A systems require a soil absorption area. As previously mentioned, an I/A system can potentially overcome site and environmental constraints but at a premium cost to the property owner. In remedial situations, I/A technologies with nitrogen reduction allow for either a 50 percent reduction in leaching area; a two foot reduction in the groundwater separation requirement; or a two foot reduction in the depth of naturally occurring soil under the leach field. If a property has either severe soil limitations or high groundwater, the area could potentially use I/A wastewater treatment and disposal systems. However, if a property has both severe soil limitations and high groundwater, then I/A wastewater treatment and disposal systems are not an option. As previously discussed, the Soil Conservation Service classifies soils and their suitability for sewage disposal. At least some portion of the need areas have soils with severe subsurface disposal system limitations due to soils and groundwater. Thus, I/A systems would be difficult to site within each of the need areas, and therefore, are not recommended as the wastewater disposal option to serve the need areas of the Island.

C. WASTEWATER COLLECTION, TREATMENT AND DISPOSAL ALTERNATIVES

Flow and Waste Reduction

The Town of Nantucket understands the significance of reducing its wastewater flows. One of the ways to ensure this minimization is to implement water conservation measures to reduce water use. A variety of water conservation options have been presented by the DEP in the "1992 Water Conservation Standards for the Commonwealth of Massachusetts". These options are discussed below.

- **Public Education**

  Public education involves the dissemination of information and getting public support by providing a basic understanding of sound water resources management. One of the three main areas of emphasis that should be included in an educational program is explaining to water users the various costs that are associated with providing water. These costs include planning, engineering, construction, operation, maintenance, treatment, wastewater facilities costs, piping, leak detection, infiltration/inflow reduction measures, compliance costs, salaries and benefits, protection costs, training, and public education. Other areas of emphasis include providing water system users with tangible evidence of the cost savings and environmental benefits that can be attained through water conservation. Materials for education programs may be sought from the Massachusetts Water Works Association, the New England Water Works Association and other organizations, and funded by local water and sewer revenues.

  The “1992 Water Conservation Standards” makes the following suggestions for developing a successful public education program: (1) the largest users should be targeted early on to realize the greatest potential savings; (2) public education should reach to the schools to get the children involved; (3) water bills should include a worksheet to enable customers to track water use and conservation, and figure the dollar savings; (4) publicly advertise water conservation successes (and failures) / public service announcements; (5) joint advertising with hardware stores to promote household conservation devices; and (6) provide information on landscaping, gardening, and lawn care practices that promote water conservation.

- **Leak Detection and Repair**

  Leak detection and repair is intended to reduce the amount of water lost via leaks in the water distribution system. This maintenance activity is considered most important in older water systems. Leak detection programs can vary but should be carried out regularly by the water suppliers. The full-cost pricing structure described below should include the costs for leak detection surveys and repairs.

- **Metering**

Complete system metering lets customers know how much water they are using, provides Nantucket with valuable knowledge of customer use patterns, assists in demand management programs, and enables Nantucket to bill the customer accurately. With accurate knowledge about current demand, Nantucket can more effectively identify potential water savings, assist specific users to implement water saving measures, determine unaccounted for water, and thereby provide the opportunity to reduce overall system demand and plan efficiently for system growth. Metering costs should be recovered through water rates, and include not only the costs for the metering equipment, but also the costs associated with reading the meters regularly.

- **Pricing**

  Full-cost pricing refers to price levels that recover all the direct and indirect costs associated with providing water. For all sectors of water use, knowing the costs associated with providing water and sewer services creates an appreciation of the importance of conserving water and promotes greater understanding of the direct relationship and environmental implications of individual water use and community water resources, especially during seasonal or drought shortages. The pricing structure for water should include the complete cost to run the system. These costs include pumping, maintenance, electricity/fuel, treatment, distribution system operation and maintenance, watershed/well site purchase/protection, capital replacement fund, capital depreciation account, and debt service, purchase and installation of water conservation retrofit equipment, public education program, staff and benefits, and leak detection and repair.

- **Residential Water Use**

  Residential water use from public water suppliers in Massachusetts amounts to about 450 million gallons per day. Increasing efficiency of use and implementing conservation measures can realize significant savings for consumers and suppliers, both in energy and water costs. Residential users should be encouraged to use the following water saving devices: low-flow showerheads, faucet aerators, toilet displacement devices and/or low-flow toilets, and toilet leak detection kits.

- **Public Sector Water Use**

  Public municipal and state buildings and facilities should serve as demonstrations of water saving techniques and concepts. The public should be aware that the state and municipalities are not only doing their part, but also leading the way. Government facilities (schools, hospitals, public offices, etc.) should be built or retrofitted with water conservation devices such as faucet aerators, low flow shower heads, toilet displacement devices or low-flow toilets, and self-closing faucets. Other public sector policies should include charging contractors for using fire hydrants for pipe flushing and other construction purposes.

- **Industrial, Commercial, and Institutional Water Use**

  The bulk of industrial, commercial, and institutional water use is for heating, cooling, and processing, but often includes an appreciable sanitary and landscaping component. Conservation measures must be tailored to reflect the type of water use and characteristics of individual facilities. A reduction in facility water uses as well as a reduction in pollutant discharge often accompany the implementation of source reduction programs. Water conservation can be built into an industry's strategy to comply with sewer and discharge requirements and often results in monetary savings following short payback periods. All industrial, commercial, and institutional water users should be required to develop and implement a written water policy addressing at a minimum demand management, leak detection and repair, a program of preventive maintenance, and a program of employee education. They should also be required to perform water audits to determine the location and amount of water used for heating, cooling processing, sanitary use, and outdoor use. This information could then be used to determine areas to conserve water. Industrial, commercial, and institutional users should also be required to install water saving sanitary devices.

- **Water Supply System Management**

  Nantucket has many options for improving the efficiency of its operations and encouraging water conservation by consumers. The Local Water Resources Management Plan developed by the Water Resources Commission can provide a framework for implementing these standards and establishing long-term priorities and plans for system maintenance, source protection, and, as necessary, new source development. These plans, upon DEP approval, will allow Nantucket to effectively use existing supplies during times of drought or emergency. Nantucket should develop strategies to reduce peak demands and should carry out water supply system audits to determine where water can be saved.

Configurations and Alternative Sewer Systems

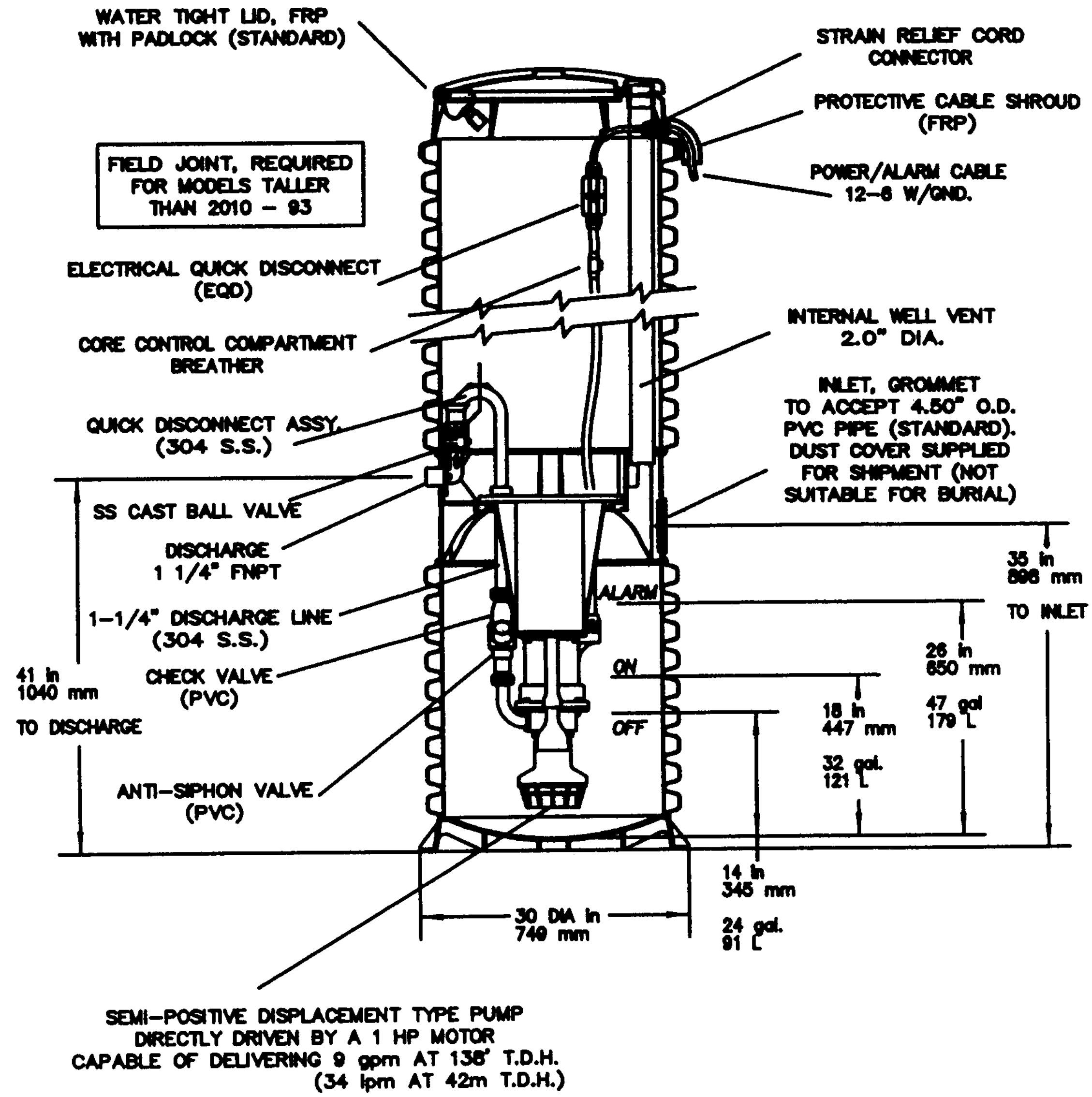
- **Gravity Sewer System**

  A gravity sewer system consists of sewer lines that allow residential, commercial, and industrial customers to discharge into a sanitary system consisting of gravity pipes which flow downhill and are not pressurized. Gravity sewer systems operate by collecting the wastewater via continuously sloped pipe, typically eight inches minimum diameter, and transport the wastewater to local low points in the collection system. The design of a gravity sewer system is dependent on the velocity of the wastewater within the pipes. Minimum velocities are set to assure that suspended matter does not settle out in the conduit, while maximum velocities are set to prevent erosion of pipe material. Extremely flat or hilly terrain poses problems to gravity sewer installation since the gravity sewers must continually slope downward. This results in the sewer becoming increasingly deep or the need for a pump station. Pump stations are located at the local low points to collect and pump the wastewater to the next high point in the collection system, where the process continues.

- **Low Pressure Sewer System**

  A low-pressure sewer system has proven to be a viable alternative to gravity sewer systems. A low-pressure sewer system includes small diameter pressure sewers fed by individual grinder pumps at each source or can be configured so that the pump system may also serve multiple sources. A pressure sewer system makes use of small diameter piping, ranging in size from 1-¼ to 4 inches in diameter, buried at a shallow depth following the profile of the ground. The pressure main and service pipe are generally manufactured from polyvinyl chloride (PVC) or high density polyethylene (HDPE). The pressure sewer mains and laterals are buried just below the depth of frost penetration following the contour of the ground.

  The pressure sewer system is separated into branches of sewers of different sizes depending on the number of connections to each branch. Standard manholes are not required in a pressure sewer system. Instead, flushing connections/drain manholes are installed at the end of branches and where major changes in direction or size of pipe occurs. Air relief/vacuum valve manholes are installed at high points in the system to allow trapped air to escape. Each source will utilize a grinder pump for discharge of sewerage into the main. Each grinder pump unit is equipped with a grinder pump, check valve, tank and all necessary controls. The units can be located outdoors close to each source's existing septic tank or cesspool so that the connection to the existing service pipe exiting the building can be made easily. The units can also be located inside the building. The grinder pump macerates the solids present in the wastewater to a slurry in a manner that is similar to a kitchen sink garbage grinder and discharges wastewater to the pressure sewer collection pipes. If a malfunction occurs, a high liquid level alarm is activated. This alarm may be a light mounted on the outside of the building or an audible alarm, which can be silenced by the customer. The customer will then notify the Town or a Town approved technician or contractor to come and make the necessary repair. Figure 5C-1 shows a schematic of a typical grinder pump unit.



NOTE: A CONCRETE ANCHOR
IS REQUIRED TO PREVENT TANK FROM FLOATING.
SEE INSTALLATION INSTRUCTIONS
OR
SPECIFIC CUT SHEET
FOR SIZE AND WEIGHT OF ANCHOR

SOURCE: ENVIRONMENT ONE CORPORATION

A low-pressure sewer system collects and transports the wastewater from each customer located in low points to the nearest gravity sewer. Each customer would provide the service pipe from their building to the grinder pump, the grinder pump, and service pipe to the property line. The Town would provide the service pipe and appurtenances from the property line to the low-pressure sewer. Within the right-of-way, air relief manholes with air and vacuum valves would be installed at all high points and terminal flushing drain manholes would be installed at all low points. In addition, cleanouts would be installed every 1,000 feet. As an option the Town may consider to purchase and install the grinder pump units within the roadway right-of-way.

- **Vacuum Sewer System**

  Like the low-pressure sewer system, the vacuum sewer system is used where gravity sewer systems are impractical and/or not economically feasible. The vacuum collection system consists of three main components: (1) services, (2) collection mains, and (3) the vacuum station. As with pressure sewers, the materials used for the collection mains and service pipe are typically PVC or HDPE. The pipe diameter for the collection mains range from a minimum of 4 to 10 inches. The service lines have a minimum diameter of 3 inches. The service lines consist of a vacuum valve, auxiliary vents, valve pit/sump or buffer tank. The valve pit/sump accepts the waste from the customer. Included within the valve pit is a vacuum valve, which provides the interface between the vacuum in the collection piping and the atmospheric air in the building sewer, and a controller, which regulates the vacuum cycle frequency. When the vacuum valve is closed, system vacuum within the collection piping is maintained; when it is open, the system vacuum evacuates the contents of the sump. An auxiliary vent is installed on the customer's service lateral and is necessary to provide the volume of air that will follow the wastewater into the main. Buffer tanks are also used as holding tanks to collect and regulate large flows such as those flows from apartment buildings, schools and other large users, and are required when gravity flow switches to vacuum flow. Vacuum systems can be buried at a shallow depth due to the high velocity (15 to 18 feet per second) of sewage which keeps the lines from freezing. The collection mains can follow the profile of the ground as long as there are small elevation changes. The collection lines need to have a minimum slope of 0.2 percent toward the vacuum station. Uphill liquid transport or temporary increases in elevation can be accomplished by the insertion of lifts (vertical profile changes) along the sloped route to the station. These lifts can consist of two 45-degree elbows connected by a straight piece of pipe and are limited to a length of three feet. The collection mains are all connected to a vacuum station located in the center of the service area. The vacuum created by the system pulls sewage to the vacuum station and pumps it to its ultimate disposal point in the downstream collection system. This station has a collection tank and a vacuum tank. The wastewater is stored in the collection tank until a sufficient volume accumulates and it is then evacuated. In addition to the collection and vacuum tanks, the vacuum station includes: vacuum pumps to create the vacuum for wastewater transport; wastewater pumps to transfer the wastewater which is pulled into the collection tank by the vacuum pumps to the disposal point in the downstream collection system; controls; motor control center; chart recorder; and a fault monitoring system to alert the operator of irregularities such as low vacuum levels. Therefore, the vacuum station requires an electrical connection, however, electrical connections at each user are not necessary. A standby generator is required for this station so that the system can continue to operate in the event of a power failure.

Wastewater Treatment, Disposal, Reuse, Land Applications

As previously discussed, alternatives were presented for discharge of sewage from Nantucket's need areas to various decentralized facilities. In this section, the alternative of treating Nantucket's sewage at a new wastewater treatment facility, at the recently re-designed Siasconset Wastewater Treatment Facility, and/or at the Surfside Wastewater Treatment Facility will be explored. The alternative will require a detailed look at process requirements, cost impacts, land requirements, structure sizing, treatment ability, etc., as well as, looking into the existing treatment facilities and disposal systems capacities.

In general, the new treatment facility alternative consists of providing an appropriate level of sewerage treatment that would allow treated effluent discharge on the Island of Nantucket. As such, the treatment technologies analyzed must be capable of producing an effluent that meets DEP criteria. The following issues will be discussed in this section: (1) Effluent discharge options; (2) Proposed effluent limitations; (3) Four general treatment categories: suspended growth biological process, fixed film biological processes, physical/chemical processes and natural systems processes; (4) Existing Surfside and Siasconset wastewater treatment facilities; (5) Evaluation criteria; and (6) Potential Reuse Opportunities.

The treatment categories and technologies described in this section do not represent all of the treatment processes necessary, only the central processes which accomplish most of the treatment needed to meet proposed effluent limitations. It is assumed that all treatment technologies will need preliminary screening of large objects, grit removal and disinfection. The need for primary clarification will depend on the specific technology involved, but it is assumed that many will require it. These issues will be addressed in detail once the treatment technologies have been screened.

- **Effluent Discharge Options**

  Surface Water Discharges

  The discharge of treated wastewater to surface waters is being evaluated as an option for disposal in Nantucket. Surface waters also include wetland areas adjacent to streams and waterbodies. This disposal option involves discharging highly treated effluent from a treatment facility directly to a surface water body, stream or wetland system. For purposes of this discussion, the location of the discharge is considered independent of the location of the treatment facility since the treated effluent could be transmitted along a pipeline.

  The discharges of pollutants to surface waters is regulated by DEP under the Surface Water Discharge Permit Program (314 CMR 3.00) and the Massachusetts Clean Water Act (MGL c.21, s.26-53). The point source discharge of pollutants is regulated by the National Pollutant Discharge Elimination System (NPDES) permit program administered by the EPA under Section 402 of the Clean Water Act. EPA is the lead agency in NPDES permitting using compliance with water quality standards set under the DEP state Surface Water Discharge Permit Program (314 CMR 3.00). The DEP cosigns the issued permit, if it is determined that water quality standards will be met, a 401 Water Quality Certificate is issued.

The Surface Water Discharge and NPDES Permit Program have been established to limit or prohibit discharges of pollutants to surface waters to assure that surface water quality standards of receiving waters are protected, maintained or attained. The antidegradation provision of the Surface Water Quality Standards (314 CMR 4.04) requires that in all cases existing uses shall be maintained and protected.

The Massachusetts Division of Marine Fisheries designates the following surface waters and harbors in Nantucket as shellfish growing areas:

Polpis Harbor	Sesachacha Pond
Nantucket Harbor West and East	Nantucket Southeast Coastal
Head of the Harbor	Madaket Harbor
Coskata Pond	Northwest Coastal
Nantucket East Coastal	Nantucket Northeast Coastal

Nantucket Southwest Coastal (Hummock Pond and Clark Cove)

The effluent parameter of concern for a surface water discharge is phosphorus, which, even at relatively low concentrations, can increase the growth of aquatic plants, and produce algal blooms. Such conditions reduce the aesthetic and recreational utility of receiving waters. Lakes, ponds, and small or slow moving streams are most sensitive to increases in phosphorus and other nutrient loadings, due to their low flow through rates. Table 5C-1 outlines the minimum criteria for Class B waters, the anticipated designation of receiving waters, as well as additional minimum criteria for surface waters.

Although EPA has stated that discharges to local surface waters should be considered, they have expressed concerns that the local surface waters provide little or no dilution. The larger surface waterbodies and streams in Nantucket include: Sesachacha Pond, Long Pond, Tom Nevers Pond, Miacomet Pond, Coskata Pond, Hither Creek, and Gibbs Pond. In addition, the larger harbors include: Nantucket

TABLE 5C-1
TOWN OF NANTUCKET
CWMP / EIR
SUMMARY OF WATER QUALITY CRITERIA FOR CLASS B STREAMS

CLASS B WATERS (Minimum Criteria)	Description
Dissolved Oxygen	Shall not be less than 6.0 mg/L in cold water fisheries and 5.0 mg/L in warm water fisheries
Temperature	Shall not exceed 68°F in cold water fisheries and 83°F in warm water fisheries
pH	Shall be in a range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the background range
Fecal Coliform Bacteria	Shall not exceed the geometric mean of 200 organisms per 100 ml, not shall mare than 10 percent of samples exceed 400 organisms per 100 ml
Solids	Free from floating, suspended and settleable solids
Color and Turbidity	Free from color and turbidity in concentrations or combinations that are objectionable
Oil and Grease	Free from oil , grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste
Taste and Odor	None in such concentrations or combinations that are aesthetically objectionable
Additional Minimum Criteria for All Surface Waters	All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits, float as debris, scum or other matter to form nuisances
Bottom Pollutants or Alterations	All surface waters shall be free from pollutants in concentrations or combinations, or from alterations that adversely effect the physical or chemical nature of the bottom
Nutrients	Shall not exceed site-specific limits necessary to control accelerated growth of algae and other plants.
Radioactivity	Free from radio-active substances in concentration or combinations that would be harmful
Toxic Pollutants	Free from pollutants in concentrations or combinations toxic to humans, aquatic life or wildlife

Harbor, and Madaket Harbor. These surface water bodies are either suffering for poor water quality or are used for recreational purposes. The harbors are used for shellfish harvesting, which would represent an incompatible use. In addition, it is doubtful that the U.S. Environmental Protection Agency and/or Massachusetts Department of Environmental Protection would approve a surface water discharge for Nantucket, as the waterways have already experienced declining water quality due to elevated nutrient levels. As such a surface water discharge to these ponds and harbors is not being considered further. The two existing wastewater treatment facilities on the Island discharge to rapid infiltration basins.

Due to the stringent regulatory requirements facing the surface water discharge, this disposal option is not considered as a reliable alternative and therefore a detailed evaluation of this discharge option has not been developed for this document. The only purpose of presenting it in this document was to address the opportunities and constraints associated with wastewater disposal.

Groundwater Discharges

The discharge of treated wastewater to groundwater is being evaluated as an option for disposal in Nantucket. This disposal option would involve the discharge of highly treated effluent from a wastewater treatment facility into an infiltration bed designed to handle the estimated discharge. For discussion purposes, the location of the discharge is considered independent of the location of the treatment facility since the treated effluent could be transmitted along a pipeline to the infiltration system.

The requirements for groundwater discharge of wastewater are outlined in the Groundwater Discharge Permit Program (314 CMR 5.00 and 6.00). The principal constituent of concern for groundwater discharges is nitrates, a primary component of treated wastewater. Potential sites for use as a groundwater disposal site must be comprised of sandy or gravely soils that exhibit medium infiltration rates. Sites which contain poor soil permeability, high groundwater levels, and ledge, inhibit the downward flow of water and are generally unacceptable. Soil properties can be amended by excavating and amending the soils in the discharge area or mounding the infiltration beds. This approach may be infeasible for larger systems designed for large wastewater flows but may be appropriate for small systems.

The most difficult of these physical constraints to overcome is the shallow depth to bedrock. Title 5 requires that 4 feet of naturally occurring pervious material be located beneath the bottom of the leaching facility. In areas where bedrock is 4 feet or less from the natural ground surface, a system cannot be installed in accordance with Title 5. Soils with slight or moderate limitations for wastewater disposal are considered acceptable for effluent beds. The groundwater discharge options within Nantucket are also restricted by discharge standards that prohibit anti-degradation. The Nantucket County Soil Survey Report by the U.S. Department of Agriculture indicates that soil classifications having severe soil limitations to septic disposal represent approximately 14.2 percent and the soil classifications having severe groundwater limitations to septic disposal represent approximately 18.3 percent of the total land are of Nantucket.

- **Proposed Effluent Limitations**

  Effluent limitations are dependent upon the method and location of treated effluent discharge. As discussed above, there are two ultimate effluent discharge options: surface water and groundwater discharge. A surface water discharge would involve discharging treated effluent to a stream, pond, lake or wetland area. A groundwater discharge would involve the discharge of treated effluent to the ground and percolation through the soil to the groundwater. Groundwater discharge can be accomplished by discharging the treated effluent to rapid infiltration sand basins; using spray irrigation or overland discharge; or to subsurface disposal beds similar to Title 5 septic systems. Another groundwater discharge method would be to utilize subsurface injection through wells.

A stream, pond or lake surface water discharge was determined to be infeasible in Nantucket because of the more stringent effluent requirements associated with small, intermittent low flow streams and primarily groundwater fed ponds. While a properly sited system with highly treated effluent discharged to a surface water body through a constructed wetland offers a high degree of treatment, it likely will not be able to meet water quality requirements regarding metals where there is little or no dilution. Accordingly, surface water discharges have been eliminated from further consideration.

For Nantucket, it was determined that groundwater discharge would be the most feasible means of effluent discharge. The requirements for groundwater discharges can be found in 314 CMR 5.00. According to these regulations, the minimum effluent limitations for a Nantucket treatment facility are shown in Table 5C-2.

TABLE 5C-2
TOWN OF NANTUCKET
CWMP / EIR
PROPOSED EFFLUENT LIMITATIONS

Parameter	Open Beds Proposed Limits (1)	Subsurface/Spray Irrigation Proposed Limits (2)
Biochemical Oxygen Demand (BOD_5)	30 mg/L	10 mg/L
Total Suspended solids (TSS)	30 mg/L	10 mg/L
Total Nitrogen	10 mg/L	<10 mg/L
Fecal Coliform	200 mpn/100 ml	200 mpn/100 ml
Oil and Grease	15 mg/L	15 mg/L

(1) 314 CMR 5.00
(2) Proposed limits for subsurface disposal to prevent plugging of disposal area and to eliminate the need for a reserve area.
Note: mg/L = milligrams per liter; mpn/100 ml = most probable number per 100 milliliters

Beneficial reuse of wastewater typically is associated with the application and reuse of water for irrigation. In this context reuse also applies to discharging treated wastewater into the ground to recharge the aquifer used for supplying drinking water. The technology exists, through the use of micro-filtration and membrane technologies, if necessary, to produce very clean effluent to meet most reuse needs.

Reuse of the wastewater effluent as seasonal irrigation at golf courses could reduce water use at the course as well as minimize the summer loadings to adjacent waterbodies during the critical spring-to-fall growing season. This irrigation reuse is considered a secondary disposal option since a permanent effluent disposal solution will still be required in the off months when the golf courses are not operating.

DEP's opinion is that a properly planned and sited discharge that has received a high level of treatment can be sited in a Zone II and still protect the environment and public health, although DEP strongly recommends that discharges of highly treated wastewater to the groundwater outside of a Zone II be considered first.

Based on the Interim Guidance on Reclaimed Water Use issued by DEP (Draft, September 1, 1998), new discharges from wastewater treatment plants within aquifer recharge areas (Zone IIs) must meet the discharge and treatment standards as shown in Table 5C-3. These standards apply to the reclaimed water at the point of discharge from the treatment facility, unless otherwise noted. Siting a wastewater disposal site within a Zone II is normally a prohibited use unless all other feasible alternatives have been explored.

TABLE 5C-3
TOWN OF NANTUCKET
CWMP / EIR
CLASS 1 GROUNDWATER PERMIT STANDARDS

Parameter	Standard
pH	6 to 9
BOD	≤ 10 mg/L or ≤ 30 mg/L
Turbidity	≤ 2 NTU or ≤ 5 NTU
Fecal Coliform	median of 0 colonies/100 ml over continuous, running 7 day sampling periods, not to exceed 14/100 ml or 200 colonies/100 ml
TSS	5 mg/L or 10 mg/L
Total Nitrogen	< 10 mg/L

The EPA New England Region has expressed concerns regarding the groundwater discharge of wastewater within the Zone II. The concerns expressed by the EPA include the reliability of the treatment facilities and adequacy of the water supply monitoring programs for detecting potential health risks associated with contaminants in the wastewater. Based on these concerns, EPA is not recommending discharge within a Zone II as a preferred option.

- **Required Land Areas**

  The land area required for each alternative is the sum of the area required for the actual treatment facility and the area required for effluent disposal. The land area required for the actual facility is dependent upon the size of the treatment plant as well as the treatment technology chosen. This is a highly variable parameter, thus it will be discussed in general in the following subsection (Treatment Technologies and Evaluation Criteria) as it relates to the specific technologies, which will be defined more precisely in the screening process and subsequent detailed analyses of the prospective alternatives.

Land areas required for effluent disposal are dependent upon the soil characteristics of the site and the method of disposal. Effluent disposal can be achieved through surface or subsurface application. Tables 5C-4 and 5C-5 include approximate land area requirements for surface and subsurface disposal assuming a percolation rate of 5 to 10 minutes per inch and an application rate of 4 and 2.5 gallons per day/square feet, respectively.

These areas will have to be tailored to the specific facility and site once screening is complete and soil characteristics have been determined.

TABLE 5C-4
TOWN OF NANTUCKET
CWMP / EIR
AREAS REQUIRED FOR SURFACE APPLICATION
OF TREATED EFFLUENT

Surface Application (Open Sand Beds) Application Rate: 4 gpd/ft^2 (1)						
Average Daily Flow	**Leaching Area**		**Reserve Area**		**Total Area**	
Gpd	**ft^2**	**Acres**	**ft^2**	**Acres**	**ft^2**	**Acres**
200,000	50,000	1.15	50,000	1.15	100,000	2.30
400,000	100,000	2.30	100,000	2.30	200,000	4.59
600,000	150,000	3.44	150,000	3.44	300,000	6.89
800,000	200,000	4.59	200,000	4.59	400,000	9.18
1,000,000	250,000	5.74	250,000	5.74	500,000	11.48

(1) Based on recommendations in the "Guidelines for the Design, Construction, Operation, and Maintenance of Small Sewage Treatment Facilities with Land Disposal."

TABLE 5C-5
TOWN OF NANTUCKET
CWMP / EIR
AREAS REQUIRED FOR SUBSURFACE APPLICATION
OF TREATED EFFLUENT

Surface Application (Open Sand Beds) Application Rate: 2.5 gpd/ft^2(1)						
Average Daily Flow	Leaching Area		Reserve Area		Total Area	
Gpd	ft^2	Acres	ft^2	Acres	ft^2	Acres
200,000	44,600	1.02	133,200	3.06	177,800	4.08
400,000	89,000	2.04	266,400	6.12	355,400	8.16
600,000	133,400	3.06	399,600	9.17	533,000	12.23
800,000	177,800	4.08	532,800	12.23	710,600	16.31
1,000,000	222,400	5.11	666,600	15.30	889,000	20.41

(1) Based on recommendations in the "Guidelines for the Design, Construction, Operation, and Maintenance of Small Sewage Treatment Facilities with Land Disposal".
(2) According to the "Guidelines," the area between the leaching facilities can be used as the reserve area.

Treatment Technologies

In this section, a total of 14 treatment technologies will be described. These treatment technologies to be discussed can be broken down into four broad categories as follows:

Suspended Growth Biological Processes

Conventional Activated Sludge/Extended Aeration
Pure Oxygen Activated Sludge
Sequencing Batch Reactors
Oxidation Ditch
A/O Systems

Fixed Film Biological Processes

Trickling Filters
Rotating Biological Contactors
Activated Biofilters

Physical/Chemical Processes

Chemical Coagulation
Granular Activated Carbon
Zimpro PACT

Natural Systems Processes

Aquaculture
Constructed Wetlands
Solar Aquatics™

The 14 wastewater treatment alternatives listed above are described in the following paragraphs:

- **Suspended Growth Biological Treatment**

  Suspended growth treatment is a biological process that consists of microorganisms in suspension feeding on organic pollutants in the wastewater. This process is accomplished aerobically and therefore outside air is added. The added air serves two purposes in that it provides microorganisms with their needed supply of oxygen and also maintains the suspension of biomass. Within the suspended growth biological processes category, a total of five alternatives will be considered. These treatment alternatives do not need to be proceeded by primary treatment units in order to meet the proposed BOD_5 and TSS effluent requirements. Suspended growth processes are capable of producing an effluent that meets 10 mg/L BOD_5, 10 mg/L TSS, 19 mg/L NO_3 and 1 mg/L NH_3.

Conventional Activated Sludge/Extended Aeration

In the Conventional Activated Sludge (CAS) process, treatment is accomplished by microorganisms in suspension. The process usually consists of a rectangular shaped aeration tank and a final clarifier that separates out the biomass for either wasting or recycling. Since in colder climates, an older sludge age is required to achieve the required BOD_5 effluent levels, extended aeration, which is a variation of the activated sludge process, is commonly used. With extended aeration, aeration time is up to 4 times longer than with the typical CAS system. Using longer aeration times allows the facility to operate over a wider range of flows and loads. However, such systems are usually limited to relatively low organic loads and therefore are generally applicable to flows less than 1 MGD. Sludge generated in the process is recycled and aerobically digested; therefore, very little sludge is wasted compared to the typical CAS system. The extended aeration system achieves better than secondary levels of treatment and can generally reduce BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L. Some biological nitrogen removal occurs as a consequence of periodic high waste load-low oxygen and low wasteload-high oxygen cycles creating a suitable environment for the appropriate bacteria. However, it is not anticipated that the levels of total nitrogen removal required will be achieved without modification of the normal extended aeration process or without additional treatment processes.

Although CAS/Extended Aeration Systems have been used successfully in this country for over 70 years and it has been proven to be a flexible and reliable process which produces year-round secondary treatment quality effluent, it has been known to require relatively complex process monitoring and control, and the process is subject to shock loadings and solids washout during flow surges. Another drawback of the process is that it produces a sludge that is difficult to thicken and dewater.

Perhaps a more serious drawback to the use of this treatment technology is that without added treatment units, the process cannot reliably reduce nitrogen to required levels. This is an issue when considering groundwater discharge. Climate is also an issue because extended aeration cycles in cold weather hinder treatment performance. The use of extended aeration may also have regulatory and legal implications because of its inability to meet required effluent limitations.

Construction and operation costs for CAS/Extended Aeration are usually not especially high, although operation costs are higher than other treatment processes because of the relatively complex operational requirements. Electric power usage of Extended Aeration facilities tend to be high as a result of long aeration times and therefore these facilities generally have higher operation costs.

Pure Oxygen Activated Sludge

Pure Oxygen Activated Sludge is a variation of CAS in which pure oxygen is added to the aeration tank rather than air. Pure oxygen systems are used when it is an advantage to keep aeration tank volumes and sizes small. Pure oxygen activated sludge tanks are smaller (about one third (1/3) the volume) than CAS tanks because more oxygen is available and therefore less time and volume are needed to degrade organic pollutants. Due to the smaller footprint size, this process is commonly used for treatment facilities with severe site constraints. Like CAS/extended aeration systems, pure oxygen systems achieve better than secondary levels of treatment and can generally reduce BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L. The pure oxygen process is not capable, however, of reducing total nitrogen to required levels without additional treatment processes.

Pure Oxygen Activated Sludge has many of the same benefits and drawbacks as the CAS Process. The capital costs are about the same: the savings due to the smaller tankage are comparable to the additional costs of the sophisticated oxygen generation equipment. Additional drawbacks of Pure Oxygen Activated Sludge are that it tends to cost more to operate than CAS due to the oxygen required. The principle consideration, here and with CAS/extended aeration, is the inability of the process to reliably reduce nutrients to required levels.

Sequencing Batch Reactors

Sequencing Batch Reactors (SBR's) are a variation of activated sludge biological treatment. In the SBR process, the mixing, aeration and settling takes place in one basin, not in separate basins typical of CAS processes. SBR's operate on a fill-and-draw principle in which wastewater flows into a basin and is mixed and aerated using mechanical and/or diffused aeration. When a basin is full, flow is diverted to a parallel basin while mixing and aeration continues in the full basin. After a period of time, mixing and aeration is stopped and the tank contents are allowed to settle. Excess sludge is removed from the bottom of the tank while the treated effluent is decanted from the top. The SBR process achieves better than secondary levels of treatment and can generally reduce BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L. An added advantage of the SBR process is that nitrogen can be reduced to required levels without additional equipment and tankage. If the SBR is run with an anoxic cycle, it can reduce total nitrogen to 10 mg/L. If phosphorus removal is required, the SBR process can be run with both an anaerobic cycle and anoxic cycle reducing the phosphorous levels to about 1.5 mg/L.

The Sequencing Batch Reactor is used in relatively low flow, space-limited applications. A particular advantage of the SBR is that it can handle shock and variable flow and load. Another advantage of the SBR is that no secondary clarifiers are required.

There may be some community acceptance issues as a result of the relatively large tankage involved with the SBR process. The SBR combines the settling and aeration steps into one tank that limits the size of the footprint of the facility. SBR's can be built above-ground with exposed tank walls or can be constructed at grade level depending on the terrain of the site. The above-ground tankage is a possible aesthetic concern. Enclosing the above-ground tankage in a building is an option; however, it would drive the cost of the SBR alternative up.

Oxidation Ditch

The oxidation ditch is a variation of the extended aeration process in which oxygen is imparted to the wastewater through mechanical surface aerators. In the other types of suspended growth systems described so far, the oxygen is usually provided by diffused aeration. The oxidation ditch is characterized by its distinctive "race track", oval shape. Like extended aeration, the oxidation ditch achieves better than secondary levels of treatment and can generally reduce BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L. The oxidation ditch is not capable, however, of reducing total nitrogen to required levels without additional treatment processes.

An oxidation ditch is a special type of extended aeration process, and as a result, its utilization will raise many of the criteria issues raised with CAS/extended aeration. The only notable difference is the configuration used and community acceptance issues that might surface as a result. The "race track" type configuration employed takes up more space than typical extended aeration layouts. The larger space required would cost more to purchase land and to build, and the layout does not lend itself well to a building enclosure. Residents in the area may find a large, unenclosed "race track" shape in their area unsightly.

Anaerobic/Anoxic/Oxic Systems

For the purposes of this report, Anaerobic/Anoxic/Oxic Systems are defined as those processes that utilize a combination of anaerobic, anoxic and oxic (aerobic) stages to reduce nitrogen and phosphorus. The removal of nitrogen occurs in a two step process. The first step is done aerobically and involves the biological oxidation of ammonia-nitrogen to nitrate-nitrogen. The second step is done in an anoxic basin and reduces nitrate-nitrogen to nitrogen gas. The first step is known as nitrification and the second step is known as denitrification.

Systems designed to remove nitrogen, A/O Systems, generally consist of an anoxic stage followed by an aerobic stage, and a final clarifier that recycles settled sludge to the anoxic zone. Nitrification occurs in the aerobic zone and denitrification occurs in the anoxic zone. The anoxic zone is strategically placed ahead of the aerobic zone in order to take advantage of influent organics that aid in denitrification. The A/O System can generally reduce BOD_5, TSS and Total Nitrogen to 10 mg/L.

A variation of this process is the A^2O^2 process that consists of four sequential stages: an anoxic stage, aerobic stage, anoxic stage, and aerobic stage. This A^2O^2 process can reduce BOD_5 and TSS to 10 mg/L, and Total Nitrogen to about 4 mg/L.

Systems designed to remove phosphorus and nitrogen, A^2O Systems, utilize anaerobic, anoxic and aerobic stages. Most biological wastewater treatment processes can reduce phosphorus by 10 to 20 percent. Phosphorus is reduced in wastewater treatment because it is an essential nutrient for biological cell growth. Placing the anaerobic stage first followed by anoxic and aerobic stages can enhance the amount of phosphorus removal. Placement of the anaerobic stage first and following it with an aerobic stage causes a type of bacteria to predominate, which takes up, more than the standard amount of phosphorus. These bacteria accomplish the needed phosphorus reduction. Nitrogen is removed in the anoxic-aerobic stages, as discussed in the previous paragraphs. Typically A^2/O systems can remove phosphorus to levels below 3 mg/L and nitrogen to levels below 10 mg/L. Phosphorous removal, however, is typically not required for groundwater disposal unless the location for the groundwater discharge is in close proximity to a sensitive surface waterbody.

The levels of treatment obtained by all three of the Anaerobic/Anoxic/Oxic systems discussed above are consistent with effluent limitations required for this study.

Many of the treatment technologies discussed in the previous paragraphs were not able to meet proposed nutrient effluent discharge requirements. An A/O system, with one of the above technologies as the aerobic component, will result in proposed effluent requirements being met. The following treatment technologies could serve as a component of the A/O system: extended aeration, pure oxygen activated sludge, and oxidation ditch. Sequencing batch reactors were not considered because they have the ability to meet nitrogen requirements without the addition of an A/O system.

Of the treatment technologies available, extended aeration offers the most benefits when used in conjunction with an A/O process. Pure oxygen activated sludge tends to be more expensive than extended aeration due to the cost of purchasing and generating the oxygen. The oxidation ditch tends to take up more space, would be more costly to build and would be faced with community acceptance issues as well.

- **Fixed Film Biological Processes**

  Fixed Film Biological Processes are like suspended growth biological processes in that they rely on microorganisms to accomplish reduction of organic pollutants. The difference between the two is the medium in which the microorganisms thrive. With suspended growth systems, the biological population is kept in suspension in a tank. With fixed film processes, microorganisms grow on a surface and wastewater is applied to the surface or the surface is applied to the wastewater. These treatment alternatives need to be preceded by primary clarifiers in order to meet the required BOD_5 and TSS effluent requirements. Depending on the fixed film biological process implemented, secondary treatment levels or better can be achieved. A total of three fixed film biological processes will be considered.

Trickling Filters

With Trickling Filters, organic pollutant removal is accomplished by passing wastewater over a collection of loosely packed media. Microorganisms grow on the surface of the media and feed on the organic matter in the wastewater. With time, the biological growth falls off the media and flows out of the trickling filter tank with the treated wastewater. Air, needed by the microorganisms to degrade organics, is entrained in the wastewater as it falls though the media. The typical process also employs a secondary clarifier to separate biological matter from treated wastewater. Trickling filters can accomplish secondary levels of treatment and can generally reduce BOD_5 and TSS to 30 mg/L. Trickling Filters are not capable of consistently achieving BOD_5 and TSS levels of 10 mg/L in colder climates. In warmer climates a two stage Trickling Filter can generally reduce BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L. Nitrification (i.e., oxidation to convert ammonia into nitrate) is also possible, but total nitrogen removal is not feasible using trickling filters.

Trickling Filters can not remove nitrogen to required levels. The nature of the Trickling Filter is such that it must be covered to perform properly. As such, it will not be able to operate in Nantucket's climate without this protection. Another option is to enclose the Trickling Filter in a building, however this is not recommended due to the ventilation requirements of the filters. Covering of the treatment process is assumed to be necessary for community acceptance, however it will add to the construction cost of the facility.

Rotating Biological Contactors

Similar to Trickling Filters, Rotating Biological Contactors (RBC's) involve growing bacteria on media. However, RBC's utilize large moving disks that rotate through the wastewater rather than stationary media, which has wastewater, passed over it. The rotating disk causes the microorganisms to be exposed to cycles of air and wastewater (organics). The rotating action also causes shear forces to slough off the bacterial growths. A final clarifier captures the sloughed-off biological material. The principles involved are essentially the same for RBC's and Trickling Filters. The advantage of RBC's is that they tend to be more reliable and less susceptible to shock loading. Aerobic RBCs can generally reduce BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L. A two stage RBC with both an anoxic and oxic stage combined with the addition of methanol can economically reduce BOD_5, TSS and Total Nitrogen to 10 mg/L. With the use of RBCs, sludge thickening is not required.

Wastewater treatment using rotating biological contactor technology is a compact, relatively simple and reliable process that can easily be designed to remove nitrogen. The nature of the RBC is such that it must be covered to perform properly. Covering of the treatment process is also necessary for community acceptance. Another option is to enclose the RBC in a building, however this is not recommended due to access issues for operation and maintenance and the high cost to provide proper lighting and ventilation.

Activated Biofilters

An Activated Biofilter (ABF) is a dual biological process that employs both suspended growth and fixed film processes. In its typical arrangement, a fixed film process (such as a trickling filter) is placed in series with a suspended growth process (such as conventional activated sludge). The media used in the ABF process is commonly redwood boards because the return activated sludge is mixed with the influent flow upstream of the trickling filter. The two systems are usually combined in the Activated Biofilter arrangement in order to take advantage of the strengths of each process. They are resistance to shock loads and ease of maintenance for trickling filters and the flexibility and high-quality effluents of conventional activated sludge. This type of system is capable of nitrification, however removal of total nitrogen is not feasible with this process. The ABF is capable of reducing BOD_5 and TSS to 10 mg/L, NO_3 to 19 mg/L and NH_3 to 1 mg/L.

The Activated Biofilter is a treatment technology, which utilizes both, suspended growth and fixed film systems. These types of systems can not remove nitrogen to required levels. While also taking advantage of the best features of suspended growth and fixed film systems, Activated Biofilters also suffer similar criteria problems for each type of system as described in the previous sections.

- **Physical/Chemical Processes**

  Physical/Chemical Processes are those processes that involve removal of pollutants solely through the use of gravity settling and chemical addition and/or the addition of particles that attract pollutants to surfaces. Biological activity is not intended to be the principal pollutant-reduction mechanism in physical/chemical treatment. The following three physical/ chemical alternatives will be discussed:

Chemical Coagulation

In general, particles in wastewater do not have an affinity for one another and do not have a great tendency to agglomerate. Chemical coagulation involves the addition of chemicals to increase particle affinity and therefore the tendency for agglomeration. The overall process is usually accomplished in three steps: coagulation, flocculation and sedimentation. In the coagulation step, chemicals such as aluminum sulfate or iron salts are added to the wastewater and mixed rapidly to destabilize solids. In the next step, flocculation, the destabilized solids are mixed slowly to encourage agglomeration. In the last step, the destabilized, agglomerated particles are settled out in a sedimentation tank. Chemical coagulation can remove BOD_5, TSS, insoluble organic nitrogen and phosphorus, but is not effective in removing total nitrogen to the required levels.

Chemical coagulation is not well suited to surges in flow and load, as chemical dosages would constantly require adjustment to match influent conditions. Complicated process control, large tankage and flow equalization would be required.

Chemical coagulation can remove BOD_5, TSS and phosphorus, but is not effective in removing total nitrogen to the required levels. As such, treated effluent will not be suitable for groundwater discharge that would raise regulatory and legal issues. Other issues include the cost of the chemicals, and the large quantity of chemical sludges produced.

Granular Activated Carbon

Treatment using granular activated carbon relies on the principle of adsorption. Adsorption is a physical/chemical process by which materials accumulate on surfaces. Since adsorption is a surface-active phenomenon, the larger the surface the greater the tendency for adsorption to occur. Activated carbon is a popular substance for adsorption because of its large surface area.

Granular activated carbon is typically not used in wastewater treatment because of the size and amount of solids in the waste stream. It would not be effective in removing nitrogen and phosphorus. It is better suited for removal of small particles and residual organics.

The Granular Activated Carbon process would not be very effective without significant process addition and modification. The drawbacks to the use of this process as a treatment technology are identical to chemical coagulation. In addition there are additional operation and maintenance cost issues due to the need to regenerate the carbon.

Zimpro PACT

Zimpro PACT is a patented process in which powdered activated carbon (PAC) is added to the aeration tank of the conventional activated sludge process. DuPont developed the process in the early 1970's, but Zimpro/Passavant currently holds the patent. Once in the aeration tank, the bacteria and the PAC work together to reduce organic material. The bacteria degrade most of the organics and the PAC handles the remaining portion. In the conventional arrangement, sludge and PAC are settled out in a clarifier and then returned to the aeration tank or wasted. When the PAC becomes spent, it must be replaced or regenerated. Wastewater treatment facilities employing the PACT process can achieve effluent BOD_5 and TSS of 10 mg/L, but have not achieved effluent total nitrogen and phosphorous concentrations to low levels that may be required for a facility in Nantucket.

As with Granular Activated Carbon, Zimpro PACT is usually used for the removal of small particles and residual organic matter. Zimpro PACT would not be very effective without significant process addition and modification and the drawbacks to its use as a treatment technology are identical to chemical coagulation. Zimpro PACT is commonly used for industrial discharge; however, it is generally more cost effective for industries to use some form of pretreatment rather than the PACT process. The PACT process also creates more sludge and operating costs due to the addition of PAC than the previously mentioned technologies.

- **Natural Systems Processes**

  Natural Systems Processes involve utilization of naturally occurring plants and animals for wastewater treatment. These types of systems consist of some tankage, but mostly consist of large basins, ponds and wetlands. A total of three Natural Systems Processes will be discussed.

Aquaculture

The Aquaculture process for treating wastewater generally consists of a series of greenhouses and wetlands. Influent first passes through the headworks, where grit and large objects are removed. From there, wastewater flows to a greenhouse, which houses a series of solar tanks and solar ponds. Here, aquatic and non-aquatic plants, bacteria and aquatic animals provide treatment. Next, wastewater flows to clarifiers, sand filters and constructed wetlands. The clarifiers separate biological solids from the water and the sand filters remove residual solids prior to reaching the constructed wetland. The purpose of the constructed wetland is to accomplish the last phase of nitrogen removal. Aquaculture treatment systems are capable of reducing BOD_5 and TSS to secondary treatment standards (30 mg/L). Nitrogen and phosphorus removals are also reported to be feasible.

Constructed Treatment Wetlands

Constructed treatment wetlands are essentially man-made systems designed to provide biological and chemical conditions that mimic natural wetlands systems. However, unlike a traditional treatment facilities, these treatment wetland systems offer many additional advantages, including longer service life, low O&M costs, and a variety of aesthetic values.

Treatment wetlands are comprised of rooted vascular plants within shallow flooded or saturated soils that provide conditions effective for wastewater treatment. The two types of treatment systems include surface-flow wetland systems (SF) and subsurface-flow wetland systems (SSF). The SF wetland systems consist of an excavated lined basin containing a shallow substrate that supports emergent wetland vegetation. Treatment in the SF wetland occurs primarily in the rhizomes of the plant material. The SSF wetland systems use a bed of soil or gravel media for the growth of plants. Wastewater in the SSF wetland systems flows by gravity horizontally through the media were most of the treatment occurs from interaction with aquatic microorganisms. Typical plants used in these treatment wetland systems include common reed (Phragmites communis), cattail (Typha spp.) and bulrushes (Scirpus spp.).

Wetlands have been incorporated into wastewater treatment systems for more than 25 years and have become a popular waste treatment alternative for communities in both the U.S. and Europe. Recent estimates have identified approximately 1,000 constructed wetlands are currently operating, ranging from treatment for single-family homes to large-scale municipal systems. Cities and towns such as Marion, MA, Minoa, NY, Iselin, PA; Arcata, CA; Orlando, FL; PA; Monterey, VA and Columbia, MO have combined conventional treatment technologies with treatment wetland systems to achieve discharge requirements.

The EPA issued a design manual (1988) formally recognizing constructed wetland technology, and site-specific guidelines for their design have been developed in many states. This Design Manual, "Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment Disposal" is currently being updated by EPA to address the advances in technology and understanding of these systems.

The effectiveness of these treatment wetland systems is based largely on the level of pre-treatment, conservative estimates of constituent and hydraulic loading rates, monitoring and operational strategies. Design parameters for the size of these systems vary according to the treatment goals, estimated wastewater volumes, effluent characteristics and hydraulic loading. General sizing for approximately 1 MGD with a basin depth of 3 feet and a detention time of 6 days would require approximately 6 acres.

Relatively elevated concentrations of trace metals can be found naturally occurring in the streams and waterbodies in Nantucket. These metal concentrations (i.e.: copper and lead) are found in groundwater within the aquifer. Treatment wetlands can be effective at reducing metal concentrations. Reduction of metals within the treatment wetlands can be accomplished through immobilization in the surface soils or assimilation by plants and animals. The reduction of metals is largely correlated to the inflow concentrations and detention times. Specific performance data on the removal of trace metals from treatment wetlands is limited.

Treatment wetlands systems are generally designed for the reduction of levels of conventional pollutants including, nitrates, fecal coliform, Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS). The treatment wetland systems should be viewed as a component in optimizing the overall wastewater treatment process rather than a means to reduce trace metals. The use of these wetland systems for this purpose is considered speculative. The applicability of using treatment wetlands for wastewater disposal in Nantucket is viewed as a final component in the treatment process prior to a direct discharge to surface water or groundwater infiltration system. The option of discharging treated wastewater to surface waters/wetlands is not feasible in Nantucket due to the lack of dilution potential offered by the low flow streams. However, the implementation of a treatment wetland system could function as a buffer by providing a "polishing" component in the treatment process.

In summary, the treatment wetland system could be used as part of a surface water discharge in functioning to minimize the potential impacts to natural wetland systems. Properly constructed treatment wetlands could control the quality and quantity of the discharge, reduce channelized flow and assimilate nutrient levels. The implementation of treatment wetland system as a component of the wastewater plan would require site-specific characterization of the receiving waters and development of discharge parameters.

Solar Aquatics™

The Solar Aquatics™ treatment process, a proprietary design, is characterized as a natural system by its developer. It utilizes elements of natural wetland systems, such as plants, subsurface wetland media and sand filtration with more conventional treatment elements such as diffused aeration and settling tanks. The Solar Aquatics™ process is housed in a greenhouse structure, which provides light for photosynthesis of its plant life, the ability to grow plants year-round, as well as provide an attractive appearance. Several Solar Aquatics™ facilities are currently operating in the region. Solar Aquatic™ systems are capable of reducing BOD_5 and TSS to secondary treatment standards (30 mg/L). Designs are available which are reported to reduce BOD_5, TSS and Total Nitrogen to 10 mg/L. Phosphorus removals are also reported to be feasible.

Existing Surfside and Siasconset Wastewater Treatment Facilities

- **General**

  Earth Tech provided wastewater master planning services, including facilities planning and EIR completion, for the Town of Nantucket. These services included the planning, design and construction of the Surfside Wastewater Treatment Facility and the Siasconset Wastewater Treatment Facility. The Surfside Wastewater Treatment Facility was completed in 1991. Severe storms caused significant erosion that postponed construction of the coastal Siasconset Wastewater Treatment Facility. Shortly thereafter, Earth Tech evaluated short-term measures to be utilized as interim solutions for the Siasconset wastewater disposal issue. The final result was only minor modifications being made to the existing infiltration basins in 1991.

- **Surfside Wastewater Treatment Facility**

  The Surfside Wastewater Treatment Facility treats flow from the center of Nantucket and has a design capacity of 2.24 MGD (the DEP-permitted flow is 1.8 MGD). The Surfside Wastewater Treatment Facility consists of a septage receiving tank, aerated grit chamber, three primary clarifiers that utilize ferric chloride and polymer for enhanced treatment, ten rapid infiltration basins, three aerated sludge holding tanks, one aerated septage equalization tank, and process support systems. Sludge and septage are dewatered with belt filter presses and can be mixed with wood chips in a portable mixer using aerated static pile method to produce a product that meets DEP Standards for a Type I sludge or composted with municipal solid waste.

  A key element of the facility's design is the odor control system, which treats odorous air from the sludge dewatering area, grit dewatering area, sludge storage, septage equalization, and the compost operation. The 4-stage odor control system utilizes a water cooling chamber for the compost pile off gases, an acid wash chamber for ammonia odors, a sodium hypochlorite and sodium hydroxide scrubber for hydrogen sulfide, and an activated carbon chamber for volatile organics. The process also includes chemical addition to the sludge and septage holding tanks and to the sludge suction of the belt filter press feed pumps as a back up to the air scrubbing system.

In addition, the Surfside Wastewater Treatment Facility is designed to receive an average of 11,200 gallons per day of septage. The septage can be processed using several methods: (1) Pumping to the Headworks; (2) Pumping to the Cyclone Grit Classifier; or (3) Pumping to the Aerated Sludge Holding Tanks for Belt Press Dewatering.

- **Siasconset Wastewater Treatment Facility**

  As noted above severe storms caused significant erosion that postponed construction of the coastal Siasconset Wastewater Treatment Facility and only minor modifications being made to the existing infiltration basins in 1991. Several years after the minor modifications, Earth Tech was engaged by the Town of Nantucket to evaluate the alternatives for providing wastewater treatment and disposal for the Siasconset area of the Island.

  As part of the Plan, a Needs Analysis was conducted to investigate existing conditions and to project future needs. Evaluations of topography, watersheds, natural resources, surficial geology, soils, existing land use and populations trends (sewered versus non-sewered, seasonal versus year round), water supply systems and wastewater conveyance and treatment systems were conducted and future wastewater flows were projected. It was concluded that in the year 2022, a projected peak seasonal population of 3,500 individuals would require a facility with a design average flow of about 220,000 gpd. It was also projected that the facility would meet effluent limit concentrations of 10 mg/l for BOD_5, TSS, and Total Nitrogen.

Feasible options for regional wastewater treatment and disposal at the existing Surfside Wastewater Treatment Facility were also evaluated. These options included the investigation of force main routes, pumping station requirements, environmental issues, and an analysis of existing versus projected wastewater flows at the Surfside Wastewater Treatment Facility. One of the major elements evaluated in the Facilities Plan was the alternative of treatment and disposal of wastewater within the Siasconset Planning area versus the transport of wastewater to the Surfside Wastewater Treatment Facility for treatment and disposal. Significant issues included site availability within the planning area, environmental impacts, and costs. The EIR addressed specific environmental issues, including rare and endangered species, and coastal erosion. The EIR also included detailed cost analyses of the treatment facility and sewering options.

On-site treatment and disposal was selected as the solution for the Siasconset. Sequencing Batch Reactors (SBR) were selected as the secondary treatment process for the facility. Multiple basins will be installed to allow the Operator flexibility in the number of basins to be operated during each particular season. It is anticipated that two or three larger volume basins will be operated during summer months and one or two smaller volume basins operated during winter months. The process has been designed not only to treat the projected future summer flows and loadings, but also to adequately treat the initial winter low flow and loadings.

The entire project includes construction of an influent pumping station, wastewater treatment facility and infiltration basins. The influent pumping station is located near the basins and will pump all of the wastewater to the new wastewater treatment facility. The raw wastewater will pass through a channel grinder prior to entering the pump station. Wastewater will then flow through the following processes: influent metering structure, primary clarifiers, SBRs, post equalization, effluent filters, UV disinfection system and an effluent metering structure. All treated wastewater is then discharged to the infiltration basins.

The design includes a totally covered process in order to maximize odor control at the facility. A biofilter system for treatment of the odorous air stream was chosen due to the fact that it has a low profile (below grade organic bed) and does not require any chemicals for operation.

The system has been designed to provide complete treatment without the use of chemicals. This was a requirement of the Town because of the fact that the facility is located on an island and will not be fully manned. The Siasconset Wastewater Treatment Facility will be operated as a satellite facility to the existing Surfside Wastewater Treatment Facility. A supplemental alkalinity (sodium bicarbonate) chemical feed system has been included as a safety measure for the secondary treatment process, but it is not anticipated that this system will be needed for normal operation of the process.

Potential Reuse Opportunities

As discussed previously in this section, typically treated effluent is discharged either to a surface water body or to the ground with percolation through the soil to the groundwater. A third option, discussed in this section, is to reuse the wastewater for non-potable needs. Some communities, throughout the United State, have adopted policies on wastewater reuse in an effort to conserve valuable water resources and provide a means for the disposal of treated effluent.

A properly developed wastewater reclamation program can provide valuable benefits to both the municipality and the water/wastewater system users. Fee structures can be developed whereby consumers pay a flat fee or no fee at all for unlimited use of reclaimed wastewater for lawn irrigation and other non-potable uses. If such a structure includes fees based on usage for potable water, consumers can realize an economic benefit by using reclaimed wastewater for irrigation purposes rather than potable water. Such a pricing scheme would also encourage water conservation.

The agricultural, industrial, and commercial consumers can realize similar economic benefits. With proper treatment, reclaimed wastewater demonstrates few health risks, while providing the community with a solution to their wastewater disposal problem.

The Water Environment Federation explored water reuse issues at their Annual Conference and Exposition in October 1998. Specifically, water reuse innovations and alternatives were presented as they applied to numerous Florida communities. Such technologies include water reuse for landscaping, agricultural uses, and fire protection. Following is a discussion of these alternatives, and commercial/industrial water reuse applications as they may be applied to the Town of Nantucket.

- **Landscaping**
  Reclaimed wastewater has been successfully used as irrigation water for residential, commercial, and industrial applications. Reclaimed water has several advantages over the use of potable water for irrigation. In St. Petersburg, Florida, it was shown that the application of 1½ inches of reclaimed water per week provided approximately 50 percent of the nitrogen, phosphorus, and potassium requirements for horticultural and agricultural purposes. This resulted in reduced fertilizing costs to the consumer. A study completed by St. Petersburg indicated that when chloride levels in the reclaimed wastewater were kept below 400 mg/L, plants being irrigated with reclaimed water showed significantly more growth than those plants irrigated with water from the city's potable water system.

- **Agricultural Uses**
  The City of Orlando, Florida has achieved success in wastewater reuse through the implementation of Water Conserv II, a comprehensive program whereby water is reused in agricultural irrigation systems and aquifer recharge. In areas with a significant agricultural industry, wastewater reuse can substantially reduce the amount of wastewater to be disposed of by traditional surface or subsurface application procedures. Depending on demand, reclaimed wastewater can be given

to agricultural consumers free of charge or for a nominal fee, thereby providing an incentive to farmers by decreasing costs and providing an alternative for wastewater disposal. Benefits from the nutrient enriched reclaimed wastewater are similar to those cited for wastewater reuse for landscaping purposes.

- **Fire Protection**

  The use of reclaimed wastewater for fire protection involves unique construction, permitting, and regulatory limitations. For such a system to be developed, the Town of Nantucket would have to work closely with local, state, and federal environmental and regulatory groups to develop a policy for the design of a facility utilizing reclaimed wastewater in its fire protection system. Initial design considerations would include delineating the potential uses of the facility for which the fire protection system is being designed (food preparation, retail outlet, industrial, etc.), examining construction constraints, and addressing regulatory concerns (for example, would building occupants be required to sign an agreement prohibiting them from salvaging certain items in the event of a fire). Development of this alternative could require substantial investment of time and resources, as this technology is relatively new.

- **Commercial/Industrial Uses**

  Commercial/Industrial consumers can use reclaimed wastewater for process water and other non-potable applications within their facilities, and for irrigation outside their facilities as described above. Commercial/Industrial consumers could also prove instrumental in the implementation of reclaimed wastewater in fire protection systems. The specific nature of any given industrial application would require that the industrial water reuse program be tailored to meet the specific needs of each facility.

Health concerns of the public will need to be addressed to promote acceptance of a reclaimed wastewater system. St. Petersburg, Florida, has had no reported cases of illness or disease resulting from the use of reclaimed water since the inception of their reuse program in the 1970s. This fact is significant in that homeowners have control over their use of reclaimed water, and many of the residents of St. Petersburg are elderly and thus more susceptible to disease. The specific health risks associated with the wastewater produced in the Town of Nantucket would have to be studied and addressed as part of the development of a wastewater reclamation program.

The drawbacks of reclaimed water use can be mitigated through careful planning. If demand is anticipated to exceed supply, the Town may consider installing metering devices and developing a rate structure so that usage can be monitored and controlled. The Town would need to develop the rate structure in conjunction with the potable water rate structure to ensure that incentives are still present to encourage consumers to use reclaimed wastewater for their non-potable water needs. Should the supply of reusable water exceed the demand, the Town would have to implement other wastewater disposal alternatives to supplement reuse activities. Consumers would have to be educated as to the benefits and proper use of a reclaimed wastewater system. For example, use of reclaimed water is not recommended for car washing, as the high mineral content in the wastewater will leave a mineral deposit on vehicles. Such educational objectives could be included in the water conservation plan.

Finally, construction costs must be minimized. Installing a new reclaimed wastewater distribution system in an area can be quite costly due to restoration costs associated with installing the necessary piping. However, if construction is coordinated with other projects, such as the construction of a wastewater collection system, economic benefits could be realized. If such construction activities can be coordinated, it may make economic sense to install dry lines in areas of new development to accommodate the reclaimed water supply when it becomes available.

Residuals Disposal and Reuse

In this section, technologies are reviewed for possible application in meeting the Town of Nantucket's sludge management needs if a new wastewater treatment facility is constructed. A description of each technology option is presented, focusing on the process, products and/or sidestreams, relative advantages and disadvantages. Some of these, such as dewatered sludge landfilling, are considered to be "disposal" technologies because sludge, as a waste material, is being disposed. Others are often referred to as "beneficial-use" technologies because they result in a product form of sludge that can be recycled for beneficial purposes. For example, composting processes sludge into humus-like material that contains plant nutrients and is an excellent soil conditioner. Some technologies, such as incineration, have both disposal and beneficial aspects. Ash, the end product of incineration, is usually disposed in a landfill. However, heat produced during combustion can also be recovered and is sometimes used to generate electricity. Methane recovery from sludge digestion will not be considered since it would only be provided with anaerobic digestion facilities. These facilities are typically not economical for smaller wastewater treatment facilities with flows less than 5.0 MGD.

- **Incineration with Ash Landfilling**

  Incineration reduces sludge to ash and gases, decreasing the volume for disposal by approximately 95 percent. Sludge ash is a sterile, inorganic, non-odorous powdery material that is typically conditioned with water to minimize blow-away during handling and landfilling. Incineration exhaust gas contains pollutants, which must be treated with emissions control equipment prior to release to the atmosphere.

  Federal and state regulations govern both ash handling and air pollution controls. The ash must meet the standards set forth in the RCRA toxicity characteristic leaching procedure (TCLP) prior to landfilling. Exhaust gases must meet Federal New Source Performance Standards (NSPS), National Emissions Standards for Hazardous Air Pollutants (NESHAP) and the 40 CFR Part 503 regulations with respect to emissions of hazardous air pollutants, plume capacity and flue gas temperature and oxygen content.

  Advantages of incineration as a sludge management technology are that it is a well-established and proven technology; the resultant ash is sterile and odor-free and requires minimal landfill volume; large quantities can be processed and disposed of on a continuous basis; and storage and transport requirements are minimal.

Disadvantages are that: it is a relatively complex technology requiring skilled operators; capital and operating costs, including costs for emission control, are high; and two sidestreams are produced, ash and emissions, which require additional treatment and handling. Odor production is often associated with the use of this technology due to the relatively low temperature combustion practiced at many existing incinerator facilities. However, combustion at high temperatures will be required to comply with future emissions standards, which should largely eliminate odor releases.

- **Heat-Drying with Distribution and Marketing**

  Heat-drying is a beneficial-use technology which uses heat from either flue gases or steam heat exchangers to evaporate moisture from dewatered sludge and produce an organic fertilizer/soil conditioner for distribution and marketing. A sidestream of exhaust gases is also produced which must be treated by emissions control equipment before discharge to the atmosphere.

  Both the heat-dried product and the emissions resulting from the process are subject to federal and state regulations relating to land application of sludge. The Federal NSPS, the NESHAP, 40 CRF Part 503 regulations, and state regulations would regulate the release of exhaust gases from heat drying.

  The main advantage of heat drying is that it produces a beneficial, marketable product which is less bulky and potentially more valuable than compost because of its higher nutrient content. Thus, transportation to more distant markets is sometimes practical. In addition to local marketing of the product, it can be distributed through brokers to large users such as citrus growers and tree farmers. Heat-dried product can be used as a substitute for chemical fertilizers and has numerous landscaping and horticultural applications.

Disadvantages are that it is a relatively complex and expensive technology that requires skilled operators, strict emissions/odor control, and efficient storage/handling/and marketing of a product with primarily a seasonal demand. Another factor to consider is competition from heat-dried products produced outside of the Town of Nantucket (e.g. Boston, New York City and possibly some other communities that formerly relied on ocean dumping).

- **Composting with Distribution and Marketing**

  Composting is a beneficial-use technology, which accelerates the biological decomposition of dewatered sludge through aeration and the addition of volatile organic material to produce a humus-like soil conditioner for distribution and marketing. The composting process generates two sidestreams which require treatment: a liquid sidestream consisting of condensate and leachate and an exhaust air sidestream which must be treated with odor control equipment.

  Compost can be marketed to various industries and users. Compost can be used for the following:

  Greenhouse, Nursery, and Turfgrass Use: To provide a growing medium and soil amendment in a mix with other media for potting non-food chain plants, for growing and transplanting nursery stock, and for soil enhancement prior to new seeding and maintenance.

  Golf Courses and Landscaping: To provide organic matter during maintenance and fertilizing of the grasses, and as a soil amendment.

  Landfills: As an amendment to soil used for final cover material and for subsequent slope management.

  Topsoil and Land Reclamation: As a soil amendment to improve the growing ability, nutrient content, and water retention of poor, sandy, gravel type soils.

  The main advantages of composting are the relative simplicity of the technology, the fact that it produces a beneficial and marketable product from sludge waste, and that it can aid in meeting solid waste management needs by utilizing tree trimmings and other yard wastes in the sludge composting process.

Disadvantages include potential difficulties with odor control, dependence on a successful marketing and distribution program, and substantial storage/handling requirements for a bulky product with a primarily seasonal demand. Additional factors to consider include availability of suitable land for compost application and competition for a limited market.

- **Alkaline Stabilization**

  Alkaline stabilization is a beneficial-use technology which uses exothermic (heat producing) reactions resulting from mixing alkaline materials with dewatered sludge to evaporate moisture and kill pathogens and odor-causing bacteria, while fixating (chemically binding) metals to produce an organic soil conditioner/soil substitute. Alkaline-stabilized sludge can be used for agricultural, landscaping, and land reclamation purposes. Alkaline stabilized sludge is different than compost. The chief difference is that it has a much higher inert solids content due to the chemicals added during processing.

  The main advantages of alkaline stabilization are that it is a relatively simple technology and that it produces a usable material without generating sidestreams. Disadvantages are the need for a continuous supply of alkaline material, substantial storage and handling requirements, and reliance on dependable outlets for product distribution.

- **Agricultural or Non-Agricultural Land Application**

  Land application is a beneficial-use technology in which liquid or dewatered sludge is applied directly to the land to promote agricultural or non-agricultural plant growth. Land application can also be a sludge disposal technology, when sludge is applied at higher than agronomic rates to dedicated sites. Land-applied sludge is usually pretreated for pathogen reduction and stabilized by lime conditioning or aerobic or anaerobic digestion. If the sludge is applied properly, potential sidestream problems (i.e. odors, surface run-off, and leachate) can be averted.

Advantages of land application are that it is a simple technology based on beneficial-use and little capital investment is required. Disadvantages are that: large usable land areas must be available; operation is weather- and season- dependent, necessitating provisions for sludge storage; and careful application and monitoring are required to control problems with odors, surface runoff, and leachate.

- **Dewatered Sludge Landfilling (Monofilling)**

  Monofilling is the disposal of sludge by burial in a dedicated sanitary landfill. Preprocessing typically consists of dewatering and may include anaerobic digestion or chemical treatment for stabilization. Proper design and operation is required to control leachate, volatile organics emissions, and methane gas seepage. Landfilling of dewatered sludge is regulated by the RCRA toxicity characteristic leaching procedure (TCLP), 40 CFR Part 257 requirements for landfills, and by state regulations governing landfilling. Sludge rarely fails the TCLP test and so is usually classified as non-hazardous.

  Advantages of monofilling include simple operation, minimal processing and low costs. The overwhelming disadvantage is the need for suitable landfill sites to place the dewatered sludge.

- **Co-Disposal**

  Co-disposal is the treatment and/or disposal of sludge in conjunction with municipal solid waste (MSW). Possibilities include co-incineration, co-composting, and landfill co-disposal. While co-incineration has been successfully practiced in other countries, there are only two large-scale operations in the United States – one located in the Western Connecticut region at Stamford, the other in Duluth, Minnesota. Western Connecticut also has a very small co-incinerator located in New Canaan. Typically, dry sludge solids are burned at a rate of 1 dry pound for every 5 to 8 pounds of MSW; the Stamford facility operates at a 1 to 20 ratio.

Advantages of co-incineration are the reduction in combined costs of incinerating sludge and MSW separately and the process efficiency, which allows complete burning of both materials without the use of auxiliary fossil fuels (and provides an excess of heat for steam generation if desired). Disadvantages are the dependence on a supply of MSW and coordination of sludge quantities with MSW quantities during the co-incineration process.

Co-composting sewage sludge with MSW is a co-treatment technology which has had limited acceptance in the United States in the past, but is beginning to receive interest. The process requires presorting and pulverization of MSW before mixing it with liquid sludge containing 5 to 12 percent solids. A 2 to 1 ratio of solid waste to sludge is the recommended minimum. Although beneficial product results, the quality of the compost is inconsistent and generally inferior to compost made from sewage sludge alone.

The most common co-disposal practice is sanitary landfilling, which is advantageous because of the complimentary absorption characteristics of the solid waste and the soil conditioning characteristics of the sludge. Co-disposal costs are typically lower than the costs of a dedicated sludge landfill due to the economy of scale. Disadvantages of utilizing a co-disposal site include operational problems associated with mixing refuse and sludge, increased leachate and odor potential, and site capacity concerns.

The Town of Nantucket dewaters sludge at the Surfside Wastewater Treatment Facility. Although the facility has the capability to compost the dewatered sludge using the aerated static pile method, the Town is currently hauling it to a Municipal solid waste composting facility located at the Department of Public Works in Madaket. The municipal solid waste composting facility in a privately owned and operated under a 25-year contract.

- **Contract Disposal Alternatives**

  An alternative to the Town of Nantucket disposing its own sludge is to have the material transported to a private contract disposal facility. The sludge could be transported in cake form, with a dump truck or a container truck using watertight bodies. Dump trucks typically have a normal capacity of approximately 12 cubic yards, though smaller and larger sizes are available. Container capacities typically average approximately 30 cubic yards, though smaller and larger sizes are also available. Containers can be custom made in different sizes, shapes, and dumping configurations to suit the needs of a specific location.

  The sludge could also be thickened and pumped into a tank truck in liquid form for disposal at a facility, which accepts liquid sludge. The liquid sludge is transported in tank trucks, which typically hold approximately 6,500 gallons (though smaller and larger capacities are available).

  Various facilities are available throughout the New England area. Wastestream Environmental (WSE), with facilities located in Fitchburg, Upper Blackstone, Mattabassett, and Hartford; New England Treatment Company (NETCO), located in Woonsocket, Rhode Island; Waste Management, Inc. in Rochester, New Hampshire; and Naugatuck Treatment Company in Naugatuck, Connecticut are all contract disposal facilities in the New England region. Costs at these facilities depend on how the sludge is transported (in liquid or solid form), and the sludge has to meet various criteria established by each facility. The cost will be dependent on the specific characteristics of the sludge, but typically range from $0.10 to $0.20 per gallon for liquid sludge and $90 to $100 per wet ton for dewatered sludge. This fee typically covers the tipping fee at the facility but does not cover the transportation costs from the Island.

Innovative Technologies

"Innovative technologies" is the generic term applied to a range of unconventional sludge disposal technologies. In general, these technologies have been demonstrated on a pilot scale or small facility basis, but have not seen widespread use. End products range from a compost-like material to a concrete aggregate substitute.

The following technologies are some of the more widely known, if not widely practiced innovative technologies.

- **Aggregate Production**

  This type of process is available in various forms and is generally similar to conventional incineration in that sludge volatiles are burned, leaving only the inert fraction. In one of the process variations, sludge is burned in a special furnace at very high temperatures to induce slag formation. Instead of ash, liquid slag is removed from the bottom of the furnace and dropped into a quenching medium, such as water, forming a stable, fused, glassy solid, suitable for reuse as aggregate. This process is being marketed by World Envirotech, and is used at a wastewater facility in Monticello, New York.

- **Earthworm Conversion, or Vermiculture**

  This is a stabilization process by which earthworms consume the organic material in municipal wastewater sludge. The product of Vermiculture (i.e., the worm castings) may be used as a soil conditioner, similar to compost. This technology is still in the experimental stage. There are no significant facilities in the United States.

- **Fuel from Sludge**

  The conversion of sludge solids to oil and char under pressure has been proven technically feasible under laboratory conditions. However, commercialization and scale-up have been estimated to be prohibitively expensive.

- **Deep Well Oxidation**

  This process uses conventional oil well drilling technology to position an annular reactor in a vertical position up to one mile below grade. The process takes advantage of the great hydraulic head generated by the liquid column, along with the application of head and oxygen, to oxidize the sludge organics. A small prototype facility was constructed and operated with mixed results in Longmont, Colorado early in the 1980's. Privatized facilities using modifications to the original concept are under evaluation in Houston and Detroit. Chief disadvantages of the process are corrosion or scaling of the reactor surfaces and generation of a sidestream with a high soluble organics content, which requires additional treatment. The main advantages are the generation of a relatively inert ash-like product, with low land area requirement.

As with the conventional technologies described previously, any innovative technology would also be subject to corresponding federal and state regulations governing processing and distribution. For example, the aggregate production process would be regulated in a manner similar to incineration, focusing on air quality impacts.

Each of the innovative technologies described above has its unique advantages. For example, the aggregate production process solves the problem of ash disposal resulting from conventional incineration, assuming a market for the aggregate material is found.

The major disadvantage of all innovative technologies is that they are untried and unproven on a large scale in the United States. High costs and operational problems are generally incurred in operating a facility based upon a new unproven process.

A prime example of this is the difficulties experienced by the City of Los Angeles with its innovative oil-based sludge drying system used at the Hyperion treatment plant, which represented the first large-scale adaptation of this technology for wastewater sludge in the U.S.

Stormwater Management and Groundwater Recharge Initiatives

The implementation of infiltration measures as part of stormwater management will increase the annual recharge to groundwater. One method of improving the groundwater infiltration may be creating improvements to developed subdivisions were stormwater management was never applied. Some of the recharge potential in these subdivisions could be restored by retrofitting the existing drainage systems to encourage infiltration. The incorporation of infiltration trenches and basins, dry wells and water quality swales are some of the measures that could be utilized. This stormwater management initiative would be a large undertaking and potentially expensive to accomplish.

D. EXISTING WASTEWATER TREATMENT FACILITIES AND SEWER SYSTEM CONNECTIONS AND CAPACITY

1. Village of Nantucket

In the Nantucket collection system, the gravity sewers discharge to a pumping station on Sea Street where the sewage is pumped through either of two force mains to the Surfside filter beds; a 20-inch ductile force main installed in 1981, or a 20-inch cast-iron force main relined with 16-inch polyethylene liner pipe installed in 1983-84. The total distance from the pumping station to the ten slow sand filter beds on the south shore of the Island is about 17,800 feet. The pumping station, the original force main, and original seven filter beds were built in 1929. Beginning at the pumping station, 5,300 feet of force main was repaired in 1959 and during the period repairs were in progress, an emergency force main bypass discharging to the ocean at Brant Point was constructed and placed in service to permit the repairs. The emergency bypass has been taken out of service.

The Sea Street pumping station was built in the 1930s and consists of a one-story superstructure, 30 feet by 32-feet in plan partitioned into two sections comprising of an 11-foot by 32-foot wet well extending below grade along the rear of the building and a ground level control room with a below-grade dry well occupying the remaining space on the street side.

In the 1970s a headworks facility consisting of a comminutor and by-pass bar rack was constructed to replace the manually cleaned screen cages. In addition, an emergency generator was added to maintain operation of the station in the event of a power outage. This equipment was installed in a new building located directly behind the existing superstructure and was constructed adjacent to the existing wetwell.

In the early 1990s, the pump station was upgraded to include the installation of a channel grinding mechanism, chemical addition storage and feed equipment for the force main and wetwell, activated carbon odor control system, ozone generation and wetwell distribution equipment, separation of a large wetwell into two compartments to facilitate cleaning, replacement of 2 pumps and the additional of variable speed drives.

2. Village of Siasconset

The existing Siasconset sewerage system, which dates back in part as far as 1914 and serves the densely built up area of the village along the easterly end of the island, is primarily gravity flow. It extends to Sankaty Head Lighthouse on the north, Front Street on the east, Ocean Avenue on the south, and Burnell Street on the west. The collection system consists of approximately 38,000 linear feet of sewer, ranging in size from 6 to 12 inches.

The system discharges all wastewater to four rapid sand infiltration basins located off of Low Beach Road via a 12-inch diameter gravity sewer. Currently, all wastewater flow from the Siasconset area passes through a flow-metering manhole, abandoned screening chamber and a settling tank prior to discharge at the basins. The flow metering equipment consists of a parshall flume and level element retrofitted into a manhole.

The United State Coast Guard (USCG) also has existing wastewater disposal facilities in the same area as the existing Town facilities. The USCG sewer infrastructure consists of gravity sewer on USCG property, which services the main buildings off the end of Low Beach Road, and the housing on Silver Street (cul-de-sac off of Low Beach Road). All wastewater is discharge to two rapid sand infiltration basins via a 10-inch diameter gravity sewer that runs from Low Beach Road cross-country to the basins.

The existing effluent beds noted above have been improved, however untreated wastewater is still being discharged to the ground through the rapid infiltration basins due to abandonment of the Siasconset WWTF project in 1990 because of coastal erosion concerns. The Town is currently in the final stages of design and expects to begin construction in mid 2001.

Approximately 77 percent of the Siasconset study area is sewered while the remaining buildings in the village are on private subsurface disposal systems. Through discussions with the Board of Health and a review of their files, it appears that the majority of these systems are in compliance with Title 5 of the State Environmental Code and are at present working properly. Septage pumped from these establishments is transported by truck to the Surfside Wastewater Treatment Facility. With the current zoning by-laws in town, newly constructed lots are either connected to the sewer system or have enough land available to site a Title 5 system on their property.

The area east of Front Street fronting the ocean and commonly known as Cod Fish Park is heavily developed with many summer cottages. With a reportedly high groundwater table in this area, the conditions for subsurface wastewater disposal are extremely poor. These cottages, which are below the coastal bank, are not served by the existing sewer system. Since this area is below the coastal bank and currently is experiencing severe coastal erosion, there is presently no plan to sewer this area. Any new sewer hook-ups in the Siasconset study area would ultimately flow to the new Siasconset Wastewater Treatment Facility.

When a sewer connection is considered, the impacts to the downstream gravity sewer pipes, pump stations, force mains, and treatment facilities must be determined. The existing flows in these facilities and the additional flows from the need areas must be reassessed prior to planning any new sewer system. Expansions and improvements to the existing system will be required if, with the addition of the flow from the need areas, the downstream wastewater flows exceed the capacity of these facilities. Potential improvements to these facilities may include the upgrade of gravity sewers, the addition of another pump to handle additional flows at the pump station, and/or the installation of another force main parallel to an existing force main to handle peak flows. The question of available capacity and condition of the downstream facilities is important to investigate and must be included in the technical and economic evaluation of an alternative. The CWMP/EIR Phase II Document will consider the impact of new sewer systems on the capacity of the downstream gravity sewers, pump stations, force mains and treatment facilities.

E. WASTEWATER REUSE FOR ARTIFICIAL RECHARGE

1. General

This chapter provides an overview of salient aspects, generally of a technical nature, applicable to wastewater reuse for artificial recharge. Legal, institutional, and economic aspects are not a part of this discussion. These aspects include (a) desirable wastewater treatment levels, and (b) treatment technologies that represent components of process train(s) which will produce effluent suitable for artificial ground water recharge. This chapter also provides brief descriptions of relevant representative projects currently in operation, which produce wastewater effluents for artificial recharge or potable water reuse.

2. General Requirements For Wastewater Usage For Artificial Recharge

National Research Council's report on Ground Water Recharge Using Waters of Impaired Quality (1994) has extensively researched the aspects of wastewater usage for artificial recharge. The following pertinent information is summarized using the material presented in that report.

Based on current information, wastewater used to recharge the ground water must receive a sufficiently high degree of treatment (minimum secondary treatment) prior to recharge so as to minimize the extent of any degradation of native ground water quality, as well as to minimize the need for and extent of additional treatment at the point of extraction. After proper treatment, the wastewater is ready for recharge, either through surface spreading and infiltration through the unsaturated zone or by direct injection into ground water. Recharge by infiltration takes advantage of the natural treatment processes, such as biodegradation of organic chemicals that occurs as water moves through soil. The quality of the water prior to recharge is of interest in assessing the possible risks associated with human exposures to chemical toxicants and pathogenic microorganisms that might be present in the source water. Although one can reasonably expect that such constituents will often be reduced during filtration through the soil, as well as subsequently in the aquifer, a conservative approach to risk assessment would assume that toxicants and microorganisms are not completely removed and some are affected only minimally prior to subsequent extraction and use. Thus when recharge water is withdrawn later for another purpose, it may require some degree of post treatment, depending on its intended use.

There are several operational issues that must be addressed on a site-specific basis. These concerns are related to project sustainability, treatment needs, public health impacts, and economic and institutional constraints. In the short-term, project sustainability is controlled by operating and managing the system so as to prevent or control clogging. Long-term sustainability is dependent on finding the best combination of pretreatment, soil-aquifer treatment, and post treatment for determining whether the wastewater used for recharge will exceed the treatment and removal capacity of the soil-aquifer treatment system.

Constituents of concern in municipal wastewater include organic compounds, nitrogen species, pathogenic organisms, and suspended solids. Treatment processes are readily available and have been used successfully to treat municipal wastewater effluent to levels acceptable for various recharge applications. However, even when treated to a very high degree, disinfection of the effluent with chlorine results in the formation of disinfection by-products (DBPs) with the residual organic compounds. These DBPs are of concern if the recovered ground water is to be used for potable purposes. Raw municipal wastewater may include contributions from domestic and industrial sources, infiltration and inflow from the collection system, and, in the case of combined sewer systems, urban stormwater runoff.

The occurrence and concentration of pathogenic microorganisms in raw wastewater depend on a number of factors, and it is not possible to predict with any degree of assurance what the general characteristics of a particular wastewater will be with respect to infectious agents.

Healthy individuals do not normally excrete viruses for prolonged periods, and the occurrence of viruses in municipal wastewater fluctuates widely. Viral concentrations are generally highest during the summer and early autumn months. Viruses as a group are generally more resistant to environmental stresses than many of the bacteria, although some viruses persist for only a short time in municipal wastewater.

Dissolved inorganic solids (total dissolved solids or salts, TDSs) are not altered substantially in most wastewater treatment processes. In some cases, they may increase as a result of evaporation in lagoons or storage reservoirs. Therefore, unless wastewater treatment processes specifically intended to remove mineral constituents are employed, the composition of dissolved minerals in treated wastewater used for ground water recharge can be expected to be similar to the composition in the raw wastewater.

Based on the information collected by numerous researchers, the following treatments for the two types of ground water recharge methods are considered desirable: (1) If the wastewater is indirectly discharged to the aquifer, the wastewater should receive secondary treatment followed by nitrification/denitrification, sand filtration, and disinfection; and (2) If the wastewater is used for direct injection to the aquifer, the wastewater should receive secondary treatment followed by sand filtration, a membrane process (such as micro-filtration/reverse osmosis, or similar treatment), and disinfection. It is assumed that if a membrane process is used, nitrification/denitrification will not be required because the membrane process will remove nitrogen compounds present in the wastewater.

3. Wastewater Treatment Levels and Technologies

Wastewater treatment levels are generally classified as preliminary, primary, secondary, tertiary, and advanced. The nature of each level of treatment is discussed in the following sections.

- **Primary Treatment**

  The first step in treatment, sometimes referred to as preliminary treatment, generally consists of the physical processes of screening, or comminution, and grit removal.

  Past this initial screening, primary treatment consists of physical processes to remove settleable organic and inorganic solids by sedimentation and floating materials by skimming. These also remove some of the organic nitrogen, organic phosphorus, and heavy metals. Primary treatment, together with preliminary treatment, typically removes 50 to 60 percent of the suspended solids and 30 to 40 percent of the organic matter. Primary treatment does not remove the soluble constituents of the wastewater.

Primary treatment has little effect on the removal of most biological species present in wastewater. However, some protozoa and parasite ova and cysts will settle out during primary treatment, and some particulate-associated microorganisms may be removed with settleable matter. Primary treatment does not reduce the level of viruses in municipal wastewater.

While primary treatment by itself generally is not considered adequate for ground water recharge applications, primary effluent has been successfully used in soil-aquifer treatment systems at some spreading sites where the extracted water is to be used for non-potable purposes.

A disadvantage of using primary effluent is that infiltration basin hydraulic loading rates may be lower because of higher suspended solids and weaker biological activity on and in the soil of the infiltration system. Also, too much organic carbon in the recharge water can have adverse effects on processes that occur in the soil and aquifer systems. In most cases, wastewater receives at least secondary treatment and disinfection, and often tertiary treatment by filtration, prior to augmentation of non-potable aquifers by surface spreading.

- **Secondary Treatment**

  Secondary treatment is intended to remove soluble and colloidal biodegradable organic matter and suspended solids (SS). In some cases, nitrogen and phosphorus also are removed. Treatment consists of an aerobic biological process whereby microorganisms oxidize organic matter in the wastewater. Several types of aerobic biological processes are used for secondary treatment, including activated sludge, trickling filters, rotating biological contactors (RBCs), and stabilization ponds. Generally, primary treatment precedes the biological process; however, some secondary processes are designed to operate without sedimentation; e.g., stabilization ponds and aerated lagoons.

- **Tertiary Treatment**

  The treatment of wastewater beyond the secondary or biological stage is sometimes called tertiary treatment. The term normally implies the removal of nutrients such as phosphorus and nitrogen, and a high percentage of suspended solids. However, the term tertiary treatment is now being replaced in most cases by the term advanced wastewater treatment, which refers to any physical, chemical, or biological treatment used to accomplish a degree of treatment greater than that achieved by secondary treatment.

- **Advanced Wastewater Treatment**

  Advanced wastewater treatment processes are designed to remove suspended solids and dissolved substances, either organic or inorganic in nature. Advanced wastewater treatment processes generally are used when a high-quality reclaimed water is necessary, such as for direct injection into potable aquifers. The major advanced wastewater treatment processes associated with ground water recharge are coagulation-sedimentation, filtration, nitrification-denitrification, phosphorus removal, carbon adsorption, and reverse osmosis.

Coagulation-Sedimentation

Chemical coagulation with lime, alum, or ferric chloride followed by sedimentation removes suspended solids, heavy metals, trace substances, phosphorus, and turbidity. Viral inactivation under alkaline pH conditions can be accomplished using lime as a coagulant, but pH values of 11 to 12 are required before significant inactivation is obtained.

Filtration

Filtration is a common treatment process used to remove particulate matter prior to disinfection. Filtration involves the passing of wastewater through a bed of granular media, which retain the solids. Treatment of biologically treated secondary effluent by chemical coagulation, sedimentation, and filtration has been demonstrated to remove more than 99 percent of seeded poliovirus. This treatment chain reduces the turbidity of the wastewater to very low levels, thereby enhancing the efficiency of the subsequent disinfection process.

The primary purpose of the filtration step is not to remove viruses, but to remove protozoa and helminth eggs and other suspended matter that may contain adsorbed or enmeshed microorganisms, thereby making the disinfection process more effective.

Chemical coagulation and filtration, followed by disinfection, can remove or inactivate 5 logs (99.999 percent) of seeded polio virus and bacteria through these processes alone; and subsequent to conventional biological secondary treatment, can produce effluent essentially free of measurable levels of bacterial and viral pathogens.

Nitrification

Nitrification is the biological conversion of ammonia nitrogen sequentially to nitrite nitrogen and nitrate nitrogen. Nitrification does not remove significant amounts of nitrogen from the effluent: it merely converts it to another form.

Denitrification

Denitrification removes nitrate nitrogen from the wastewater. As with ammonia removal, denitrification is usually done biologically for most municipal applications. In biological denitrification, nitrate nitrogen is used by a variety of heterotrophic bacteria as the terminal electron acceptor in the absence of dissolved oxygen (anaerobic conditions). In the process, nitrate nitrogen is converted to nitrogen gas, which escapes to the atmosphere. The bacteria in these processes require a carbonaceous food source (e.g., carbonaceous BOD, methanol).

Phosphorus Removal

Phosphorus can be removed from wastewater by either chemical or biological methods, or a combination of the two.

Carbon Adsorption

One of the most effective advanced wastewater treatment processes for removing biodegradable and refractory organic constituents is the use of granular activated carbon (GAC). GAC can reduce the levels of synthetic organic chemicals in wastewater by 75 to 85 percent. The basic mechanism of removal is by adsorption of the organic compounds onto the carbon. Carbon adsorption preceded by conventional secondary treatment and filtration can produce an effluent with a Biochemical Oxygen Demand (BOD) of 0.1 to 5.0 mg/L, Chemical Oxygen Demand (COD) of 3 to 25 mg/L, and Total Organic Compound (TOC) of 1 to 6 mg/L.

Reverse Osmosis

Reverse Osmosis (RO) is used mainly as a wastewater treatment process to remove suspended and dissolved solids (including microorganisms), either organic or inorganic. Removal is accomplished by the passage of wastewater through a semi-permeable membrane. The size, shape, chemical characteristics, and concentration of the chemical species, as well as the physical and chemical characteristics of the feed wastewater and type of RO unit employed influence constituent removal. Because of the nature of the RO process, feed wastewater must be of a fairly high quality (low suspended solids content) to prevent membrane clogging and deterioration.

Emerging Hybrid Technology

Membrane bioreactor (MBR) is an emerging technology, which combines an activated sludge reactor with a membrane filtration unit. The end result is an effluent that is similar to the one that is produced by a process train consisting of a secondary treatment followed by tertiary treatment and advanced treatment. MBR process essentially eliminates the tertiary treatment step. The MBR effluent is considered suitable for aquifer recharge.

- **Disinfection**

The most important process for the destruction of microorganisms is disinfection. Although the most common disinfectant is chlorine, ozone (O_3) and ultraviolet (UV) radiation are other prominent disinfectants used at wastewater treatment plants. Other disinfectants, such as gamma radiation, bromine, iodine, and hydrogen peroxide, have been considered for the disinfection of wastewater, but are not generally used because of economical, technical, operational, or disinfection efficiency considerations. Membrane processes (e.g., micro-filtration, ultrafiltration, and reverse osmosis) have been shown to be effective in removing microorganisms, including viruses, from municipal wastewater, but again are not commonly used. The strategy in the selection and use of disinfectants for source waters prior to recharge should recognize the possibility that the nature and quantities of the disinfection by-products (DBPs) that may be formed are different from those in conventional water treatment. For example, both chlorine and ozone react in wastewater with organic precursors, which are likely to be greater in number and concentration than in freshwater sources of drinking water, to form DBPs. Accordingly, treatment of water for potable purposes is being modified to minimize the use of oxidizing disinfectants. However, in the treatment of wastewater for non-potable purposes, the numbers and concentration of DBPs are of less concern because long-term ingestion is not an issue.

Chlorine

The efficiency of disinfection with chlorine depends on the water temperature, pH, degree of mixing, time of contact, presence of interfering substances, concentration and form of chlorinating species, and the nature and concentration of the organisms to be destroyed. In general, bacteria are less resistant to chlorine than viruses, which in turn are less resistant than parasite ova and cysts.

The chlorine dosage required to disinfect a wastewater to any desired level is greatly influenced by the constituents present in the wastewater. Secondary effluent can be disinfected with chlorine to achieve very low levels of coliform bacteria, although complete destruction of pathogenic bacteria and viruses is unlikely to occur. Chlorination of secondary effluent that has received further treatment to remove suspended matter can produce wastewater that is essentially free of bacteria and viruses. Chlorine, at the normal concentrations used in wastewater treatment, may not destroy helminth eggs, Giardia lamblia, and Crypto sporidium species.

Ozone

Ozone is a powerful disinfecting agent and a powerful chemical oxidant in both organic and inorganic reactions. Due to the instability of ozone, it must be generated on site from air or oxygen carrier gas. Ozone destroys bacteria and viruses by means of rapid oxidation of the protein mass, and disinfection is achieved in a matter of minutes. Some disadvantages are that the use of ozone is relatively expensive and energy intensive, ozone systems are more complex to operate and maintain than chlorine systems, and ozone does not maintain a residual in water. Ozone is a highly effective disinfectant for advanced wastewater treatment plant effluent, and it removes color and contributes dissolved oxygen. It also breaks down recalcitrant organic compounds into more biodegradable compounds, which is advantageous for ground water recharge and soil-aquifer treatment.

Ultraviolet Radiation

Irradiation of wastewater with ultraviolet radiation for disinfection is potentially a desirable alternative to chemical disinfection, owing to its inactivating power for bacteria and viruses, affordable cost, and the absence of chemical disinfection by-products. Exposure of microorganisms to the appropriate amount of electromagnetic (EM) radiation disrupts the cells' genetic material and interferes with the reproduction process. Some bacteria have repair enzyme systems that are activated by similar EM energies, and thus these particular bacteria may repopulate disinfected waters after disinfection when exposed to light. UV disinfection for water and wastewater is the newest of the disinfection technologies and therefore, valuable large-scale field applications are still under study. However, the trend is toward more use of UV disinfection.

4. Wastewater Recharge/Drinking Water Reuse Experience In The U.S.A.

There are approximately 1,900 wastewater reuse projects currently operating throughout the USA (approximately 34 states have such projects). Only a very small number (probably less than 10) of those projects use direct wastewater recharge into an aquifer. In most cases, the wastewater is used (after proper treatment) for irrigation of urban landscapes and agricultural land or industrial purposes.

Within the United States, wastewater reuse is most common in Florida, California and Arizona. Prominent projects of wastewater reuse for drinking water or ground water recharge are as follows:

- **Water Factory 21 in Orange County, California**

  The Orange County Water District (OCWD) has been injecting high quality reclaimed water into selected coastal aquifers to establish a saltwater intrusion barrier. Seawater intrusion was first observed in municipal wells during the 1930s as a consequence of basin overdraft. Over-drafting of the ground water continued into the 1950s. Over-pumping of the ground water resulted in seawater intrusion as far as 3.5 miles inland from the Pacific Ocean by the 1960s.

OCWD began pilot studies in 1965 to determine the feasibility of injecting effluent from an advanced wastewater treatment (AWT) facility into potable water supply aquifers. Construction of an AWT facility, known as Water Factory 21, began in 1972 in Fountain Valley, and injection of the treated municipal wastewater into the ground began in 1976.

Water Factory 21 accepts activated-sludge secondary effluent from the adjacent County Sanitation Districts of Orange County wastewater treatment facility. The 15 MGD water reclamation plant processes consist of: lime clarification for removal of suspended solids, heavy metals, and dissolved minerals; re-carbonation for pH control; mixed-media filtration for removal of suspended solids; activated carbon absorption for removal of dissolved organic compounds; reverse osmosis for demineralization and removal of other constituents; and chlorination for disinfection and algae control.

Prior to injection, the product water is blended 2:1 with deep well water from an aquifer not subject to contamination. The blended water is chlorinated in a blending reservoir before it is injected into the ground. Depending on conditions, the injected water flows toward the ocean, forming a seawater barrier; inland to augment the potable ground water supply; or in both directions. On average, well over 50 percent of the injected water flows inland. It is estimated that this injected water makes up no more than 5 percent of the water supply for area residents who rely on ground water.

- **County Sanitation Districts of Los Angeles County Ground Water Recharge Projects**

  Since 1962, the Whittier Narrows Water Reclamation Plant (WRP) has used reclaimed water along with surface water and storm water to recharge ground water in the Montebello Forebay area of Los Angeles County by surface spreading of the reclaimed water. The reclaimed water makes up a portion of the potable water supply for the area residents that rely on ground water. From 1962 until 1973, the Whittier Narrows WRP was the sole provider of reclaimed water in the form of disinfected secondary effluent for recharge. Some surplus effluent from a third treatment plant, the Pomona WRP, is released to the San Jose Wash, which ultimately flows to the San Gabriel River and becomes an incidental source for recharge in the Montebello Forebay.

  The WRPs start their wastewater treatment with primary and secondary biological treatment. In 1978, all three WRPs added tertiary treatment with mono- or dual-media filtration and chlorination/dechlorination to their treatment regimes.

  After leaving the reclamation plants, the reclaimed water is conveyed to one of several spreading areas (either specially prepared spreading grounds or dry river channels or washes). In the process of ground water recharge, the water percolated through an unsaturated zone of soil ranging in average thickness from about 10 to 40 feet before reaching the ground-water table. The usual spreading consists of five days of flooding, during which water is piped into the basins and maintained at a constant depth. The flow is then discontinued. The basins are then allowed to drain and dry out for 16 days. This wet and dry cycle maintains the proper conditions for the percolation process.

- **Denver's Direct Potable Water Reuse Demonstration Project**

  In 1968, the Environmental Protection Agency (EPA) allowed Denver to divert water from the Blue River on the west side of the Continental Divide on the condition that it examine a range of alternatives to satisfy projected future demands of a growing metropolitan area. The Direct Potable Water Reuse Demonstration Project was designed to examine the feasibility of converting secondary effluent from a wastewater treatment plant to water of potable quality that could be piped directly into the drinking water distribution system. In 1979, plans were developed for the construction of a demonstration facility to examine the cost and reliability of various treatment processes. The 1.0 MGD treatment plant began operation in 1985, and during the first three years, many processes were evaluated. Data from the evaluation period was used to select the optimum treatment sequence, which was used to produce samples for a two-year animal feeding health- effect study. Comprehensive analytical studies defined the product water quality in relation to existing standards and to Denver's current potable supply. The project water exceeded the quality of Denver's drinking water for all chemical, physical, and microbial parameters tested except for nitrogen, and alternative treatment options were demonstrated for nitrogen removal. The final health-effect study demonstrated no health effects associated with either water. The raw water supply for the reuse plant was unchlorinated secondary effluent (treated biologically) from the metropolitan Denver wastewater treatment facility. Advanced treatment included high-pH lime treatment, single- or two-stage re-carbonation, pressure filtration, selective ion exchange for ammonia removal, two-stage activated carbon adsorption, ozonation, reverse osmosis, air stripping, and chlorine dioxide disinfection. Side stream processes included a fluidized bed carbon reactivation furnace, vacuum sludge filtration, and selective ion exchange regenerant recovery.

- **San Diego's Total Resource Recovery Project**

  San Diego, California imports virtually all of its water supply from other parts of the state. New sources of imported water are not readily available; the availability of existing supplies is diminishing. The city is thus actively investigating advanced water treatment technologies for reclaiming municipal wastewater that is presently being discharged to the Pacific Ocean. Preliminary experiments were conducted at the bench-scale (20,000 gallons per day) Aqua I facility in Mission Valley from 1981 to 1986. The pilot-scale (300,000 gallons per day secondary, 50,000 gallons per day advanced) treatment Aqua II Total Resource Recovery facility operated at Mission Valley from 1984 through 1992. The full-scale demonstration Aqua III facility (1.0 MGD secondary, 500,000 gallons per day advanced) was constructed in Pasqual Valley and began full-time operation in October 1994.

  The Aqua II pilot facility uses channels containing water hyacinths for secondary treatment followed by a 50,000 gal/day advanced treatment system designed to upgrade the secondary effluent water to a quality equivalent to raw water for potable reuse. A technical advisory committee in conjunction with the city selected the tertiary and advanced process trains in 1985. Tertiary treatment to produce a low-turbidity water suitable for reverse osmosis feedwater was provided by a package water treatment plant, with ferric chloride coagulation, flocculation, sedimentation, and multimedia filtration. The system included ultraviolet light disinfection, cartridge filtration, chemical pretreatment, reverse osmosis using thin-film composite membranes, aeration tower decarbonation, and carbon adsorption. The final process train produces water that meets U.S. drinking water standards.

- **Tampa Water Resource Recovery Project**

  The Tampa Water Resource Recovery Project was developed to satisfy the future water demands of both the City of Tampa and the West Coast Regional Water Supply Authority. The proposed project involves the supplemental treatment of the Hookers Point Advanced Wastewater Treatment (AWT) Facility effluent to achieve acceptable quality for augmentation of the Hillsborough River raw water supply. In 1993, a pilot plant was designed, constructed, and operated to evaluate supplemental treatment requirements, performance, reliability, and quality.

Source water for the pilot plant was withdrawn downstream from AWT Facility denitrification filters prior to chlorination. The pilot plant facility evaluated four unit process trains, all of which included preaeration, lime treatment and recarbonation, and gravity filtration, followed by either (1) ozone disinfection, (2) reverse osmosis and ozone disinfection, (3) ultrafiltration and ozone disinfection, or (4) granular activated carbon (GAC) adsorption and ozone disinfection. The process train including GAC adsorption and ozone disinfection was selected for design.

The City of Tampa's industrial base is mostly food oriented. Inputs to the wastewater system were confirmed by a "vulnerability analysis." Tampa has an active pretreatment program, and there has been no interference with the plant's biological process since startup in 1978.

The design of the advanced treatment plant allows for rejection of water at any level of treatment and diversion back to the main plant. The use of a bypass canal for storage and mixing provides a large storage capacity and constant dilution of product water with canal and river water. Water can be diluted from the aquifer when river water is not available. Flood control gates allow the canal to be flushed if a problem is detected. Canal water can be drawn through a "linear well field" along the canal to provide further ground water dilution. Five miles of canal and river provide additional natural treatment prior to the intake for the drinking water treatment plant.

5. Public Health Issues of Wastewater Effluent Recharge

The following material is derived from the information provided in the National Research Council's Report on Ground Water Recharge Using Waters of Impaired Quality (1994).

A major consideration in the use of wastewater effluent for artificial recharge is the possible presence of chemicals in the effluent that may be hazardous to human health. At the present time, according to the National Research Councils Committee Report on Ground Water Recharge Using Waters of Impaired Quality, on the basis of available information, there is no indication that the health risks from using reclaimed wastewater are greater than those from using existing water supplies or that the concentrations of chemicals, with several exceptions, or microorganisms are higher than those established in drinking water standards set by the EPA.

Studies have been made of the chemical and microbiological characteristics of recovered water, although they are limited in number and scope. Several studies have shown that the recovered water can meet drinking water standards, even when the recharge source is treated municipal wastewater. Such findings lead some experts to the conclusion that these extracted waters are as acceptable as water supplied from traditional sources. Other experts strongly disagree; saying that water originating from an impaired source is inherently more risky. For instance, disinfection of the recharge waters may develop a different mix of disinfection by-products (DPBs), often unidentified, from those found in conventional water supplies. Also, the characterizations of the organic material and the full range of microbiological constituents are incomplete. In addition, source waters of impaired quality and recharge water withdrawn from the aquifer at the point of use may contain some contaminants at higher concentrations than are likely to be present in conventional water supplies. And throughout the whole process, there is increased reliance on technology and management, leaving open the door for errors. Thus, the question arises whether drinking water standards developed for conventional water supply systems are sufficiently protective of human health when ground water is recharged with waters of impaired quality. There is a substantial amount of uncertainty principally related to the presence of synthetic organic chemicals, inorganic chemicals, disinfection by-products, and pathogenic organisms.

The assessment of health risks associated with recharge using wastewater effluent is far from definitive because there are limited chemical and toxicological data and inherent limitations in the available toxicological and epidemiological methods. The limited data and extrapolation methodologies used in toxicological assessments provide a source of limitations and uncertainties in the overall risk characterization.

Similarly, epidemiological studies suffer from the need for very long time periods required, because cancers have latency periods of 15 year or more. Also, such studies require large populations to uncover the generally low risks associated with low concentrations of toxicants. Past studies of the possible adverse health effects from reclaimed water have tended to be limited in terms of toxicological characterization and have focused only on those chemicals for which drinking water standards exist.

6. Summary and Conclusions

Many communities currently use water sources of varying quality, including sources that receive significant upstream discharges of wastewater. In this sense, cities upstream of drinking water intakes are already providing water reclamation in their wastewater treatment facilities; for they treat the water, then release it into the raw water supply used by downstream communities.

A small but growing number of communities include the use of highly treated wastewater to augment water supply. Projects currently operating in the United States generally produce reclaimed water that meets or exceeds the quality of the raw waters those systems would use otherwise, as measured by current standards established by the Safe Drinking Water Act.

Current potable reuse projects and studies have demonstrated that technology exists to produce reclaimed water of excellent measurable quality and to ensure system reliability.

Assessment of health risks associated with recharge using wastewater effluent is far from definitive because there are limited chemical and toxicological data and inherent limitations in the available toxicological and epidemiological methods.

6.0 REVIEW OF PUBLIC PARTICIPATION PROGRAM

A. GENERAL

Earth Tech will work closely with the Town, the Board of Selectmen, the Department of Public Works and the Nantucket Planning and Economic Development Commission to develop and implement a responsive yet manageable public education program designed to build consensus for the recommended CWMP/EIR. Earth Tech, as part of the SRF application and administration process, prepared and submitted a Public Participation Program Work Plan to the Town and DEP prior to initiating the project. The public participation program is similar to the ongoing program which, Earth Tech has implemented for the Siasconset Wastewater Facilities Plan Project, however, this Work Plan will be Island-wide in its appeal. The purpose of this public education/participation program will be to inform the public of the scope and progress of the planning study, to describe the results of the wastewater needs analysis and siting alternatives selection process, and to encourage public input throughout the entire planning process.

A mailing list has already been developed for the Siasconset Project. This list contains the regulatory and funding agencies having jurisdiction over this type project, as well as individuals, civic, and special-interest organizations. This mailing list will undoubtedly increase in order to incorporate the additional members of the public that will be interested and/or concerned about this Island-wide CWMP/EIR project. The mailing list will be used to distribute project fact sheets and responsiveness summaries.

As part of the Siasconset public education process, Earth Tech has assisted the Town in establishing three permanent information depositories for project information to be viewed by the public. These depositories are located at the Office of the Town Clerk, the Nantucket Planning and Economic Development Commission, and the Nantucket Athenaeum. Earth Tech intends to continue using these depository sites for displaying information generated during the CWMP/EIR process.

As with the Siasconset project, these depositories will enable the public to view project information including:

- Massachusetts Department of Environmental Protection (DEP) Administrative Consent Orders;
- DEP SRF program information including the Project Approval Certificate;
- Approved Plan of Study;
- Public Participation Work Plan;
- Project fact sheets;
- Legal advertisements and press releases published for public meeting notification, newspaper articles, responsiveness summaries, draft reports, miscellaneous project documentation, project implementation and meeting schedules, project progress reports, findings and recommendations, and
- Draft and final versions of the CWMP reports. Names and addresses left by readers at the depositories will be supplemented onto the project mailing list. The goal will be to maintain these depositories throughout the project planning period.

The intensity and the length of the public participation program will depend on how the Phase I and Phase II study concept unfolds. However, both Phase I and Phase II, will include a public education and participation program which will include two (2) public meetings to discuss the alternatives and environmental impacts and other project concerns and impacts including funding and coordination efforts. The public hearing at the very end of the CWMP/EIR process will present the short list of screened alternatives and the CWMP/EIR recommendations. Earth Tech will prepare presentation materials to be used at the public meetings and hearing. All materials will be submitted to the Town, the DEP, and the depositories for review prior to the meetings/hearing dates. Earth Tech will attend and provide assistance to the Town for the public meetings/hearing and provide assistance in the preparation of legal notices, press releases, and news stories.

Earth Tech will prepare and distribute responsiveness summaries after each public meeting and the hearing. These responsiveness summaries will identify the public participation activities and document significant questions, comments, concerns and suggestions by the public and responses by Town staff and Earth Tech. The responsiveness summaries will be distributed to the depositories, active participants and the mailing list. Major issues which have been addressed during the public meetings and have been included in the responsiveness summaries during the Siasconset Project include project planning area, existing and future growth conditions and sewering needs, treatment facility in Siasconset versus transporting wastewater to the existing Surfside Wastewater Treatment Facility or other remote site, types of wastewater treatment and the degree of wastewater treatment required, effluent disposal requirements, odor control, pumping requirements, siting criteria and status of site evaluation efforts, impacts of site selection, cost issues, and environmental aesthetic considerations and other impact issues. The responsiveness summaries will be included as an Appendix to the public education/public participation chapter in the CWMP/EIR Phase II and Phase III Documents. Earth Tech anticipates that issues similar to those encountered in the Siasconset study will be addressed in the Town's CWMP/EIR. Some of the major issues CWMP/EIR scrutiny include:

- Treatment capacity of the Surfside WWTF;
- Advanced odor control;
- Coastal erosion;
- Siting issues;
- Growth; and
- Sensitive environmental receptors.

B. PUBLIC MEETING

The Town of Nantucket held a Public Informational Meeting on the results of the CWMP/EIR Phase I Document on July 29, 1999. A presentation included a summary of (1) the CWMP/EIR process, (2) the CWMP/EIR objectives, (3) existing wastewater disposal problems, (4) identification of areas of wastewater disposal need and (5) options for wastewater collection, treatment and disposal.

Based on the meeting, additional Board of Health data was obtained, the areas of wastewater disposal needs redefined and the completion of the CWMP/EIR Phase I Document was delayed until "The Nantucket Comprehensive Plan" was completed by the Nantucket Planning and Economic Development Commission.

C. CIRCULATION LIST

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7.0 CONCLUSIONS AND RECOMMENDED FUTURE ACTION

A. PURPOSE

The purpose of this section is to present the short-listing of wastewater treatment and disposal alternatives within the Town of Nantucket to be carried forward for further analysis as part of Phase II of the CWMP/EIR process. The section identifies and summarizes the potentially feasible wastewater disposal sites and wastewater treatment alternatives to accommodate the wastewater flows from the need areas. This evaluation of sites and alternatives accommodates the information compiled on recommended need areas, environmental screening ratings, and preliminary engineering and technical criteria.

B. RECOMMENDED AREAS OF NEED

The recommended areas of wastewater disposal need are shown on Figure 7B-1 (pocket) which were previously identified in this report are summarized as follows:

Madaket	Somerset
Monomoy	Shimmo
Polpis	Town
Pocomo	Town -WPZ
Quidnet	Warrens Landing
Siasconset	Wauwinet

C. WASTEWATER TREATMENT ALTERNATIVES

Selection of a wastewater treatment technology is based on technical, environmental, institutional and economic factors. The 14 wastewater treatment technologies considered for the Town of Nantucket are discussed in detail in Section 5.0. In order to determine which technologies are best suited to the needs of the Island of Nantucket, the technologies have been screened. Screening is defined as applying certain criteria on the technical, environmental, institutional and economic factors to eliminate less feasible treatment technologies. The overall purpose of screening is to reduce the total number of alternatives to a short list of the best treatment options. The best treatment options will have the most favorable impacts applying the following general criteria listed below.

Technical Factors

Technical factors are related to physical and engineering issues. Such issues considered under this criterion are:

- Flow and Loading: In order to provide greater flexibility in the operation of the facility, treatment technologies which cannot deal with variable flow and loading are screened out;
- Land/Site Requirements: Land/Site requirements for the treatment technologies are compared against land available;
- Suitability for groundwater Discharge: Due to the fact that Zone II's are where the suitable soil limitations are located, the treatment technologies must be able to produce an effluent suitable for groundwater discharge into a Zone II;
- Climate: The treatment technology must be able to function in Nantucket's climate;
- Sludge Disposal: The treatment technology must be capable of producing a sludge which can be incorporated into long-term sludge disposal plan; and
- Ease of Operation: The treatment technology must not require specialized staff.

Environmental Factors

The treatment technologies under consideration all require a discharge of treated wastewater effluent which can not adversely impact the environment and permit process. The principal environmental factors are associated with the treated wastewater discharge to the environment. The evaluation centers on the impact the discharge will have on surface and/or groundwater quality, aquifer recharge/stream flow maintenance, and habitat.

Institutional Factors

Institutional factors are those related to community acceptance, regulatory and legal issues. These issues are further described as follows:

- Community Acceptance Issues: Human environmental issues which may be a concern. The potential for objectionable odors must be considered when siting a facility;
- Regulatory Issues: The treatment technology must be able to meet requirements imposed by federal, state and local regulatory agencies such as

groundwater discharge permit, surface water discharge permit, environmental permits, and other requirements; and

- Legal Issues: The treatment technology must comply with all applicable laws.

Economic factors

The last screening criterion evaluated is economic factors. Economic factors consist of the cost to design, construct, and operate the treatment technology, and the ability of the Town to pay for it. Because of aesthetics and odor control concerns, satellite facilities may have to be covered or enclosed in a building. Therefore a technology which will allow for a compact process and a small footprint would be required which may eliminate certain other technologies.

Summary

Based on the above, the following three wastewater treatment technologies are considered the most favorable and will be evaluated in detail in Phase II of the CWMP/EIR process: (1) Anaerobic/Anoxic Systems; (2) Rotating Biological Contactors; and (3) Sequencing Batch Reactors. Refer to Table 7C-1.

D. ALTERNATIVES ANALYSIS DISCUSSION

An alternatives analysis to determine the optimal wastewater treatment and disposal options for each need area is required. The analysis considers each need area as a single entity and the combined need areas for the entire Town of Nantucket. To determine the optimal wastewater treatment and disposal option for each need area a similar criteria to that used in the needs analysis was utilized. The four options that are being considering are as follows:

TABLE 7C-1
TOWN OF NANTUCKET
CWMP / EIR
WASTEWATER TREATMENT TECHNOLOGIES SCREENING MATRIX

TREATMENT TECHNOLOGY	TECHNICAL FACTORS						ENVIRONMENTAL FACTORS		INSTITUTIONAL FACTORS			ECONOMIC FACTORS		TOTAL FAVORABLE IMPACTS
	Flow and Loading	Land / Site Requirements	Land Disposal	Climate	Sludge Disposal	Ease of Operation	Groundwater Impacts	Permitting Impacts	Acceptance Issues	Regulatory Issues	Legal Issues	Construction Cost	Operation Cost	
SUSPENDED GROWTH BIOLOGICAL PROCESSES														
CAS / Extended Aeration		X		X		X			X			X		5
Pure Oxygen Activiated Sludge		X		X						X	X	X	X	6
Sequencing Batch Reactors	X	X	X	X	X	X	X			X	X	X	X	11
Oxidation Ditch					X	X								2
A / O Systems		X	X	X	X		X	X	X	X	X	X		10
FIXED FILM BIOLOGICAL PROCESSES														
Rotating Biological Contactors	X	X	X	X	X	X	X	X		X	X	X	X	12
Trickling Filters	X	X			X	X							X	5
Activated Biofilters	X	X			X	X							X	5
PHYSICAL / CHEMICAL PROCESSES														
Chemical Coagulation		X		X					X					3
Granular Activated Carbon		X		X					X					3
Zimpro PACT		X		X					X					3
NATURAL SYSTEMS PROCESSES														
Aquaculture	X				X	X			X		X		X	6
Constructed Wetlands	X				X	X		X	X	X	X		X	8
Solar Aquatics	X				X	X			X		X		X	6

Variances to Conventional Title 5 Septic Systems

Determine if the properties within a need area can accommodate conventional Title 5 septic systems by allowing variances to either the Town By-law or Title 5 requirements. The criteria used to determine whether variances to conventional Title 5 systems are feasible for a need area are lot size, soil, and groundwater. If a need area has an average lot size of less than or equal to one-half acre but does not have either severe soil or groundwater limitations, the area could potentially use variances to conventional Title 5 systems. If a need area has an average lot size less than or equal to one-half acre with either severe soil or groundwater limitations, then variances to conventional Title 5 system are not an option.

On-site Innovative Alternative Wastewater Treatment and Disposal Systems

Determine if the properties within a need area can accommodate innovative alternative systems (e.g. recirculating sand filter, Amphidrome™ Process, Bioclere™ System) to effectively treat and dispose of wastewater. The criteria used to determine whether on-site solutions are feasible for a need area are soil limitations and seasonally high groundwater. If a need area has either severe soil limitations or high groundwater, the area could potentially use innovative alternative wastewater treatment and disposal systems. If the area has both severe soil limitations and high groundwater, then innovative alternative wastewater treatment and disposal systems are not an option.

Communal Wastewater Treatment and Disposal Systems

Determine if there are treated wastewater effluent disposal sites within a need area (larger treatment facilities that would collect and treat wastewater from a neighborhood, 50 to 150 homes, within a need area). If a need area cannot sustain variances to conventional Title 5 septic systems or on-site wastewater treatment and disposal sites, within or near a need area, will be investigated to locate a site with suitable conditions for a small treatment facility and disposal site to service the wastewater flows from the need area.

Local Wastewater Treatment and Disposal Systems

Determine if there are sites within Nantucket to dispose of treated wastewater effluent via ground discharge from the identified need areas or a portion of the identified need areas. If a need area cannot sustain variances to conventional Title 5 septic systems, on-site innovative alternative systems, or communal wastewater disposal systems sites, other local sites will be investigated to locate a geographic area with suitable conditions for a larger wastewater treatment facility and disposal site to service the wastewater flows from two or more need areas.

E. SCOPE OF CWMP/DEIR PHASE II DOCUMENT

The scope of the CWMP/DEIR Phase II Document will analyze the selected alternatives in accordance with the revised scope that will be issued by the Secretary of Environmental Affairs and comments received on the CWMP/EIR Phase I Document.

The CWMP/DEIR Phase II Document will present draft recommendations for wastewater management in the identified areas of the Town of Nantucket where on site conventional Title 5 septic systems are shown to be inadequate. Specific recommendations by Study Area will take into account the appropriateness of utilizing innovative alternative systems, communal systems, local and/or regional wastewater collection, treatment and disposal facilities, and residuals treatment and disposal. The CWMP/EIR Phase II Document will evaluate the environmental, technical design and institutional costs associated with each alternative and recommend the appropriate long term solution to the wastewater disposal problems in the Town of Nantucket.