Town of Dartmouth, Massachusetts

Board of Public Works

DRAFT

SUPPLEMENT TO FACILITY PLAN FOR ULTIMATE DISPOSAL ALTERNATIVES

July, 1988

Fay, Spofford & Thorndike, Inc.

Engineers

FAY, SPOFFORD & THORNDIKE, INC.
ENGINEERS

191 SPRING STREET, P.O. BOX 802
LEXINGTON, MASSACHUSETTS 02173
(617) 863-8300

July 13, 1988

Board of Public Works
759 Russells Mills Road
South Dartmouth, MA 02748

Attention: Mr. Alan B. Mercer, Sr., Chairman

Subject: Dartmouth, Massachusetts
Supplement to Facility Plan for
Ultimate Disposal Alternatives

Gentlemen:

We are pleased to submit this draft of the subject report which addresses the alternatives available for the ultimate disposal of effluent from the Dartmouth wastewater treatment plant. This report is a supplement to the January 1988 Step 1 - Facility Plan for Expansion of Wastewater Treatment Facility and Collection System. Included herein is a description, discussion, and evaluation of the available ultimate disposal options, followed by the preliminary analysis and elimination of all but two alternatives. These two alternatives--land application and ocean disposal--are given indepth consideration with regard to feasibility, availability of suitable land, environmental impacts, and cost comparisons.

An Ocean Outfall Study performed by our subconsultant, Jason M. Cortell and Associates, Inc., is found in Appendix I of this report. The summary and conclusions of the Ocean Outfall Study constitute Chapter 4 of the main body of this report. Based on the results of our studies, we recommend the continued use of the existing ocean outfall with an increased effluent flow of 4.2 million gallons per day. This alternative is the most cost efficient and environmentally sound solution for effluent disposal. Other reasons for our recommendation are detailed within the text.

ACKNOWLEDGEMENTS

We wish to express our sincere appreciation to the Board of Public Works and to the Town officials for their efforts and cooperation, especially to Mr. Manuel Branco, Superintendent of the Department of Public Works, and Mrs. Phyllis Pettengill, secretary for the Department of Public Works.

This report was authored by Carolyn J. Loomis, an engineer on staff, under supervision of the undersigned. We will be happy to review this report and to discuss the recommendations with the Board of Public Works at its convenience.

Very truly yours,

FAY, SPOFFORD & THORNDIKE, INC.
By

Wallace W. Reed

Wallace W. Reed
Senior Vice President

CJL:am
Enclosure
1072W

Dartmouth, Massachusetts

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Summary, Conclusions and Recommendations

1. Introduction

This supplement to the Facility Plan presents the results of engineering studies made to determine the recommended method of ultimate disposal of wastewater effluent in the Town of Dartmouth, Massachusetts. The Step 1 - Facility Plan for Expansion of Wastewater Treatment Facility and Collection System was updated in January of 1988. This report includes discussion and evaluation of the available ultimate disposal alternatives, an ocean outfall study of the effects on Buzzards Bay of the ocean disposal alternatives, location and suitability of the potential land application sites, and a comparison of the preferred land application and ocean outfall alternatives.

Currently the Ocean Sanctuaries Act generally prohibits additional municipal wastewater treatment discharge into the ocean sanctuary, which, in this case, is Buzzards Bay. However, the Town has received special legislation (Chapter 369 of Acts of 1984 - see Appendix C), granting a waiver of the Ocean Sanctuaries Act to "improve its municipal wastewater treatment facility and appurtenances thereto, and, as a result of such improvement, to increase its ocean discharge of wastewater subject to the regulations and restrictions established by the Department of Environmental Management; provided that said department determines that there is no other disposal method, including land application, that may be approved by federal and state agencies".

2. Ultimate Disposal Alternatives

This report includes analyses of the following ultimate disposal alternatives:

- wetlands application and aquaculture
- lake discharge
- river discharge
- estuary discharge
- reuse of water
- land application
- ocean disposal

All of the alternatives, except land application and ocean disposal, are eliminated from further study based on the lack of suitable discharge locations.

3. Land Application

Land application is the application of wastewater treatment plant effluent to the land either by surface application or spraying. The three land application alternatives studied are: slow rate irrigation, rapid infiltration, and overland flow. Slow rate irrigation is the application to effluent to a vegetated land surface with the effluent being treated as it flows through the plant and soil matrix. Rapid infiltration is the application of effluent to moderately or highly permeable soils, without vegetation, by either spreading in a basin or by sprinkling. Overland flow is the application of effluent to the top of a grass covered slope.

Based on the availability of suitable land, the rapid infiltration alternative is determined to be the preferred land application alternative. A cost comparison of the following three alternatives is presented:

Scheme	Description	Present Worth Cost
I	Rapid Infiltration of 2.2 MGD & Ocean Disposal of 2.0 MGD	$16,606,000
II	Rapid Infiltration of 4.2 MGD	$23,140,000
III	Ocean Disposal of 4.2 MGD	$ 1,124,000

Present worth costs are based on an Engineering News Record index (ENR) of 5,212 for August 1990 for capital costs and 5,457 for June 1991 for operation and maintenance costs. August 1990 is the mid-construction date and June 1991 is the project completion date, as presented in the Step 1 - Facility Plan for Expansion of Wastewater Treatment Facility and Collection System.

4. Ocean Outfall Study Summary and Conclusions

The experimental analyses conducted for the proposed wastewater treatment plant expansion from 2.0 MGD to 4.2 MGD with associated increased ocean discharge included:

- hydrographics
- water quality
- dispersion analysis
- sludge quality
- sediment analyses
- marine resources

Due to existing tidal currents and projected good effluent quality from the wastewater treatment plant, there would be minimal impact on the water quality at the Zone of Initial Dilution (ZID) at the present outfall location. No impacts on the ZID could be attributed to metals or pesticides. Residual chlorine was found to decay three fold between the treatment plant and the sampling point closest to the outfall. No physical alteration or relocation of the existing outfall is necessary, since an increase in discharge from 2.0 MGD to 4.2 MGD was not found to have a measurable impact on the bay's residual BOD or dissolved oxygen levels. A future conditional closure area around the present outfall may be possible based on the bacteriological impacts to shellfish, the operational history of the wastewater treatment facility, and shellfish data after plant startup.

5. Recommended Plan

The preferred land application alternative is compared to the expanded use of the existing ocean outfall for disposal of the projected future flow of 4.2 MGD in the year 2010. Due to the tremendous difference in costs of using rapid infiltration vs. costs of using ocean disposal and the minimal environmental impact on the receiving waters, it is recommended that the Town continue to use the existing ocean outfall for ultimate disposal of wastewater effluent.

6. Implementation

The Town of Dartmouth, Massachusetts, maintains the existing sewage works and has the legal authority to implement the

recommended plan. No funding is necessary for the recommended plan, since no modifications to the existing ocean outfall is required for the ultimate disposal of the year 2010 average daily design flow of 4.2 MGD. Local funds for O&M costs will be raised through an approved system of general taxation (50%) and "sewer-user charges" (50%). Construction funds for the treatment facilities are from special state grants.

1. INTRODUCTION

CHAPTER 1 - INTRODUCTION

A. Study Purpose and Scope

In 1983 the draft report entitled "STEP 1 - Facility Plan for Expansion of Wastewater Treatment Facility and Collection System" was prepared for the Town of Dartmouth. The report recommended the following improvements:

1. Expansion of the wastewater treatment plant to 4.2 MGD (average daily flow) utilizing the conventional activated sludge process with composting of sludge.

2. Construction of a community subsurface disposal system for the homes adjacent to Lake Noquochoke.

3. Implementation of a Septic System Maintenance Program (SSMP) with rehabilitation of problem systems for all remaining unsewered areas throughout the town.

4. Expansion of the town's sewer system to include upgrading of all existing pumping stations, and construction of 31.4 miles of gravity sewer, 1.5 miles of force main, and 3 new pumping stations.

In the addendum to Chapter 8 of the Facility Plan it was recommended, due to the proposed Bristol County House of Correction to be built in Dartmouth, that the initial phase of expansion of the wastewater treatment facility and collection system include the following:

1. Construction of a new permanent Faunce Corner Road Pumping Station.

2. Construction of an additional length of interceptor sewer from Faunce Corner Road to the proposed jail which will be built on the westerly side of Faunce Corner Road, approximately one-half mile northerly of the railroad right-of-way.

3. Construction of a new force main and gravity sewer from the Faunce Corner Road pumping station to the interceptor in Faunce Corner Road.

4. Expansion of the wastewater treatment plant to 4.2 MGD (average daily flow) utilizing the conventional activated sludge process, composting of sludge, and ultimate disposal of effluent via the existing outfall.

Since the draft of the Facility Plan was completed, the Department of Environmental Quality Engineering (DEQE) has requested the updating of the Facility Plan and additional studies to consider other ultimate disposal alternatives, namely land application and alternative ocean outfall sites. This report will present the results of the additional ultimate disposal studies.

Currently the Ocean Sanctuaries Act prohibits "any new municipal wastewater treatment discharge into the ocean sanctuary" (refer to Appendix E). Dartmouth petitioned for and received special legislation (refer to Appendix C) granting it a waiver of the Ocean Sanctuaries Act to "improve its municipal wastewater treatment facility and appurtenances thereto, and, as a result of such improvement, to increase its ocean discharge of wastewater subject to the regulations and restrictions established by the Department of Environmental Management; provided that said department determines that there is no

other disposal method, including land application, that may be approved by federal and state agencies" provided that the improvements "are of equal or greater effectiveness in avoiding degradation of the water quality of the affected ocean sanctuary and the surface and ground water of the area for which the facility is providing wastewater treatment; and that such discharge shall have, at a minimum, secondary treatment".

The scope of this report includes:

* A General Plan which shows potential land application sites, areas of potential groundwater for water supply wells, areas where large withdrawals of groundwater may induce movement of freshwater/saltwater interface, soils suitable for rapid infiltration, areas excluded from consideration as land application sites due to level of development, and municipal water supply wells.

* A description of the existing ultimate disposal alternatives which include wetlands application, lake discharge, river discharge, estuary discharge, groundwater discharge, land application, and ocean disposal.

* A description and presentation of the design criteria for the available land application alternatives which include: slow rate irrigation, rapid infiltration, and overland flow systems.

* A presentation of the location and suitability of potential land application sites.

* The results of the ocean outfall portion of this study which includes field sampling, hydrographic measurements, water and bacteriological modeling, and impacts assessment.

* A comparison of the land application alternatives and ocean outfall alternatives which will include a present worth cost analysis of the alternatives and a recommendation of the preferred ultimate disposal alternative.

B. Planning Area

The planning area is the entire Town of Dartmouth which is located in Southeastern Massachusetts on Buzzards Bay. The town is in the southern portion of Bristol County and is bordered by the Town of Westport on the west, the City of Fall River and the Town of Freetown on the north, the City of New Bedford on the east, and Buzzards Bay on the south.

C. Effluent Limitations

As discussed in Chapter 1 of the updated Facility Plan the existing National Discharge Elimination System (NPDES) Permit sets the effluent quality limitations for the wastewater treatment facility. The facility currently discharges treated wastewater under a discharge permit (Federal No. MA0101605, State No. M-35) dated October 11, 1978 and expiring May 31, 1984.*

The effluent quality limitations as set forth in the NPDES permit are presented on the next page.

* Permit has been renewed by Town but new permit has not been issued by the State

TABLE 1-1

CURRENT DISCHARGE LIMITATIONS

Effluent Characteristics	Monthly Average	Weekly Average	Daily Maximum
Flow (MGD)	2.0	N/A	N/A
Biochemical Oxygen Demand, 5 Day (BOD5), 20° C (mg/l)	30	45	50
Total Suspended Solids (SS) (mg/l)	30	45	50
Settleable Solids (mg/l)	0.1	0.1	0.3
Fecal Coliform Bacteria (count/ 100 ml)	200	400	400
Total Coliform Bacteria (count/ 100 ml)	1000	2000	2000
Chlorine Residual	N/A	N/A	N/A
pH	Between 6.0 and 9.0		

2. ULTIMATE DISPOSAL ALTERNATIVES

CHAPTER 2 - ULTIMATE DISPOSAL ALTERNATIVES

A. Available Ultimate Disposal Alternatives For Wastewater

The methods available for ultimate disposal of wastewater include: wetlands applications and aquaculture, lake discharge, river discharge, estuary discharge, groundwater recharge, land application, and ocean disposal.

Wetlands Application and Aquaculture

In recent years experiments have been conducted using wetlands for the treatment of wastewater. Wetlands application consists of applying the treated effluent to wetlands including artificial wetlands, existing wetlands or peat lands. The application of effluent to existing freshwater and saltwater wetlands is being studied in various locations. Two artificial wetlands treatment systems have been developed at the Brookhaven National Laboratory on Long Island, New York. Cattails and duckweed were planted in these artificial wetlands, but are not regularly harvested. The harvesting of vegetation is essential for effective nutrient removal. A peat lands system has been designed in Minnesota using a sprinkler system with underdrains. Nitrogen removal is achieved in the peat lands system by grass planted on the peat surface. An underdrained system would not be acceptable in Dartmouth since the renovated effluent would still require ultimate disposal.

Aquaculture is the use of aquatic organisms for achieving wastewater treatment. Experiments are being conducted at the Woods Hole Oceanographic Institution using shellfish and in Oklahoma City, Oklahoma using catfish and shiners. As indica-

ted by the several studies sited above, wetlands application of effluent and aquaculture are currently only experimental technologies. Due to the uncertainties inherent in wetlands application and aquaculture, the use of either type of system in Dartmouth would require in-depth studies in accordance with 314 CMR 3.10 (3), (4), (5), and (6) to determine the specific environmental impacts. Since other proven treatment methods are more readily available for use in Dartmouth, neither the wetlands application nor the aquaculture method of treatment will be given further consideration in this report.

Lake Discharge

The discharge of treated wastewater effluent into lakes is an example of disposal by dilution. Effluent may be disposed of in oceans, estuaries, rivers, and lakes, and is generally preferred in this order based on the dilution capacities of the bodies of water. However, in an inland location where a stream or river is not available, disposal of effluent to a lake may be necessary.

The two lakes which are located in Dartmouth are the Cedar Dell Lake and Lake Noquochoke. Lake Noquochoke is several times larger than Cedar Dell Lake and is located in the northwestern part of the town, south of I-195, north of Route 6, near the Westport town line. From discussions with members of the Board of Health, the area surrounding the lake is considered to be a high priority for sewers. The homes are on small lots near the lake's edge. Originally the homes were for summer use only, but are now used year round without any significant expansion or upgrading of the existing on-site disposal systems. No direct connections of domestic waste from these homes to the lake have been found by the Board of Health. It

is suspected by members of the Board of Health, that leachate from the on-site disposal systems near the lake's shoreline, flows into the lake, causing frequent closing of the lake to swimming. The lake is located in the groundwater recharge area, about 3.4 miles northwest of the existing municipal water supply wells. The lake is fed by the Shingle Island River and discharges through the East Branch of the Westport River. It is a backup water supply for the City of Fall River.

Cedar Dell Lake is located in the central part of town, southerly of Old Westport Road, easterly of Lucy Little Road, and about 2000 feet westerly of Southeastern Massachusetts University. The lake is approximately 20 acres in area. No connecting streams are visible on the United States Geological Survey (USGS) map. The lake is located within the groundwater recharge area, about 1.3 miles northerly of the existing municipal water supply well. Since Cedar Dell Lake is so small and has no inlet or outlet streams (visible on the USGS map), its dilution capacity is severely limited.

Due to the existing concerns about the pollution of Lake Noquochoke by the disposal systems located on the lake's edge, the feasibility of treating any effluent there is limited. Due to the limited dilution capacities of these two lakes, the disposal of effluent to a lake in Dartmouth will not be considered further in this report.

River Discharge

River discharge is another example of disposal by dilution. In addition, the action of living organisms that consume organic matter and the sedimentation process that leaves deposits on the river bottom also help contribute to the disposal

process. The major rivers in Dartmouth are: the Paskamanset, Slocums, Copicut, and Shingle Island Rivers. The Slocums River is a tidal estuary of the Paskamanset River and will be discussed in the estuary discharge section of this chapter.

The Paskamanset River has a water quality classification as stated in 314 CMR of class B. The river flows south for approximately 9 miles in an area located northerly of Route I-195 and ultimately empties into the Slocums River. At its nearest approach, the river is approximately 800 feet from the existing wastewater treatment plant. In the late sixties, when the design of the original Dartmouth Wastewater Treatment Facility was being contemplated, the direct and indirect discharge of effluent to the Paskamanset River was deemed unacceptable because of concerns of adverse impacts on the river. Instead, the existing six mile outfall sewer was designed to discharge the effluent to Buzzards Bay.

The Copicut and Shingle Island Rivers have a water classification of B. The Copicut River flows in a southerly direction from the Fall River town line to the Shingle Island River. The Shingle Island River flows in a south southwesterly direction from an area near the Fall River town line to Lake Noquochoke, which drains to the east branch of the Westpart River. Both rivers are located several miles northerly of the wastewater treatment plant. As stated in the 208 Areawide Wastewater Management Plan developed by the Southeastern Regional Planning and Economic Development District (SRPEDD) these two rivers are antidegradation segments. As defined by the Massachusetts Clean Water Act no municipal discharge can take place in an antidegradation segment. As a consequence, these two rivers are protected from future wastewater discharges.

Due to the fact that the Copicut and Shingle Island Rivers are antidegradation segments and, as such, no municipal wastewater discharge is permitted into them, the only river in Dartmouth where river discharge is feasible is the Paskamanset. However, this river runs through the primary aquifer recharge area and, as indicated by the DEQE in their letter dated October 19, 1987 (see Appendix A), is considered to be an antidegradation segment due to its low flow characteristics. Therefore, it is believed that the Paskamanset River could not accept a discharge of the magnitude required in Dartmouth, i.e. 2.2 MGD, using conventional treatment methods. The river discharge method of ultimate disposal will not be given further consideration in this report.

Estuary Discharge

An estuary is roughly defined as the zone in which a river meets the sea. An estuary discharge is also an example of disposal by dilution. The analysis of the dilution of effluent in an estuary is complicated by the ebb and flow of tides which can cause a reverse in the direction of the flow within the estuary.

The Slocums River, which is a tidal estuary of the Paskamanset River, is a broad tidal stretch that empties into Buzzards Bay. Its water quality classification is SA, which is the highest water quality classification for salt water. At its northernmost point, the river is located 1.7 miles south southwesterly of the wastewater treatment plant. The Slocums River has been closed to shellfishing since 1977 indicating that degradation of the water quality has already taken place.

The estuary discharge alternative will not be given any further consideration for the following reasons:

1. The Slocum River has been closed to shellfishing since 1977 indicating that degradation of the water quality in this area has already taken place. Any additional discharge to the river could increase the level of degradation.

2. The DEQE has stated in their letter of October 19, 1987 that the Paskamanset/Slocums River is an antidegradation segment, and as much, cannot accept a discharge of this magnitude, i.e. 2.2 MGD, using conventional treatment methods.

Reuse of Water

There are two types of water reuse, direct and indirect. Indirect reuse is what takes place as several municipalities use a certain body of water, i.e. stream, river, or lake, for both a water supply and wastewater disposal. Therefore, over a period of time, water in the given body of water can be reused many times before reaching the sea. Direct reuse of treated wastewater effluent as a municipal water supply is generally not done. However, the use of treated wastewater effluent for industrial use, agriculture or for the development of artificial lakes for recreational purposes is becoming more prevalent.

Although few industries currently reuse wastewater effluent directly, there is enormous potential for this to occur since water supplies are generally limited. If treated properly, effluent can be used for general plant application, for cooling water and for boiler feedwater. Examples of industrial reuse

of effluent include: the Bethlehem Steel Company's Sparrows Point plant in Maryland, Cosden Oil and Chemical Company at Big Spring, Texas, and the Texas Company's Amarillo Refinery in Amarillo, Texas. Since there are no significant industrial water users in Dartmouth, the industrial reuse of effluent is not a viable alternative.

Agricultural reuse of wastewater treatment plant effluent consists of using effluent for irrigation for crop production. In the United States, the use of effluent for irrigation of agricultural lands is generally isolated to the arid and semi-arid regions. The primary concern of this method of ultimate disposal is that it may cause a public health hazard. Generally, it is believed that disease can be transmitted by the ingestion of uncooked vegetables that have been irrigated with treatment plant effluent. Since there are questions regarding the public health using this type of ultimate disposal system and since Dartmouth's climate is neither arid nor semiarid, agricultural reuse will not be investigated further. Rather, the application of effluent to land for disposal as opposed to irrigation for crop production will be addressed.

Wastewater effluent is used for recreational purposes in the Santee County Water District in San Diego County, California. A series of artificial lakes is being fed by the effluent from the treatment plant. The lakes are used for boating, fishing, and swimming. The shore around the lakes is used for playgrounds and picnic areas. Other recreational uses of wastewater effluent include irrigation of golf courses, a common practice in many areas of the Southwest. Due to the abundance of natural recreational attractions in Dartmouth and since the irrigation of golf courses with effluent is not necessary, the reuse of effluent for recreational purposes will not be considered as a viable ultimate disposal alternative in Dartmouth.

Groundwater recharge is the replenishment of groundwater supplies through artificial recharge with floodwaters, industrial wastes, and municipal wastewater. Surface spreading or pumping underground may be used to introduce effluent into the groundwater. Many recharge projects are currently in operation and given the growing need for groundwater supplies, these types of recharge systems will become more common. The use of septic systems is actually an indirect recharge of the groundwater with effluent. Since Dartmouth has had to close a municipal supply well and has not pumped a newly developed well due to contamination, the prospect of groundwater recharge would not be met favorably by the townspeople. In addition, the introduction of effluent into the groundwater could result in the spreading of contaminants already existing in the area. Extensive studies and development costs required for this ultimate disposal alternative would be prohibitive. Due to the environmental impacts of this method of ultimate disposal, groundwater recharge will not be considered as a viable alternative in Dartmouth.

In summary, reuse of water and groundwater recharge in Dartmouth will not be given further consideration as a means of ultimate disposal for the following reasons:

1. There are no existing industrial water users in Dartmouth and any industrial reuse outside of Dartmouth would result in increased costs for transportation to the industrial reuse site.

2. There are questions regarding public health in using this ultimate disposal system and the climate in Dartmouth is neither arid nor semi-arid, hence reuse of effluent for agricultural purposes is both unnecessary and limited by seasonal factors such as rainfall and freezing.

3. The introduction of effluent into the ground could result in the spread of contaminants should they already exist in the area.

Land Application

Land application is the application of wastewater treatment plant effluent to the land either by surface application or spraying. The land on which the effluent is applied may be vegetated, unvegetated or forested. The three primary land application alternatives are a) slow rate irrigation, b) rapid infiltration, and c) overland flow.

Slow rate irrigation is the application of wastewater to a vegetated land surface with the effluent being treated as it flows through the plant-soil matrix. A portion of the flow is used by the vegetation and the rest percolates through the soils to the groundwater. In a rapid infiltration system, most of the applied wastewater percolates through the soil, with the treated effluent draining naturally to either surface waters or to where it joins the groundwater. The overland flow system consists of applying effluent to the upper end of a prepared vegetative covered slope and allowing it to flow over the vegetated surface to runoff collection ditches. The runoff may have to be further treated or disposed of outside any groundwater recharge area. These three land application alternatives will be discussed in more detail later in this report.

Ocean Disposal

Ocean disposal typically consists of a submarine outfall with or without a diffuser(s) at the end. The ultimate dispo-

sal of effluent is by dilution. The design of the outfall outlet should allow the treated effluent to mix with the receiving water in a manner so as to minimize environmental impacts. This is accomplished by discharging the effluent through a single or multiport diffuser well below the surface in an area of high velocities and low aquatic life concentrations,all in accordance with the receiving water standards.

Completed in 1974, the existing outfall sewer in Dartmouth originates at the wastewater treatment plant, where the effluent is pumped, extends out to the access road then easterly on Russells Mills Road, southerly on Bakerville Road, southeasterly on Rock O'Dundee Road and southerly on Smith Neck Road, to Salter's Point, with the discharge point located approximately 3400 feet south southeasterly of Salter's Point. The outfall sewer is 27-inch diameter prestressed concrete pipe originating at the treatment plant, changing to 30 inch diameter pipe at Rock O'Dundee Road, 24-inch pipe on Smith Neck Road, and 24-inch subaqueous prestressed concrete cylinder pipe for the subaqueous portion of the outfall. The total length of the outfall sewer from the treatment plant to the outlet structure is approximately 6.4 miles. The outlet structure consists of a single 24-inch prestressed concrete pipe with two-22 1/2° bends embedded in concrete and riprap. The discharge is about nineteen feet below the surface and at 45 degrees up from the ocean floor. During the construction of the existing outfall, the ocean floor was observed to consist of numerous large boulders. The receiving water is Buzzards Bay which is classified as SA, the highest water quality class for saltwater. The existing discharge permit allows for an average daily discharge of 2.0 MGD through the outfall. The continued use of this ultimate disposal alternative for the additional 2.2 MGD in the

design year (for a total of 4.2 MGD), as permitted by special legislation, will be considered in depth later in this report. The legislation requires that no other feasible alternative exist.

B. Elimination of Alternatives

The wetlands application and aquaculture alternative(s) for ultimate disposal of effluent will not be considered further in this report since both are experimental technologies. The lake discharge alternative has been eliminated, since there are no lakes located in Dartmouth which have an adequate dilution capacity. The river discharge alternative has also been eliminated since there is no acceptable river for discharge. The Copicut and Shingle Island Rivers are classified as anti-degradation segments, and therefore are protected in the future against any wastewater discharges. The Paskamanset/ Slocums River have been eliminated since they are considered to be antidegradation segments due to their low flow characteristics, and, as such, cannot accept a discharge of this magnitude, i.e. 2.2 MGD, using conventional treatment methods (refer to letter in Appendix A).

The use of the wastewater treatment plant effluent for industrial reuse, agricultural reuse, recreational purposes, or groundwater recharge has been eliminated from further consideration for the following reasons. No industry is located in Dartmouth, hence it is not a viable alternative. Agricultural reuse for the purposes of crop production has been eliminated, since public health concerns exist for this type of ultimate disposal system and Dartmouth's climate is neither arid or semiarid which would necessitate extensive irrigation. Reuse

of wastewater effluent will not be given further consideration as an ultimate disposal alternative since there are numerous natural recreational attractions in Dartmouth, hence the creation of artificial lakes is not necessary. In addition, because of the inadequate limited groundwater supply, all recharge areas must be protected from contamination.

The two ultimate disposal alternatives which will receive further consideration in this report are land application and ocean disposal.

3. LAND APPLICATION

CHAPTER 3 - LAND APPLICATION

A. Land Application Alternatives to be Studied

The three land application alternatives to be studied are: slow rate irrigation, rapid infiltration, and overland flow. A general description of each follows.

Slow Rate Irrigation

Slow rate irrigation of effluent is the most widely used of the land application techniques and offers the highest degree of wastewater treatment of the land application systems. Slow rate irrigation systems can be agricultural, turf, or forest systems. Agricultural systems utilize effluent from the wastewater treatment plant for the irrigation of crops. Wastewater effluent is also used for the irrigation of turf areas in golf courses, parks, etc. This makes it possible to conserve potable water supplies which would otherwise be used for irrigation. The forest system has many advantages, including: soils that often exhibit higher infiltration rates than agricultural soils, lower site acquisition costs since forestland usually costs less than prime agricultural land, higher soil temperatures during cold weather than in agricultural lands, and systems which can be built on steeper grades than the agricultural systems. Principal limitations in the forest system include: low application rates and tolerance levels of some trees, relatively low nitrogen removal unless young developing forests are used or conditions are conducive to denitrification, requirement of fixed sprinklers which are expensive, and forest soils which may be rocky or very shallow.

The methods of application of effluent can be spraying, surface application by ridge and furrow method, or flooding. Spraying is the application of effluent under pressure to allow for a fairly uniform distribution. The spray system can be portable or permanent, moving or stationary, depending upon the type of vegetation and surface conditions. The ridge and furrow method uses gravity flow to allow the effluent to seep into the ground in the furrows while crops are planted in the ridges. The widths and depths of ridges and furrows vary with the amount of effluent to be disposed of and the type of soil. Land suitable for this method of application must be relatively flat. Drying of the furrows between applications of effluent is essential so that the soil pores do not become clogged. Application by flooding consists of intermittently inundating the land with a certain depth of effluent. Land suitable for this method of application must be level or nearly level so that a uniform depth of effluent can be maintained. Drying of the land between flooding applications is not necessary to prevent clogging.

The minimum operating temperature for the slow rate irrigation system is 25°F, therefore storage must be provided for days with a temperature below 25°F. Recommended application rates range from a low of 0.5 in./wk. to a high of 3.9 in./wk, depending on the type of soils, slopes, ground cover, and other factors. The effluent is applied intermittently by alternating the application and infiltration periods with drying or resting periods. The resting period may be several hours per day for this slow rate irrigation alternative. The appropriate application rate is determined by using the following water balance equation.

precipitation + applied treated wastewater
= evapotranspiration + percolation

Runoff is not included since the slow rate irrigation system is based on having no runoff. The recommended soils for this type of system include moderately permeable soils with good crop/forest productivity when irrigated.

The removal rates of wastewater constituents such as biological oxygen demand (BOD), suspended solids (SS), nitrogen, phosphorus, trace elements, microorganisms,and trace organics are dependent upon loading rates, crops, and soil characteristics. The mechanisms responsible for treatment and removal of these wastewater constituents are discussed below. BOD is removed by filtration and bacterial action. Loading rates for BOD and SS are usually not a concern in the design of slow rate irrigation systems, since the typical loading rates are far below the loading rates at which treatment performance is affected. Suspended solids are primarily removed through filtration. Residues and inert solids remaining after oxidation become part of the soil matrix.

The mechanisms for nitrogen removal in slow rate irrigation systems include crop uptake, nitrification-denitrification, ammonia volatization, and storage in the soil. Nitrogen is removed primarily by crop uptake, which varies with the type of crop grown and the crop yield. Harvesting of the crop is necessary for effective nitrogen removal. Denitrification can increase the nitrogen removal particularly if there exists high levels of organic matter in the soil (characteristic of primary effluent), high soil cation exchange capacity (characteristic of fine-textured and organic soils), neutral to slightly alkaline soil pH, alternating saturated and unsaturated soil moisture conditions, and warm temperatures. Removal of nitrogen by ammonia volatization can be significant if the soil pH is above 7.8 and the cation exchange capacity is low (sandy, low organic soils).

Adsorption and chemical precipitation are fixation processes by which phosphorus is removed from solution. Removal efficiencies for slow rate irrigation systems are generally very high and are more dependent on the soil properties than on the concentration of phosphorus applied. A small portion of the phosphorus applied is taken up and removed by the crop leaving a residual concentration of phosphorus in the percolate that will generally be less than 0.1 mg/l. Therefore, a detailed analysis would be necessary to determine the useful life of the system before saturation of the soil, at which time phosphorous would be released into the percolate.

Removal of trace elements in a slow rate irrigation system combines the mechanisms of adsorption, precipitation, ion exchange, and complexation. Removal of trace elements from the percolate is nearly complete in soils suitable for slow rate irrigation systems, therefore it is not a concern for design.

Microorganisms removed in a slow rate irrigation system include bacteria, viruses, parasitic protozoa, and helminths (worms). Removal mechanisms include straining, adsorption, desiccation, radiation, predation, and exposure to adverse conditions. Protozoa, helminths, and bacteria are removed by straining at the soil surface. Viruses are removed almost entirely by adsorption. Microorganism removal is not a limiting factor in the design of a slow rate irrigation system.

Trace organics are removed by sorption, degradation, and volatilization. Based on existing data it appears that the slow rate irrigation system is quite effective in removing trace organics in the top 1 to 2 cm. (0.4 to 0.8 in.) If the wastewater being treated contains large concentrations of trace organics from industrial contributions, industrial pretreatment should be considered.

Rapid Infiltration

In the rapid infiltration system, the applied wastewater (minus evaporation) percolates through the soil, with the effluent draining naturally via a collection system to surface waters or groundwater. Wastewater is applied to moderately and highly permeable soils (such as sands and loamy sands) by either flooding in a basin or by sprinkling. Vegetation is usually not planted as part of the rapid infifltration system.

The rapid infiltration system has no recommended minimum operating temperature since floating ice on the surface of the applied effluent helps to insulate in the cold weather. Similarly, snow cover can also help insulate the applied effluent. The nitrification rate decreases in the winter months, hence a seasonal reduced loading rate may be required. Storage may be necessary: 1) if the soil permeability is on the low end of the rates recommended, 2) to regulate the application rate during emergencies, or 3) if significant daily or seasonal peaking occurs. As in the slow rate irrigation system the water balance equation is used to determine the appropriate application rate. The recommended application rate ranges from 4 in./wk. to 94 in./wk. The recommended soils for this type of land application system are rapidly permeable soils, such as sands, loamy sands, and sandy loams.

Since there is little or no consumption by plants, more of the applied wastewater percolates to the groundwater in a rapid infiltration system than in the slow rate irrigation system. Evaporation, which is generally a small percentage of the hydraulic loading rate, ranges from about 2 ft./yr. for cool regions to 6 ft./yr. for hot arid regions. Recovery of renova-

ted water by using underdrains or wells is, in many cases, an integral part of the system. In other cases, the renovated water drains to an adjacent surface water.

Suspended solids, BOD, and fecal coliforms are almost completely removed in a rapid infiltration system and when appropriate hydraulic loading cycles are used, nitrification of the applied wastewater is essentially complete. Generally, nitrogen removal averages 50% unless specific operating procedures are established to maximize denitrification. Alternating aerobic and anaerobic conditions are necessary to obtain significant nitrogen removal, since aerobic bacteria deplete the soil oxygen during each flooding cycle.

Phosphorus removal is dependent upon the physical and chemical properties of the soil and can range from 70% to 99%. As in slow rate irrigation systems, the primary removal mechanism is adsorption with some chemical precipitation. In addition, phosphorus removal is related to the residence time of the wastewater in the soil, the travel distance, and other climatic and operating conditions.

Removal of trace elements is by the same mechanisms as discussed in slow rate irrigation systems. At rapid infiltration sites, trace elements accumulate in the upper soil layers.

Effective removal of fecal coliforms is achieved with an adequate travel distance. The mechanisms of removal are the same as in slow rate irrigation systems, i.e. straining, adsorption, desiccation, radiation, predation, and exposure to adverse conditions. Due to the small size of viruses, they are not removed at the soil surface by straining, but instead, travel into the soil profile.

Trace organics are removed by volatilization, sorption, and degradation (primarily biological degradation). Chlorination before land application should be avoided since chlorination prior to land application may cause the formation of chlorinated trace organics that may be more difficult to remove.

Overland Flow

In the overland flow system the wastewater is applied to the top of a grass covered slope and allowed to flow over the vegetated surface to runoff collection ditches. Relatively impermeable soils are generally used for the overland flow process. The wastewater is renovated by physical, chemical, and biological means as it flows in a thin film down the slope. Since the soil is generally impermeable very little percolation is involved.

The minimum operating temperature for the overland flow system is the same as the slow rate irrigation system, i.e. 25°F. Application rates, however, generally must be reduced in cold weather due to a reduced rate of treatment. Periods of heavy rainfall can substantially increase the runoff of the overland flow system. Accordingly, storage must be provided for cold weather and during times of substantial rainfall. The optimum slope ranges from 2% - 8%, although slopes in the range of 1 - 12% have been used effectively. Sprinkling is the most common method of applying wastewater for overland flow, however surface flooding can be practical for effluents relatively low in suspended solids. Recommended application rates range from 2.4 - 15.7 in./wk.. The recommended soils include slowly permeable soils, such as clay loams and clays. Overland flow is best suited for use at sites having surface soils that are slowly permeable or have a restrictive layer such as a claypan

at depths of 1 to 2 feet. If overland flow is used on moderately permeable soils, consideration must be given to groundwater impacts.

The quality of renovated water is usually inferior to the native groundwater, even if the overland flow system is managed to obtain the best quality of renovated water achievable. If a concentrated source of renovated water enters the groundwater, such as from an overland flow system, it may be necessary to restrict the spread of renovated water into the groundwater basin. To limit the spread of renovated water into the aquifer, the renovated water can be collected by drains for shallow aquifers or wells for deep aquifers. After collection and additional treatment, if necessary, the renovated water can be used for irrigation, recreation (including lakes), industrial, or perhaps municipal purposes or discharged to a body of surface water.

Soluble organic materials are removed from the wastewater by biological oxidation. Suspended and colloidal organic materials are removed by sedimentation and filtration through the surface grass and organic layers. BOD removal is primarily a function of application rate and slope length and is independent of normal hydraulic loading rates. Most suspended solids are removed within a few feet of the application point due to the low flow velocities and shallow flow depths. Suspended and colloidal solids are removed by sedimentation, filtration through grass and litter, and adsorption on the biological slime layer.

Nitrogen is removed from the applied wastewater through a combination of plant uptake, denitrification, and volatilization of ammonia nitrogen. The dominant mechanism in a particular situation will depend on the forms of nitrogen present in

the wastewater, the amount of carbon available, the temperature, and the rates and schedules of wastewater application. Permanent nitrogen removal by the plants is only possible if the crop is harvested and removed from the field. 75 to 90% nitrogen removal is common. The form of runoff nitrogen is dependent on temperature and application rates and dosing schedule.

Phosphorus removal is generally in the range of 50% to 70% (on a mass basis), but with the addition of alum or ferric chloride to the wastewater just prior to application on the slope, the removal rate can be increased. As in the slow rate irrigation and rapid infiltration systems, phosphorus removal is by adsorption and precipitation, however treatment efficiencies are somewhat limited because of the limited contact between the wastewater and the limited adsorption sites within the soil.

Trace element removal in an overland flow system is by sorption on clay colloids and organic matter at the soil surface layer, precipitation as insoluble hydroxy complexes, and formation of organometallic complexes with the organic matter at the slope surface. The majority of the heavy metals accumulate in the biomass on the soil surface close to the effluent application point.

B. Minimum of Secondary Treatment Required Before Land Application in Dartmouth

Based on concerns for aquifer protection, it was mutually agreed with the DEQE, that any land application system to be investigated as an ultimate disposal alternative for Dartmouth would require a minimum of secondary treatment prior to land

The Environmental Protection Agency (EPA) has established three cases of groundwater discharge for systems where the renovated water remains underground. These cases are:

Case I - The groundwater can potentially be used as a drinking water supply. The chemical and pesticide levels in the groundwater should not exceed the levels stated in the groundwater regulations. If the existing concentration in the groundwater of an individual parameter exceeds the standards, there should be no further increase in the concentration of that parameter resulting from land application of wastewater.

Case II - The groundwater is used as a drinking water supply. Groundwater regulations apply and the bacteriological quality criterion also applies in cases where the groundwater is used without disinfection.

Case III - For other than drinking water supply. Criteria for groundwater discharge in this class is made on a case by case basis based on the present or potential use of the groundwater.

Specific groundwater regulations for the State of Massachusetts are contained in 314 CMR 6.00 which appears in Appendix G. All groundwaters are assigned to one of the classes listed below based on the most sensitive uses for which the groundwater is to be maintained and protected. The classes are:

Class I - Groundwater assigned to this class are fresh groundwaters designated as a source of potable water supply.

Class II- Groundwater assigned to this class are saline waters designated as a source of potable mineral waters, for conversion to fresh potable waters, or as raw-material for the manufacture of sodium chloride or its derivatives or similar products.

Class III- Groundwaters assigned to this class are fresh or saline waters and are designated for uses other than as a source of potable water supply. At a minimum the most sensitive use of these waters shall be as a source of nonpotable water which may come in contact with, but is not ingested by humans.

All groundwater for which a specific classification was not petitioned prior to January 1, 1985 are classified as Class I by DEQE.

The Town of Dartmouth has had contamination of some of its municipal water supply and has developed zoning regulations which prohibit certain uses of lands which are located adjacent to its municipal wells and aquifer recharge areas. The town is actively working to minimize future problems with the contamination of groundwater. It has adopted a Town By-law, which established aquifer protection districts, inside of which is prohibited the discharge of liquid or leachable wastes. The only exception is waste from a one family residential subsurface disposal system. A copy of the plan showing the aquifer protection districts is contained in a pocket at the end of this report. As defined in the Town By-law the general purpose of the Aquifer Protection Districts is:

1. to promote the health, safety and general welfare of the community;

2. to protect, preserve and maintain the existing and potential groundwater supply and groundwater recharge areas within the known aquifers of the town;

3. to preserve and protect present and potential sources of water supply for the public health and safety;

4. to conserve the natural resources of the town;

5. to protect the groundwater and groundwater recharge areas of the town from adverse development or land use practices; and,

6. to prevent blight and the pollution of the environment.

Currently, the Town of Dartmouth has four active municipal water supply wells with a combined safe yield of 1.7 MGD. The wells are identified as: Chase Road Wells A, B, and C and the Violetta Well. The Chase Road Wells A, B, and C were installed in 1962. The Violetta Well was installed in 1976. The Route 6 Well is "down" due to contamination and the Chase Road Well D is intended to be used in the future but will require treatment prior to use and the construction of a pumping station for distribution. The Chase Road Well D and the Route 6 Well were installed in 1981 and 1960, respectively. The Chase Road Wells are located easterly of Chase Road near the Paskamanset River. The Violetta Well is located southerly of Old Westport Road and easterly of Fisher Road. The Route 6 Well is located southerly of Route 6, and northerly of Old Westport Road. Because of an inadequate supply of its own, the Town receives approximately one-half of its water from the City of New Bedford under an agreement providing a maximum of 5 MGD (agreement expires in 1992).

The Town is actively exploring for additional water supply wells, however, to date, no additional wells have been located. Currently the Town has contracted to clean and reline a portion of the existing water mains, design and construct an additional storage tank, and to conduct a corrosion study. No expansion of the water distribution system is currently being planned due to the limited water supply. In addition, in the fall of 1987, the town adopted a growth plan which restricts growth of its infrastructure.

The major areas of previous water well exploration include: the northeastern corner of Town located in the Shingle Island Swamp adjacent to Pine Island and High Hill Roads; the area near the Route 6 Well; the area near the Chase Road Wells A, B, and C; and the area near the existing sewage treatment plant. No known borings or test wells have been located in any of the six potential land application sites for wastewater disposal. Protection of the aquifer recharge areas is paramount in any land application consideration.

The quantity of wastewater flow to be given land application can vary. The projected total average daily flow to the wastewater treatment plant in the design year 2010 is 4.2 MGD. Therefore, if 2.0 MGD, as allowed by the discharge permit, is conveyed to the ocean outfall for ultimate disposal, 2.2 MGD will be conveyed to the land application site(s) for ultimate disposal. Accordingly, if all of the flow from the wastewater treatment plant goes to land application a total of 4.2 MGD would receive land application.

The three flow schemes to be considered for secondary effluent in Dartmouth are listed below.

i. Treat Dartmouth's future wastewater flow of 4.2 MGD at the existing wastewater treatment plant (WWTP) with a

discharge of 2.0 MGD of secondary effluent followed by chlorination through the existing outfall sewers to Buzzards Bay. 2.2 MGD of secondary effluent will be conveyed to a proposed land application site(s) for ultimate disposal.

ii. All of Dartmouth's future wastewater flow of 4.2 MGD will receive secondary treatment at the WWTP and will be conveyed to a proposed land application site(s) for ultimate disposal.

iii. All of the future wastewater flow of 4.2 MGD will receive secondary treatment and chlorination at the WWTP followed by ultimate disposal through the existing ocean outfall.

Table 3-1 contains a summary of the design criteria for each of the three land application alternatives. Table 3-2 presents the total land area requirements based on flows and degree of treatment for the three land application alternatives being considered. In all cases, the buffer zone is assumed to be 400 feet wide, in order to screen the area from the public. For the purposes of calculating the buffer zone for each alternative, the land area required without buffer zone is assumed to be square. The buffer zone is then calculated as a 400 foot wide area encompassing the application area.

Conveyance of effluent for these alternatives can be by gravity pipe or force mains. The non-operating time listed for the rapid infiltration alternative is assumed to be about one-half the non-operating time for slow rate irrigation and overland flow alternatives, i.e. 8 weeks. The eight weeks of non-operating time will allow for storage of the effluent during periods of heavy rainfall and reduced application rates in cold weather.

TABLE 3-1

COMPARISON OF TYPICAL DESIGN FEATURES
FOR LAND APPLICATION PROCESSES (a)

	Slow Rate Irrigation	Rapid Infiltration	Overland Flow
Application Rate (in./wk.)	0.5 - 3.9	3.9 - 94	2.4 - 15.7 (b)
Minimum Preapplication Treatment	primary sedimentation	primary sedimentation	grit removal and comminution
Application Techniques	spray or surface	usually surface	spray or surface
Soil Permeability Class Range	moderately slow to moderately rapid	rapid	slow
Soil Textural Class Range	clay loams to sandy loams	sand and sandy loams	clays and clay loams
Grade Limitations	<20% on cultivated land; <40% on noncultivated land	not critical; excessive grades require much earthwork	finish slopes 2 - 8%
Depth to Groundwater (Minimum)	2 - 3.3 ft. (c)	3.3 ft. during flooding cycle; 4.9 - 9.8 ft. during drying cycle (c)	not critical (d)

(a) Typical design features for land application processes are from EPA Process Design Manual "Land Treatment of Municipal Wastewater"
(b) Range includes raw wastewater to secondary effluent, higher rates for higher level of preapplication treatment.
(c) Underdrains can be used to maintain this level at sites with high groundwater table.
(d) Impact on groundwater should be considered for more permeable soils.

TABLE 3 - 2

TOTAL LAND AREA REQUIREMENTS
BY LAND APPLICATION ALTERNATIVE

Land Application Alternative	Effluent Type	Application Rate (in./wk.)	Quantity Applied (MGD)	Non-operating Time (weeks)	Field Area Required (Ac) (1)	Area Required Without Buffer Zone (Ac) (2)	Buffer Zone (Ac.) (3)	Total Land Area Required (Ac.)
Slow Rate Irrigation	primary	0.5	2.2	17	1600 (4)	1750 (5)	340	2090
	secondary	1.0	2.0	17	750	800	230	1030
	secondary	1.0	2.2	17	800	900	240	1140
	secondary	1.0	4.2	17	1500	1700	330	2030
Rapid Infiltration	primary	5.5	2.2	8 (6)	130	210	125	335
	secondary	11.0	2.0	8 (6)	60	120	100	220
	secondary	11.0	2.2	8 (6)	65	140	105	245
	secondary	11.0	4.2	8 (6)	130	230	130	360
Overland Flow	primary	4.0	2.2	17	200	350	160	510
	secondary	8.0	2.0	17	90	180	120	300
	secondary	8.0	2.2	17	100	200	120	320
	secondary	8.0	4.2	17	200	350	160	510

NOTES

(1) Field area requirements are based on EPA Technical Report "Costs of Wastewater Treatment by Land Application", p. 63

(2) Area requirements without buffer zone are from EPA Technical Report "Costs of Wastewater Treatment by Land Application", p. 26

(3) To calculate buffer zone, land area w/o buffer zone is assumed to be square (width of buffer zone is assumed to be 400 ft., i.e. equal to buffer zone at the wastewater treatment facility)

(4) Assumed to be 800 Ac. (secondary) x 2 since the application rate is 1/2 that for application of secondary effluent

(5) Interpolated since an application rate of 0.5 in./wk. cannot be read on the land requirement chart sited in (1) above

(6) Assumed to be approximately 1/2 of the non-operating time for slow rate irrigation to provide for periods of heavy rainfall and reduced applicated rates in cold weather

The land areas generated in Table 3-2 were used to develop the total land area requirements for both land application flow schemes. Table 3-3 presents the total land area requirements for the two flow schemes. The buffer zones presented in Table 3-3 were calculated in the same manner as the buffer zones presented in Table 3-2.

D. Elimination of Overland Flow as an Ultimate Disposal Alternative

For the preliminary analysis of the land application alternatives, factors other than cost are first evaluated. Other impacts will be discussed initially in order to minimize the present worth analysis required to determine the preferred alternative. A present worth cost analysis is included later in this chapter.

The following wastewater constituents are of major concern for health and environmental reasons.

Nitrogen
Phosphorus
Dissolved solids
Microorganisms
Trace elements

Nitrates and ammonia are usually of major concern in land application systems. Storage ponds can be used for additional nitrogen removals, and work very well for slow rate irrigation and overland flow systems, but the resulting algal growth may cause soil clogging in the rapid infiltration systems. Nitrogen is often the limiting parameter for land treatment design since the EPA guidelines recommend a maximum contaminant level

TABLE 3 - 3

TOTAL LAND AREA REQUIREMENTS
BY FLOW SCHEME

	Land Application System	Quantity Applied (MGD)		Area Required w/o Buffer Zone (Ac.)			Buffer Zone (Ac.)	Total Land Area Required (Ac.)
		Primary Treated Effluent	Secondary Treated Effluent	Primary Treated Effluent	Secondary Treated Effluent	Total		
Scheme I	slow rate irrigation	0.0	2.2	0	900	900	240	1140
	rapid infiltration	0.0	2.2	0	140	140	105	245
	overland flow	0.0	2.2	0	200	200	120	320
Scheme II	slow rate irrigation	0.0	4.2	0	1700	1700	330	2030
	rapid infiltration	0.0	4.2	0	230	230	130	360
	overland flow	0.0	4.2	0	350	350	160	510

of 10 mg/L nitrate as nitrogen at the land treatment boundary to avoid methemoglobinemia in very young infants using the water supply. Land treatment systems which discharge to surface waters are generally designed to provide nitrification since ammonia is toxic to some species of young freshwater fish and depletes the dissolved oxygen content. Overland flow and slow rate irrigation systems produce a well nitrified effluent, while renovated water from the rapid infiltration systems contain very little ammonia nitrogen, if relatively short application periods are alternated with somewhat longer drying periods. When nitrogen is the limiting nutrient, nitrogen removal is performed to prevent algal blooms and increased rates of eutrophication for systems that discharge to surface waters.

Phosphorus can be a limiting nutrient that controls the eutrophication of surface waters, however there are no drinking or irrigation water standards for phosphorus. Adequate phosphorus removal in the slow rate irrigation and rapid infiltration systems is generally possible, since the phosphorus concentrations in the percolates are usually quite low (less than 1 mg/l). In the overland flow system additional treatment may be necessary if phosphorus is limited by the discharge permit.

An excessive level of total dissolved solids can cause poor taste in drinking water, may have a laxative effect on the consumer, and may corrode equipment in the water distribution system. Land treatment may be limited to processes that discharge to surface waters or renovated water recovery may be required to protect the groundwater quality in communities where the salinity of the wastewater is significantly higher than the salinity of the groundwater.

Trace elements include heavy metals and toxic organics. Heavy metals in wastewaters are generally lower than the limits established for drinking water, however some trace elements, particularly cadmium, can accumulate in the food chain while others may move through the soil and enter the groundwater. For slow rate irrigation and rapid infiltration sites the concentration of trace elements in the soil is highest near the soil surface and decreases with depth. In overland flow systems, heavy metals are adsorbed at the soil surface in the organic layer of decomposing organic material and plant roots. Metals tend to accumulate near the point of wastewater application, since adsorption occurs as the applied wastewater flows across the soil surface.

Trace or toxic organics, such as chlorinated hydrocarbons, in land application systems may travel through the soil profile and enter drinking water aquifers or accumulate in the soil profile and be taken up by plants. Although the amount of trace organics which can be removed during movement through the soil is not well understood, many trace organics are adsorbed as they move through the soil profile in slow rate irrigation and rapid infiltration systems. In the overland flow system, research indicates that sufficient removal rates can result from volatilization as the wastewater flows over the slope or from sorption near the soil surface followed by either microbial degradation or volatilization.

Microorganisms which are pathogenic to humans include bacteria, viruses, and parasitic protozoa and helminths. In slow rate irrigation and rapid infiltration systems the major mechanisms of microbial removal are straining, die-off, sedimentation, interception and adsorption. In the overland flow systems, the bacteria are removed near the soil surface by filtration, biological predation, and ultraviolet radiation. It is

possible for parasite eggs, such as Ascaris and helminths, to survive for months to years in the soil, therefore vegetables to be eaten raw should not be grown at land treatment sites for at least 1 to 2 years after land application operations have been terminated.

The overland flow system requires collection of the renovated water in runoff ditches for ultimate disposal to a body of surface water. Since the soils used for an overland flow system are generally impermeable, there is very little percolation of the effluent. In the more arid parts of the country, renovated wastewater from the overland flow system can be used for irrigation, however, in Dartmouth, there is no need to use renovated wastewater for irrigation. In Dartmouth, the purpose of land application would be to serve as an ultimate disposal system. Discharge to the ocean through an outfall is not acceptable to the reviewing authorities. However, if land application is ruled out as an ultimate disposal alternative, then discharge to the ocean (or other surface water) becomes inevitable. In addition, the quantities of runoff will increase during periods of rainfall to further increase the ultimate disposal problem.

While the overland flow system requires less land area than the slow rate irrigation system, it would require extensive site work to prepare the terrain for the application of wastewater effluent. Trees would have to be removed in the application area. The existing grades would need to be regraded to a slope between 2% - 8%, with 2% - 4% preferred for adequate detention time. The planting of selected vegetation would also be required for this type of land application system. A general review of soils in Dartmouth revealed that there are no areas of significant size with clay loams or clay, which are preferred for overland flow systems. It is possible to use

overland flow on the moderately permeable soils generally found in Dartmouth, however other land application alternatives are better suited to these soils and the more permeable the soil used for overland flow, the greater the potential for adverse groundwater impacts.

As stated earlier, the Town has had contamination of some of its municipal water supply and has developed zoning by-laws which prohibit certain uses of lands in and adjacent to municipal wells and aquifer recharge areas. Therefore, no renovated effluent can be discharged into an aquifer protection district nor should it be allowed in an aquifer recharge area. Thus, a site for ultimate disposal of effluent would need to be found and would require some means of conveying the renovated effluent to a body of surface water for ultimate disposal. As stated before, no such body of surface water exists in Dartmouth which would be allowed to receive renovated effluent.

In summary, the overland flow system will no longer be considered as a land application alternative in Dartmouth for the following reasons:

1. The overland flow system is not an ultimate disposal system unless provisions are made for gathering renovated wastewater which has accumulated in the runoff ditches and disposal in a selected body of surface water. In Dartmouth, the selected body of surface water for discharge of the renovated water must lie outside of the aquifer protection districts. No such body of surface water exists in Town.

2. Extensive work would be required to prepare the land for use as an application site for the overland flow system. This would include removing of trees, preparing of the grass covered slopes to a slope of 2% - 8%,

planting with vegetation, constructing a series of drainage ditches to collect runoff, and conveying the renovated water to a body of surface water for discharge.

3. Additional treatment of the renovated water for removal of phosphorus may be necessary prior to discharge to a body of surface water.

4. The use of moderately permeable soils found in Dartmouth would increase the potential for adverse groundwater impacts resulting from the use of an overland flow system.

5. The soils in Dartmouth are better suited to slow rate irrigation or rapid infiltration systems.

6. The quantities of runoff during periods of rainfall would significantly increase the ultimate disposal problem.

E. Preliminary Analysis of Slow Rate Irrigation and Rapid Infiltration Land Application Sites

The Town of Dartmouth has several large areas of open or undeveloped land that are of sufficient acreage to be considered as potential land application sites. Although there are several undeveloped areas located north of Route 6, these will not be considered as potential land application sites since they are located upstream of the groundwater recharge areas (see general plan). The natural drainage in Dartmouth runs generally from north to south. The land application of effluent in areas northerly of Route 6 could potentially contaminate

the groundwater recharge areas and, subsequently, the existing and any future municipal water supply wells. Southerly of Route 6 there are small areas of land which might be used for a land application system, but since each is small in comparison to the total land area required for either land application alternative, they will not be considered in the analysis of the potential sites.

In analyzing the various potential land application sites, a combination of two separate sites which yielded the necessary acreage were given consideration for the particular land application system. Naturally if there is sufficient area in a single site to accommodate a particular land application system, it would be preferable to utilizing two separate sites. Similarly, a site which is located close to the wastewater treatment facility would be preferable to a more remote site.

Six potential land application sites were identified from townwide maps. The sites will be combined into two groups for the purposes of analyzing their suitability for land application. Sites I, II, and III have similar soils and will be considered as land application sites for either a rapid infiltration or slow rate irrigation system. Sites IV, V, and VI have a much higher rate of permeability than Sites I, II, and III and will be considered for rapid infiltration only. All of the potential sites are shown on the general plan accompanying this report and the detailed description of on-site investigations are presented in Appendix F.

Site I is located westerly of Chase Road, southerly of Lucy Little Road and northerly of Woodcock Road. It is closest to the wastewater treatment facility of any of the three potential slow rate irrigation sites. It is approximately 900 acres

in size and is zoned SR-A, single residence - A, with a minimum lot size of 40,000 S.F. (square feet). A review of the Dartmouth Natural Resources Map shows some small areas of wooded swamp and shrub swamp with some very small areas of deep fresh marsh and fresh swamp. The entirety of Site I is located outside of, but adjacent to, the Town's Aquifer Protection District but 10 to 15 percent falls within the groundwater supply area. Considerable surface runoff passes through the well fields.

In summary, the two on-site investigations which took place in March and April of 1986 (refer to Appendix F) revealed that the site is not suitable for slow rate irrigation due to shallow, tight soils and very high groundwater conditions. Surface water was seen in numerous locations, as were ledge outcrops. Root systems of trees were observed to be shallow and the underlying soil to be mostly boulders. Only the top of the southernmost hill could be readily used for spray irrigation. Soils in this site are not suitable for rapid infiltration.

Site II contains approximately 900 acres and is located northwesterly of Horseneck Road and southerly of Slades Corner Road. It is zoned SR-B, single residence - B, with a minimum lot size of 80,000 S.F. Natural resources in this site include a small area of wooded swamp and a very small area of deep, fresh marsh. This site is also located outside of any Aquifer Protection District, but within the potential groundwater supply area.

Three on-site investigations were performed in March, April, and November of 1986 (Refer to Appendix F). Numerous farms were observed throughout this site, with the primary crop being fodder corn. An estimated one-third of this site might be suitable for limited spray irrigation during the drier months of the year. The high number of boulders located

throughout the site would make site preparation extremely difficult and soils in this site are not suitable for rapid infiltration.

Site III contains approximately 500 acres and is located adjacent to the existing outfall sewer southerly of Rock O'Dundee Road and northeasterly of Potomska Road. Like Site II, this site is zoned SR-B and the natural resources within the site include a small area of wooded swamp and a very small area of fresh swamp. This site lies outside the Aquifer Protection District and nearly entirely outside the potential groundwater supply area. Soils in this site are not acceptable for rapid infiltration.

Site III was investigated three times in March, April and November 1986 (Refer to Appendix F). Field observations indicate that the site is unacceptable for spray irrigation due to the high groundwater table throughout about 40 percent of the area, the high boulder content of most upland areas, and the arge amount of development around the perimeter. The only area acceptable for spray irrigation is in the south central section of the site which consists of about 80 acres. The promising area may have some historical significance due to the visible stone foundation remains.

Site IV is located northerly of Slades Corner Road, westerly of Fisher Road, southerly of Gidley Town Road near the Westport townline. The total area in this site with soils suitable for a rapid infiltration system is approximately 200 acres. The site is zoned SR-A, with a minimum lot size of 40,000 S.F. The site is located within the groundwater recharge area and within the aquifer protection district 2B - area of potential future water supply development. Natural resources in this area include an area of wooded swamp and a

small area of fresh marsh. No detailed site investigations were conducted at Site IV as it was ruled out because of its location within the groundwater protection district.

Site V is located northerly of Barneys Joy Road and westerly of the Slocums River. It is estimated that the total area within this undulating site with soils suitable for rapid infiltration is 150 acres. Zoning for this site is SR-B with a minimum lot size of 80,000 S.F. The site is located in the groundwater recharge area in an area of potential saltwater intrusion, but is located outside the aquifer protection district. Natural resources in this site include a small area of fresh marsh. The site is adjacent to an area of salt marsh.

A site investigation of Site V was performed in March of 1987 by Fay, Spofford & Thorndike, Inc. personnel, a member of the Dartmouth Department of Public Works, and two members of the DEQE. There were areas along the route traveled where the soils appeared to be very pervious and well above the groundwater table. Sufficient area seemed to be suitable for disposal of 2.2 MGD of effluent by rapid infiltration. It should be noted that these areas were not contiguous, and not level and would therefore require extensive site preparation. To further assess the suitability of this site, types and depths of soils and groundwater elevations would be necessary. This site is the most promising of all.

Site VI, located westerly of Smith Neck Road just easterly of Little River and Cedar Island, is approximately 75 acres in area. Zoning in this site is also SR-B with a minimum lot size of 80,000 S.F. The site is located in the groundwater recharge area, in an area of potential saltwater intrusion. The site is located outside the aquifer protection district. An area of wooded swamp is located adjacent to this site.

On-site investigation of this site occurred in March 1987 (Refer to Appendix F). It was observed that the water table in the majority of the area is too high to allow the construction of a rapid infiltration system. It appears that the groundwater is not more than four feet below the surface, except in a narrow 400 to 500 foot strip paralleling the cove. Approximately 20 percent of this area is occupied by existing dwellings. In addition, the Planning Board has indicated that a subdivision is being planned for 40 percent of the available area. Due to the high groundwater table, existing dwellings, and planned development, it is recommended that this site be dropped from further consideration.

In addition to limited on-site observations, the soils in each of these potential land application sites are of particular importance in assessing the feasibility of a land application system. Therefore, the soils in each of the sites will be discussed in depth. Discussion of the six sites is grouped into two groups: sites I, II & III and sites IV, V & VI. The General Plan shows the various soils throughout town as determined from U.S. Soils Conservation data.

Site I is primarily composed of Whitman extremely stony fine sandy loam with 0% to 3% slopes and Woodbridge extremely stony fine sandy loam with 0% to 8% slopes, with smaller but significant areas of Paxton extremely stony fine sandy loam with 0% to 8% slopes and Paxton very stony fine sandy loam with 0% to 8% slopes. In addition there are smaller less significant areas of other soil types scattered throughout the site.

Site II soils have large amounts of Whitman extremely stony fine sandy loam with 0% to 3% slopes and smaller areas of Paxton very stony fine sandy loam with 0% to 8% slopes, Paxton extremely stony fine sandy loam, with 0% to

8% slope and Woodbridge extremely stony fine sandy loam with 0% to 8% slopes. In addition there are smaller less significant areas of various other soil types in this site.

Site III soils have large amounts of Whitman extremely stony fine sandy loam with 0% to 3% slopes, Paxton very stony fine sandy loam with 0% to 8% slopes, and Paxton fine sandy loam with 3% to 8% slopes, and smaller areas of Woodbridge very stony fine sandy loam with 0% to 8% slopes and Woodbridge extremely stony fine sandy loam with 0% to 8% slopes. Smaller areas of other various soil types are located in this site but are less significant.

Tables 3-4 and 3-5 present a summarization of the major characteristics of the soil types listed above, with particular emphasis on the items pertinent to land application. Permeability used in these tables is measured as the number of inches per hour that water moves downward through the saturated soil. The breakdown of the ranges of permeability are as follows:

very slow	-	0.06 inches
slow	-	0.06 - 0.20 inches
moderately slow	-	0.2 - 0.6 inches
moderate	-	0.6 - 2.0 inches
moderately rapid	-	2.0 - 6.0 inches
rapid	-	6.0 - 20.0 inches
very rapid	-	20.0 inches and above

All of the six major types of soils found in Sites I, II, and III have limited suitability for use as building sites, due to the seasonal high water table, or perched water table, and as sites for septic tank absorption fields, due to the slow permeability in the substratum. Although the permeability of the surface layer and subsoil is generally moderate, these six types of soils have slow permeability in the substratum which

TABLE 3 - 4

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES I, II, III
PART I (1)

Major Soils Symbol & Type	Surface Layer	Subsoil	Substratum	Permeability		
				Surface Layer	Subsoil	Substratum
PfB - Paxton fine sandy loam	fine sandy loam - 8 in. thick	top 8 in. - fine sandy loam bottom 6 in. - sandy loam	very firm & brittle gravelly sandy loam to a depth of 60 in. or more	moderate	moderate	slow or very slow
PgB - Paxton very stony fine sandy loam	fine sandy loam - 8 in. thick	top 8 in. - fine sandy loam bottom 6 in. - sandy loam	very firm & brittle gravelly sandy loam to a depth of 60 in. or more	moderate	moderate	slow or very slow
PhB - Paxton extremely stony fine sandy loam	fine sandy loam - 2 in. thick	top 14 in. - fine sandy loam bottom 6 in. - sandy loam	very firm & brittle gravelly sandy loam to a depth of 60 in. or more	moderate	moderate	slow or very slow
WhA - Whitman extremely stony fine sandy loam	1 in. of matted organic material over 5 in. of black muck	fine sandy loam - 15 in. thick	firm mottled fine sandy loam & silt loam to a depth of 60 in. or more	moderate or moderately rapid	moderate or moderately rapid	slow or very slow
WsB - Woodbridge very stony fine sandy loam	fine sandy loam - 9 in. thick	fine sandy loam & mottled gravelly fine sandy loam - 18 in. thick	very firm, mottled sandy loam to a depth of 60 in. or more	moderate	moderate	slow or very slow
WtB - Woodbridge extremely stony fine sandy loam	fine sandy loam - 4 in. thick	fine sandy loam & mottled gravelly fine sandy loam - 23 in. thick	very firm, mottled gravelly sandy loam to a depth of 60 in. or more	moderate	moderate	slow or very slow

(1) Data on soils types are from the "Soil Survey of Bristol County Massachusetts - Southern Part" by the United States Department of Agriculture Soil Conservation Service

TABLE 3 - 5

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES I, II, III
PART II (1)

Major Soils Symbol & Type	Location	Slope (%)	Percent of Surface Cover with Stones & Boulders	Suitable Uses	Poor Suitability For	Perched Water Table	Depth to Temp. Water Table During & After Rainy Periods
PfB - Paxton fine sandy loam	tops & sides of ridges & hills	3 - 8	N/A	row crops (erosion is a hazard), hay & pasture		yes	16 - 22 in.
PgB - Paxton very stony fine sandy loam	tops & sides of ridges & hills	0 - 8	1 - 3%	trees, pasture, some cultivated crops & homesites	row crops & hay	yes	16 - 22 in.
PhB - Paxton extremely stony fine sandy loam	tops & sides of ridges & hills	0 - 8	3 - 15%	trees, pasture & homesites	farming	yes	16 - 22 in.
WhA - Whitman extremely stony fine sandy loam	in depressions & low-lying areas adjacent to drainageways	0 - 3	3 - 15%	pasture	trees & farming	no	see footnote (2
WsB - Woodbridge very stony fine sandy loam	tops & sides of hills	0 - 8	1 - 3%	trees, pasture, hay & homesites	row crops	yes	20 - 27 in.
WtB - Woodbridge extremely stony fine sandy loam	tops & sides of hills	0 - 8	3 - 15%	pasture & homesites	farming	yes	20 - 27 in.

(1) Data on soils types are from the "Soil Survey of Bristol County Massachusetts - Southern Part" by the United States Department of Agriculture Soil Conservation Service
(2) Seasonal high water table is at or near the surface in the fall, winter & spring

N/A - Not applicable

restricts the downward movement of water, as well as root development. Some small areas of soil with rapid permeability, which is required for the rapid infiltration alternative, are located within site I. These areas, however, are too small to be of any significance in analyzing the soils within the site relative to the site's suitability for rapid infiltration. No areas within sites II and III have soils with rapid permeability.

A review of the surficial geology at potential land application Sites I, II, and III revealed that all the sites are located on glacial till. A look at the flow of groundwater at each of the sites revealed that Site I drains into the Paskamanset River on the east and into the Deerfield Swamp on the west. Site II drains entirely into the Slocums River and Site III drains into the Little River on the east and into the Slocums River on the west. A review of the flood hazard map of Dartmouth revealed that all of these three potential land application sites are located within Zone C, i.e. outside the 500-year flood zone.

The occurrence of a perched water table in the potential application sites may be significant since the effluent can be applied to the soil no faster than the internal drainage rate of the soil. Where a restricting layer is present at some depth and the infiltration rate is higher than the rate of water movement through this layer, a perched water table will form and rise above the restricting layer. The water table will continue to rise until the rate of water moving through the restricting layer equals the infiltration rate. When the water table reaches the surface, the infiltration rate becomes equal to the rate of water moving through the restricting layer. At this point a sharp decrease in rate of infiltration may occur which can lead to surface runoff.

Potential land application Sites IV, V, and VI were chosen based on the permeability of the soils in these areas. Based on discussions with members of the DEQE, an application rate of at least 3 gallons/square foot/day (34 in./wk.) should be used in the selection of rapid infiltration sites. A more conservative application rate of 11 in./wk. is shown on Table 3-2 and is the basis for determining the field area required for rapid infiltration of secondary effluent. A soil permeability of 2 inches/hour is required for a rapid infiltration system so that the soil does not become overly saturated with the application of 3 gallons/square foot/day of effluent. All sections throughout the undeveloped areas of town consisting of soils with a permeability of at least 2 inches/hour were determined and have been shaded on the attached General Plan. The result was the selection of Sites IV, V, and VI which contain substantial areas with soils suitable for rapid infiltration.

The discussion of soils in Sites IV, V and VI will be limited to the soils which are suitable for rapid infiltration, since the other types of soils are of little consequence.

Site IV has a large amount of Gloucester-Hinckley complex with rolling terrain. Other soils include Hinckley gravelly fine sandy loam, Merrimac fine sandy loam with 0% - 3% slopes and Merrimac fine sandy loam with 3% - 8% slopes.

Site V soils are predominantly Hinckley gravelly fine sandy loam with 8% - 15% slopes with lesser amounts of Merrimac fine sandy loam with 3% - 8%, Hinckley gravelly fine sandy loam with 3% - 8% slopes, Gloucester-Hinckley complex with undulating terrain, Agawam fine sandy loam with 0% - 3% slopes, Agawam fine sandy loam with 3% - 8% slopes and only a token amount of Merrimac fine sandy loam with 0% - 3% slopes.

Site VI soils are overwhelmingly Merrimac fine sandy loam with 0% - 3% slopes with a smaller area of Merrimac fine sandy loam with 3% - 8% slopes.

All of the thirteen soils types (suitable for rapid infiltration) found in Sites IV, V and VI have poor suitability for septic tank leaching fields or sanitary landfills due to groundwater pollution hazards resulting from the rapidly permeable soils. Soils in these three sites have permeabilities which range from moderately rapid to very rapid (i.e. 2 in./hr to over 20 in./hr).

A review of surficial geology in each site revealed that Site IV is about one third glacial till and about two thirds stratified drift associated with the Slocums River. Site V is about 20% glacial till and about 80% stratified drift associated with the Slocums River. Site VI is entirely stratified drift associated with the Little River. A review of the flow of groundwater at each of these sites reveals that Site IV drains to Destruction Brook, Site V drains to the Slocums River and Site VI drains to the Little River.

F. Elimination of Rapid Infiltration and Slow Rate Irrigation in Sites I, II, and III

The preliminary study of the major soil types in potential land application Sites I, II, and III was done to determine if the soils are suitable for all the land application alternatives. Tables 3-4 and 3-5 present the selected characteristics of the six major soils types found in Sites I, II, and III (i.e: surface layer, subsoil and substratum composition, permeability, location, slope, percent of surface covered with stones & boulders, suitable uses, poorly suited uses, presence of a perched water table, and depth to temporary water table

during and after rainy periods). Although there are smaller and much less significant areas of other soil types, these six major soils types represent approximately 80 - 90 percent of the soils found in Sites I, II, and III.

Further analysis of the soils information together with a determination of the soil suitability by ranking factors as presented in the EPA Process Design Manual "Land Treatment of Municipal Wastewater" was undertaken. Table 3-6 presents soil characteristics of the predominant soils in sites I, II and III. Table 3-7 presents a tabulation of the ratings and the overall suitability for land application for the six major soils types found in Sites I, II, and III. Table 3-7 shows that all six major soils types should be eliminated from consideration for rapid infiltration since the minimum depth to groundwater is not sufficient and permeability is too slow. Other conditions found in Sites I, II, and III which are not conducive to a rapid infiltration system include the presence of bedrock, surface boulders and wet areas. Accordingly, the rapid infiltration alternative will not be given any further consideration as a land application alternative in Sites I, II, and III.

At this point the rapid infiltration and overland flow land application systems have been eliminated in Sites I, II, and III. The slow rate irrigation system will now be analyzed for Sites I, II, and III. Because of physical constraints, no site in itself is large enough for slow rate irrigation. A combination of two or more sites would be necessary to provide sufficient area for the land application of a minimum of 2.2 MGD of effluent. From Table 3-5, it is evident that five of the six major soils types in Sites I, II, and III are poorly suited for row crops or farming. This is largely due to the boulders prevalent in these areas and the seasonally high water table.

TABLE 3-6

PREDOMINANT
SOIL CHARACTERISTICS FOR USE
IN DETERMINING SUITABILITY FOR LAND APPLICATION
BY RATING FACTORS (4)
AT
SITES I, II, AND III

Major Soil Type	Soil Depth (1) (in.)	Min. Depth to Ground-water (in.)	Minimum Permeability (2) (in./hr)	Grade (%)	Existing Land Use (3)
Paxton fine sandy loam (PfB)	60	16-22	<0.2	3-8	forest
Paxton very stony fine sandy loam (PgB)	60	16-22	<0.2	0-8	forest
Paxton extremely stony fine sandy loam (PhB)	60	16-22	<0.2	0-8	forest
Whitman extremely stony fine sandy loam (WhA)	60	0	<0.2	0-3	forest
Woodbridge very stony fine sandy loam (WsB)	60	20-27	<0.2	0-8	forest
Woodbridge extremely stony fine sandy loam (WtB)	60	20-27	<0.2	0-8	forest

(1) Depth of profile to bedrock
(2) Permeability of most restrictive layer in soil profile
(3) All potential land application sites are primarily forest with some agricultural and developed areas
(4) Data on soils types are from the "Soil Survey of Bristol County Massachusetts - Southern Part" by the United States Department of Agriculture Soil Conservation Service

TABLE 3 - 7

DETERMINATION OF SUITABILITY FOR LAND APPLICATION
BY RATING FACTORS (1)
AT SITES I, II, AND III

Major Soil Type	System Type	Soil Depth(2)	Min. Depth to Ground-water	Permea-bility(3)	Grade	Existing Land Use	Total	Suitability(4)
Paxton fine sandy loam (PfB)	slow rate irrig.-agri.	8	0	3	6	1	18	moderate
	slow rate irrig.-forest	8	0	3	8	4	23	moderate
	overland flow	7	2	8	5	1	23	moderate
	rapid infiltration	4	E (5)	E	4	1	--	eliminate
Paxton very stony fine sandy loam (PgB)	slow rate irrig.-agri.	8	0	3	6	1	18	moderate
	slow rate irrig.-forest	8	0	3	8	4	23	moderate
	overland flow	7	2	8	5	1	23	moderate
	rapid infiltration	4	E	E	4	1	--	eliminate
Paxton extremely stony fine sandy loam (PhB)	slow rate irrig.-agri.	8	0	3	6	1	18	moderate
	slow rate irrig.-forest	8	0	3	8	4	23	moderate
	overland flow	7	2	8	5	1	23	moderate
	rapid infiltration	4	E	E	4	1	--	eliminate
Whitman extremely stony fine sandy loam (WhA)	slow rate irrig.-agri.	8	0	3	8	1	20	moderate
	slow rate irrig.-forest	8	0	3	8	4	23	moderate
	overland flow	7	2	8	8	1	26	high
	rapid infiltration	4	E	E	8	1	--	eliminate
Woodbridge very stony fine sandy loam (WsB)	slow rate irrig.-agri.	8	0	3	6	1	18	moderate
	slow rate irrig.-forest	8	0	3	8	4	23	moderate
	overland flow	7	2	8	5	1	23	moderate
	rapid infiltration	4	E	E	4	1	--	eliminate
Woodbridge extremely stony fine sandy loam (WtB)	slow rate irrig.-agri.	8	0	3	6	1	18	moderate
	slow rate irrig.-forest	8	0	3	8	4	23	moderate
	overland flow	7	2	8	5	1	23	moderate
	rapid infiltration	4	E	E	4	1	--	eliminate

NOTE: The higher the ranking, the greater the suitability

(1) Rating factors are from the EPA Process Design Manual "Land Treatment of Municipal Wastewater", p. 2-24

(2) Depth of the profile to bedrock

(3) Permeability of most restrictive layer in soil profile

(4)

Land Application System Type	Overall Suitability Rating Low	Moderate	High
slow rate irrig.-agri.	(15	15-25	25-35
slow rate irrig.-forest	(15	15-25	25-35
overland flow	(16	16-25	25-35
rapid infiltration	(16	16-25	25-35

(5) E=Excluded, rated as poor

Although there are existing farms in Sites I, II, and III, these farms, when combined, do not yield sufficient area (1140 Ac.) for the agricultural slow rate irrigation system required for the ultimate disposal of a minimum of 2.2 MGD of effluent.

Sufficient land for a forested slow rate irrigation system may exist. However, high site development costs and large storage capacity would be needed. Another factor affecting the selection process is groundwater protection. As stated earlier, It is essential to preserve the groundwater recharge areas throughout the Town. Sites I and II can be eliminated from slow rate irrigation because of surface runoff into aquifer recharge/aquifer protection districts. Similar conditions exist at Site III, but only to a limited extent.

In summary, the slow rate irrigation alternative will be eliminated from further consideration as a means of ultimate disposal in Dartmouth for the following reasons.

1. The surface and subsurface runoff flows into aquifer recharge/aquifer protection districts in Sites I and II and, to a lesser extent, at Site III.

2. Site III by itself is inadequate in size to meet the needs for slow rate irrigation.

3. Because of seasonally high groundwater, storage capacity up to 4 or 5 months may be required.

4. The six major soils types found in Sites I, II, and III are poorly suited to row crops and farming due to the boulders, a seasonally high water table, and soil erosion.

5. The existing farms in Sites I, II, and III do not contain sufficient area for the application of 2.2 MGD of effluent.

6. The diversity of the sites and the physical characteristics would make the installation and maintenance of a forested system very costly.

G. Analysis of Rapid Infiltration in Sites IV, V, and VI

Thirteen major soils types with a minimum permeability of 2 in./hr. are present in Sites IV, V, and VI. Tables 3-8 and 3-9 present the selected characteristics of the thirteen major soils types found in these sites.

Table 3-10 presents the soil characteristics for use in determining suitability for land application by rating factors. Table 3-11 presents an analysis of the soil suitability by rating factors as presented in the EPA Process Design Manual "Land Treatment of Municipal Wastewater". Although the overland flow and slow rate irrigation types of systems are no longer being considered in Sites IV, V, and VI, they are included in Table 3-11 for completeness. Ratings in Table 3-11 confirm that overland flow should be eliminated from consideration in Sites IV, V, and VI and that the soils are moderately to highly suited to either slow rate irrigation or rapid infiltration.

Site IV is located within the groundwater recharge area and within the Aquifer Protection District 2B - area of potential future water supply development. Due to the limited municipal water supply in Dartmouth and the absolute need to protect the existing and future municipal water supply, rapid infiltration in Site IV will not be considered.

TABLE 3 - 8

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES IV, V, VI
PART I (1)

Major Soils Symbol & Type	Surface Layer	Subsoil	Substratum	Permeability: Surface Layer	Permeability: Subsoil	Permeability: Substratum
AgA - Agawam fine sandy loam	fine sandy loam - 1 in. thick	17 in. - fine sandy loam	to 28 in. - loamy fine sand, 28-41 in. - sand, 41-60 or more - gravelly sand	moderately rapid	rapid	rapid
AgB - Agawam fine sandy loam	fine sandy loam - 1 in. thick	17 in. - fine sandy loam	to 28 in. - loamy fine sand, 28-41 in. - sand, 41-60 in. or more - gravelly sand	moderately rapid	rapid	rapid
GcB - Gloucester-Hinckley complex						
Gloucester	fine sandy loam - 8 in. thick	15 in. - top 3 in. gravelly fine sandy loam, mid. 7 in. - gravelly sandy loam, bot. 5 in.- very gravelly loamy sand	very gravelly loamy coarse sand to a depth of 60 in. or more	rapid	rapid	rapid
Hinckley	gravelly fine sandy loam - 6 in. thick	14 in. - top 3 in. gravelly fine sandy loam, bot. 11 in. gravelly loamy coarse sand	very gravelly coarse sand to a depth of 60 in. or more	rapid	rapid	very rapid
GhB - Gloucester-Hinckley complex						
Gloucester	fine sandy loam - 2 in. thick	21 in. - top 9 in. gravelly fine sandy loam, mid. 7 in. - gravelly sandy loam, bot. 5 in. - very gravelly loamy sand	very gravelly loamy coarse sand to a depth of 60 in. or more	rapid	rapid	rapid
Hinckley	gravelly fine sandy loam - 2 in. thick	18 in. - top 7 in. gravelly fine sandy loam, bot. 11 in. gravelly loamy coarse sand	very gravelly coarse sand to a depth of 60 in. or more	rapid	rapid	very rapid

TABLE 3 - 8 (Cont'd)

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES IV, V, VI
PART I (1)

Major Soils Symbol & Type	Surface Layer	Subsoil	Substratum	Permeability: Surface Layer	Permeability: Subsoil	Permeability: Substratum
GhC - Gloucester-Hinckley complex						
Gloucester	fine sandy loam - 12 in. thick	21 in. - top 9 in. gravelly fine sandy loam, mid. 7 in. - gravelly sandy loam, bot. 5 in.- very gravelly loamy sand	very gravelly loamy coarse sand to a depth of 60 in. or more	rapid	rapid	rapid
Hinckley	gravelly fine sandy loam - 2 in. thick	18 in. - top 7 in. gravelly fine sandy loam, bot. 11 in. gravelly loamy coarse sand	very gravelly coarse sand to a depth of 60 in. or more	rapid	rapid	very rapid
HgA - Hinckley gravelly fine sandy loam	gravelly fine sandy loam - 6 in. thick	14 in. - top 3 in. very friable gravelly fine sandy loam, bot. 11 in. gravelly loamy coarse sand	very gravelly coarse sand to a depth of 60 in. or more	rapid	rapid	very rapid
HgB - Hinckley gravelly fine sandy loam	gravelly fine sandy loam - 6 in. thick	14 in. - top 3 in. gravelly fine sandy loam, bot. 11 in. - gravelly loamy coarse sand	very gravelly coarse sand to a depth of 60 in. or more	rapid	rapid	very rapid
HgC - Hinckley gravelly fine sandy loam	gravelly fine sandy loam - 2 in. thick	18 in. - top 7 in. gravelly loamy coarse sand, bot. 11 in. - gravelly loamy coarse sand	very gravelly coarse sand to a depth of 60 in. or more	rapid	rapid	very rapid
MeA - Merrimac fine sandy loam	fine sandy loam - 11 in. thick	12 in. - top 8 in. gravelly sandy loam & gravelly coarse sandy loam, bot. 4 in. - gravelly loamy coarse sand	gravelly coarse sand to a depth of 60 in. or more	moderately rapid	rapid	rapid

TABLE 3 - 8 (Cont'd)

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES IV, V, VI
PART I (1)

Major Soils Symbol & Type	Surface Layer	Subsoil	Substratum	Permeability		
				Surface Layer	Subsoil	Substratum
MeB - Merrimac fine sandy loam	fine sandy loam - 11 in. thick	12 in. - top 8 in. gravelly sandy loam & gravelly coarse sandy loam, bot. 4 in. - gravelly loamy coarse sand	gravelly coarse sand to a depth of 60 in. or more	moderately rapid	rapid	rapid
WnA - Windsor loamy sand	loamy sand - 2 in. thick	24 in. - top 10 in. - loamy sand, bot. 14 in. - sand	sand to a depth of 60 in. or more	rapid	rapid	rapid
WnB - Windsor loamy sand	loamy sand - 2 in. thick	24 in. - top 10 in. - loamy sand, bot. 14 in. - sand	sand to a depth of 60 in. or more	rapid	rapid	rapid
WnC - Windsor loamy sand	loamy sand - 2 in. thick	24 in. - top 10 in. - loamy sand, bot. 14 in. - sand	sand to a depth of 60 in. or more	rapid	rapid	rapid

(1) Data on soils types are from the "Soil Survey of Bristol County Massachusetts - Southern Part" by the United States Department of Agriculture Soil Conservation Service

TABLE 3 - 9

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES IV, V, VI
PART II (1)

Major Soils Symbol & Type	Location	Slope (%)	Percent of Surface Cover with Stones & Boulders	Suitable Uses	Poor Suitability For	Perched Water Table	Depth to Temp. Water Table During & After Rainy Periods
AgA - Agawam fine sandy loam	in woodland	0 - 3	N/A	row crops, hay & pasture	septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A
AgB - Agawam fine sandy loam	in woodland	3 - 8	N/A	row crops, hay & pasture	septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A
GcB - Gloucester-Hinckley complex	on small hills	undulating	N/A	row crops, hay, pasture & trees	septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A
GhB - Gloucester-Hinckley complex	on small hills, in woodland	undulating	1 - 3%	pasture & trees	row crops, hay, septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A
GhC - Gloucester-Hinckley complex	on small hills, in woodland	rolling	1 - 3%	pasture & trees	row crops, hay, septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A
HgA - Hinckley gravelly fine sandy loam	in woodland, near large streams & rivers	0 - 3	N/A	row crops, hay, pasture & trees	septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A
HgB - Hinckley gravelly fine sandy loam	in woodland, near large streams & rivers	3 - 8	N/A	row crops, hay, pasture & trees	septic tank absorption fields or sanitary land- fills (groundwater pollution hazard)	no	N/A

TABLE 3 - 9 (Cont'd)

CHARACTERISTICS OF MAJOR SOILS TYPES IN
POTENTIAL LAND APPLICATION SITES IV, V, VI
PART II (1)

Major Soils Symbol & Type	Location	Slope (%)	Percent of Surface Cover with Stones & Boulders	Suitable Uses	Poor Suitability For	Perched Water Table	Depth to Temp. Water Table During & After Rainy Periods
HgC - Hinckley gravelly fine sandy loam	in woodland, near large streams & rivers	8 - 15	N/A	hay, pasture & trees	row crops, septic tank absorption fields or sanitary landfills (groundwater pollution hazard)	no	N/A
MeA - Merrimac fine sandy loam	adjacent to or near large streams & rivers	0 - 3%	N/A	row crops, hay, pasture & trees	septic tank absorption fields or sanitary landfills (groundwater pollution hazard)	no	N/A
MeB - Merrimac fine sandy loam	adjacent to or near large streams & rivers	3 - 8%	N/A	row crops, hay, pasture & trees	septic tank absorption fields or sanitary landfills (groundwater pollution hazard)	no	N/A
WnA - Windsor loamy sand	near or adjacent to streams and rivers	0 - 3%	N/A	cultivated crops, hay, pasture & trees	septic tank absorption fields or sanitary landfills (groundwater pollution hazard)	no	N/A
WnB - Windsor loamy sand	near or adjacent to streams and rivers	3 - 8%	N/A	cultivated crops, hay, pasture & trees	septic tank absorption fields or sanitary landfills (groundwater pollution hazard)	no	N/A
WnC - Windsor loamy sand	near or adjacent to streams and rivers	8 - 20%	N/A	hay, pasture & trees	cultivated crops, septic tank absorption fields or sanitary landfills (groundwater pollution hazard)	no	N/A

(1) Data on soils types are from the "Soil Survey of Bristol County Massachusetts - Southern Part" by the United States Department of Agriculture Soil Conservation Service

N/A - Not applicable

TABLE 3-10
PREDOMINANT
SOIL CHARACTERISTICS FOR USE
IN DETERMINING SUITABILITY FOR LAND APPLICATION
BY RATING FACTORS (4)
AT
SITES IV, V, AND VI

Major Soil Type	Soil Depth (1) (in.)	Min. Depth to Ground-water (in.)	Minimum Permea-bility (2) (in./hr)	Grade (%)	Existing Land Use (3)
Agawam fine sandy loam (AgA)	60	(5)	2-6	0-3	agricultural or open space
Agawam fine sandy loam (AgB)	60	(5)	2-6	3-8	agricultural or open space
Gloucester-Hinckley complex (GcB)	60	(5)	6-20	3-8	agricultural or open space
Gloucester-Hinckley complex (GhB)	60	(5)	6-20	3-8	agricultural or open space
Gloucester-Hinckley complex (GhC)	60	(5)	6-20	8-15	agricultural or open space
Hinckley gravelly fine sandy loam (HgA)	60	(5)	6-20	0-3	agricultural or open space
Hinckley gravelly fine sandy loam (HgB)	60	(5)	6-20	3-8	agricultural or open space
Hinckley gravelly fine sandy loam (HgC)	60	(5)	6-20	8-15	agricultural or open space
Merrimac fine sandy loam (MeA)	60	(5)	2-6	0-3	agricultural or open space

TABLE 3-10
PREDOMINANT
SOIL CHARACTERISTICS FOR USE
IN DETERMINING SUITABILITY FOR LAND APPLICATION
BY RATING FACTORS (4)
AT
SITES IV, V, AND VI

Major Soil Type	Soil Depth (1) (in.)	Min. Depth to Ground-water (in.)	Minimum Permea-bility (2) (in./hr)	Grade (%)	Existing Land Use (3)
Merrimac fine sandy loam (MeB)	60	(5)	2-6	3-8	agricultural or open space
Windsor loamy sand (WnA)	60	(5)	>6.0	0-3	agricultural or open space
Windsor loamy sand (WnB)	60	(5)	>6.0	3-8	agricultural or open space
Windsor loamy sand (WnB)	60	(5)	>6.0	8-20	agricultural or open space

(1) Depth of profile to bedrock
(2) Permeability of most restrictive layer in soil profile
(3) All potential land application sites are primarily forest with some agricultural and developed areas
(4) Data on soils types are from the "Soil Survey of Bristol County Massachusetts - Southern Part" by the United States Department of Agriculture Soil Conservation Service
(5) Assumed to be in the range of 48 - 96 inches

TABLE 3 - 11

DETERMINATION OF SUITABILITY FOR LAND APPLICATION
BY RATING FACTORS (1)
AT SITES IV, V, AND VI

Major Soil Type	System Type	Soil Depth(2)	Min. Depth to Ground-water	Permeability(3)	Grade	Existing Land Use	Total	Suitability(4)
Agawam fine sandy loam (AgA)	slow rate irrig.-agri.	8	4	8	8	4	32	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	8	4	—	eliminate
	rapid infiltration	4	2	9	8	4	27	high
Agawam fine sandy loam (AgB)	slow rate irrig.-agri.	8	4	8	6	4	30	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	5	4	—	eliminate
	rapid infiltration	4	2	9	4	4	23	moderate
Gloucester-Hinckley complex (GcB)	slow rate irrig.-agri.	8	4	8	6	4	30	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	5	4	—	eliminate
	rapid infiltration	4	2	9	4	4	23	moderate
Gloucester-Hinckley complex (GhB)	slow rate irrig.-agri.	8	4	8	6	4	30	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	5	4	—	eliminate
	rapid infiltration	4	2	9	4	4	23	moderate
Gloucester-Hinckley complex (GhC)	slow rate irrig.-agri.	8	4	8	4	4	28	high
	slow rate irrig.-forest	8	4	8	6	3	29	high
	overland flow	7	4	E	2	4	--	eliminate
	rapid infiltration	4	2	9	1	4	20	moderate
Hinckley gravelly fine sandy loam (HgA)	slow rate irrig.-agri.	8	4	8	8	4	32	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	8	4	—	eliminate
	rapid infiltration	4	2	9	8	4	27	high
Hinckley gravelly fine sandy loam (HgB)	slow rate irrig.-agri.	8	4	8	6	4	30	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	5	4	--	eliminate
	rapid infiltration	4	2	9	4	4	23	moderate
Hinckley gravelly fine sandy loam (HgC)	slow rate irrig.-agri.	8	4	8	4	4	28	high
	slow rate irrig.-forest	8	4	8	6	3	29	high
	overland flow	7	4	E	2	4	--	eliminate
	rapid infiltration	4	2	9	1	4	20	moderate
Merrimac fine sandy loam (MeA)	slow rate irrig.-agri.	8	4	8	8	4	32	high
	slow rate irrig.-forest	8	4	8	8	3	31	high
	overland flow	7	4	E	8	4	--	eliminate
	rapid infiltration	4	2	9	8	4	27	high

TABLE 3 - 11

DETERMINATION OF SUITABILITY FOR LAND APPLICATION
BY RATING FACTORS (1)
AT SITES IV, V, AND VI

Major Soil Type	System Type	Soil Depth(2)	Min. Depth to Ground-water	Permeability(3)	Grade	Existing Land Use	Total	Suitability(4)
Merrimac	slow rate irrig.-agri.	8	4	8	6	4	30	high
fine sandy	slow rate irrig.-forest	8	4	8	8	3	31	high
loam	overland flow	7	4	E	5	4	--	eliminate
(MeB)	rapid infiltration	4	2	9	4	4	23	moderate
Windsor	slow rate irrig.-agri.	8	4	8	8	4	32	high
loamy sand	slow rate irrig.-forest	8	4	8	8	3	31	high
(WnA)	overland flow	7	4	E	8	4	--	eliminate
	rapid infiltration	4	2	9	8	4	27	high
Windsor	slow rate irrig.-agri.	8	4	8	6	4	30	high
loamy sand	slow rate irrig.-forest	8	4	8	8	3	31	high
(WnB)	overland flow	7	4	E	5	4	--	eliminate
	rapid infiltration	4	2	9	4	4	23	moderate
Windsor	slow rate irrig.-agri.	8	4	8	0	4	24	moderate
loamy sand	slow rate irrig.-forest	8	4	8	5	3	28	high
(WnC)	overland flow	7	4	E	E	4	--	eliminate
	rapid infiltration	4	2	9	E	4	19	moderate

NOTE: The higher the ranking, the greater the suitability

(1) Rating factors are from the EPA Process Design Manual "Land Treatment of Municipal Wastewater", p. 2-24
(2) Depth of the profile to bedrock
(3) Permeability of most restrictive layer in soil profile
(4)

Land Application System Type	Overall Suitability Rating Low	Moderate	High
slow rate irrig.-agri.	<15	15-25	25-35
slow rate irrig.-forest	<15	15-25	25-35
overland flow	<16	16-25	25-35
rapid infiltration	<16	16-25	25-35

(5) E=Excluded, rated as poor

From the site investigations, Site V appears to have sufficient areas where the soils are pervious and well above the groundwater table. Although not contiguous, enough acreage (270 Ac. - see Table 3-3) appears suitable for ultimate disposal of 2.2 MGD of effluent by rapid infiltration. Soil borings would be necessary in the areas which appear to be suitable within this site to confirm the types and depths of soils and the groundwater elevations. It should be noted, however, that most of this land is not level and will require extensive site preparation. In addition, the area surrounding Site V is not currently on the municipal water supply. If land application were to be conducted on Site V, the existing municipal water supply distribution system would need to be extended to serve the homes near the site. Also, plume dispersion interaction with the salt marsh around the area should be studied. Site V is prime land for residential development due to its location adjacent to Slocums River. Based on a conversation with the Superintendent of the Department of Public Works concerning recent sales in the area, an attempt to acquire this land would result in a cost of approximately $100,000 per 2 acre house lot.

Site VI is located in the groundwater recharge area in an area of potential saltwater intrusion. The water table in the majority of the area is too high to allow the construction of rapid infiltration facilities. It is doubtful that the groundwater is more than four feet below the surface except in the area paralleling the cove, 400 - 500 feet back from the cove. Approximately 20 percent of this area is occupied by existing dwellings. Furthermore, the Planning Board has indicated that a subdivision is in the planning stages for 40 percent of the available area. As is the case with Site V, an extension of the existing municipal water supply distribution system would be necessary to serve the homes located adjacent to this site if it is to be used for land application. Also, as in the case

of Site V, an attempt to acquire this land would result in a cost of approximately $100,000 per house lot (2 Ac.), since it is considered prime land for residential development due to its location adjacent to Little River.

In all three sites, extensive site preparation would be required to prepare the site for rapid infiltration. Limited storage would be required to allow for periods of heavy rainfall or periods with a temperature below the minimum operating temperature of 25°F.

In summary, the rapid infiltration alternative of land application will be eliminated from Sites IV and VI because:

1. Site IV is located within the groundwater recharge area, as well as the Aquifer Protection District 2B - area of potential future water supply development.

2. Land application in Site IV would not be approved by DEQE, since it could adversely impact future water supply areas.

3. The water table in the majority of Site VI is too high to allow for construction of rapid infiltration facilities.

4. Approximately 20 percent of Site VI is occupied by existing dwellings and buffer zones would consume much of the suitable acreage.

5. The Planning Board has indicated that a subdivision is in the planning stages for about 40 percent of the available area in Site VI.

6. If land application were conducted in Site VI, an extension of the municipal water supply distribution system would be necessary to serve the homes adjacent to the site.

7. Land acquisition costs for Site VI would be in the range of $100,000 per 2 acre house lot.

H. Preferred Land Application Alternative and Preferred Site

Based on the reasons stated in the previous sections of this chapter, the preferred site is Site V. The preferred land application alternative is rapid infiltration.

The rapid infiltration system being considered would require a storage pond to allow for periods of extreme rainfall or periods with a temperature below the minimum operating temperature of 25°F, unless the application fields are covered. Covering of the application fields would allow for application of effluent during periods of heavy rainfall or when the operating temperature is below 25°F and effectively reduce the non-operating time of the rapid infiltration system to zero.

Terracing of the land will be required to ensure that the fields are level for equal distribution of effluent. The separation of flow for land application vs. ocean outfall disposal would take place at the wastewater treatment plant site. The effluent to be used for land application would be pumped to a storage pond to be located at the land application site, rather than at the wastewater treatment plant site. The storage pond would be sized to hold about eight weeks flow.

4. OCEAN OUTFALL STUDY

CHAPTER 4 - OCEAN OUTFALL STUDY*

A. Summary

Environmental analyses were conducted for the following parameters in support of the request for an expansion of the Town of Dartmouth wastewater treatment plant capacity from 2.0 MGD to 4.2 MGD with ocean discharge.

Hydrographics
Water Quality
Dispersion Analysis
Sludge Quality
Sediment Analyses
Marine Resources

The ocean discharge for the Dartmouth treatment facility is located in Buzzards Bay approximately 3,000 feet south of Salters Point.

Analyses reported herein were conducted in keeping with requirements of the Massachusetts Department of Environmental Quality Engineering (DEQE). Such requirements stipulate that existing physical, chemical, and biological conditions be documented at the site of the present and/or alternative outfall and that modelling be conducted to determine the level of impact at the outfall location and to make appropriate adjustments in design to avoid adverse water quality degradation.

Hydrographics

Hydrographic measurements were conducted utilizing current meters, drogue, and dye tracking techniques. Current meter data indicated higher current speeds at the surface (also

* Excerpt from Ocean Outfall Study (Appendix I)

with greater scatter) and tidal velocities decreased with depth. Tidal currents predominate with a variation of approximately 6 cm/s. Dye tracking from the present outfall was found to parallel the shoreline, while remaining offshore, with maximum ebb and flood tide velocities of 58.5 cm/s and 64 cm/s, respectively. Drogue tracking at the alternative outfall location resulted in the finding of local anomalies. Deeper loca current reversals may be present, as was the case on October 4, 1985, when currents travelled in a direction opposite to that of the flood tide direction.

Water Quality

Water quality monitoring was conducted to determine conditions within the Zone of Initial Dilution (ZID), areas downstream of the present outfall, the location of the alternative outfall, and a control station.

Analyses included field determination of dissolved oxygen, temperature, specific conductance, and pH. Stratified samples were collected for laboratory analyses of nutrients, redox parameters, metals, and pesticides. All analyses indicated water quality conditions within the ZID to be relatively unaffected by the present discharge and no anomalies were found at the other locations. Detailed measurements for dissolved oxygen and salinity were conducted within the ZID to assist in the near field analyses. These investigations resulted in the discovery that near field impacts from the existing 2.0 MGD discharge are limited only to a minor degree in an area within 100 feet of the outfall boil. BOD, suspended solids, nutrients, metals, and pesticide concentrations were found to be extremely low (meeting Class SB water quality criteria) within the ZID.

Analyses were also conducted on the treated effluent quality. Concentrations of residual chlorine were also

limit of impact to surface and deeper waters was found to be within 100 feet of the outfall.

2. No impacts to the quality of water within the ZID was found to be attributable to metals or pesticides.

3. Residual chlorine was found to decay three-fold between the Dartmouth treatment plant and the closest sampling point to the outfall.

4. An increase of discharge volume from 2.0 MGD to 4.2 MGD was found not to have a measureable impact on BOD or dissolved oxygen. Furthermore, any physical alteration to the configuration of the present outfall via a diffuser was deemed unnecessary, as was the relocation of the outfall to the alternative site in deeper water further into Buzzards Bay.

5. Based on analyses of marine sediments at the present outfall location, an expansion to 4.2 MGD is not expected to result in a deterioration of sediment quality. Additionally, there is no need for underwater construction which would result in disturbance of sediments.

6. The shellfish beds in the vicinity of the present outfall are within a shellfish closure area. In order to protect public health, harvesting is not allowed. Expansion of the discharge volume at the present site will not result in any alteration or impact to existing quahog beds. However, in the location of the alternative outfall, quahog beds are commercially harvested. Should the outfall be relocated to the alternative site, these shellfish beds would also be

closed to harvesting as a protective measure. Even if the beds near the present outfall were to be opened, their value is not at all comparable to that of the beds near the alternative outfall site due to the less than optimal bottom substrate at the present site. Based on bacteriological impacts to shellfish, the operational history of the treatment facility, improved design, and shellfish data, a smaller conditional closure area around the present outfall may be possible in the future.

7. Marine benthic resources (with the exception of harvestable quantities of shellfish) at either location are not expected to suffer adverse impacts from the operation of the expanded outfall, since dilution and good effluent quality aid in the prevention of adverse impacts to water sediment quality. Unnecessary further construction or modification of underwater utilities (i.e., a diffuser and/or alternative outfall) would result in a temporary adverse impact to bottom marine resources.

with greater scatter) and tidal velocities decreased with depth. Tidal currents predominate with a variation of approximately 6 cm/s. Dye tracking from the present outfall was found to parallel the shoreline, while remaining offshore, with maximum ebb and flood tide velocities of 58.5 cm/s and 64 cm/s, respectively. Drogue tracking at the alternative outfall location resulted in the finding of local anomalies. Deeper loca current reversals may be present, as was the case on October 4, 1985, when currents travelled in a direction opposite to that of the flood tide direction.

Water Quality

Water quality monitoring was conducted to determine conditions within the Zone of Initial Dilution (ZID), areas downstream of the present outfall, the location of the alternative outfall, and a control station.

Analyses included field determination of dissolved oxygen, temperature, specific conductance, and pH. Stratified samples were collected for laboratory analyses of nutrients, redox parameters, metals, and pesticides. All analyses indicated water quality conditions within the ZID to be relatively unaffected by the present discharge and no anomalies were found at the other locations. Detailed measurements for dissolved oxygen and salinity were conducted within the ZID to assist in the near field analyses. These investigations resulted in the discovery that near field impacts from the existing 2.0 MGD discharge are limited only to a minor degree in an area within 100 feet of the outfall boil. BOD, suspended solids, nutrients, metals, and pesticide concentrations were found to be extremely low (meeting Class SB water quality criteria) within the ZID.

Analyses were also conducted on the treated effluent quality. Concentrations of residual chlorine were also

5. COST COMPARISONS

CHAPTER 5 - COST COMPARISONS

Based on the preferred land application alternative and preferred site, the flow schemes to be used for the cost comparisons are:

I. Ultimate disposal by land application (rapid infiltration) at Site V of 2.2 MGD of secondary effluent with ocean disposal of 2 MGD of secondary effluent (treated at the existing wastewater treatment plant site).

II. Ultimate disposal by land application (rapid infiltration) at Site V of 4.2 MGD of secondary effluent (treated at the existing wastewater treatment plant site).

III. Ocean disposal of 4.2 MGD of secondary effluent (treated at the existing wastewater treatment plant site).

The costs for Schemes I, II, and III are presented in Tables 5-1, 5-2, and 5-3. The upgrade of the wastewater treatment plant has been omitted from the cost comparisons since it is common to all three schemes. Scheme I assumes that any flow up to 2 MGD will be disposed of through the ocean outfall with the flow in excess of 2 MGD to be disposed of at the land application site. The facilities to separate the flow in excess of 2 MGD and divert it to the land application site will be built at the wastewater treatment plant site. A schematic of the site layout for the rapid infiltration alternative appears in Figure 5-1.

The following assumptions have been used to determine the costs for the three schemes.

1. Transmission of the effluent will consist of 5.7 miles of 20" force main.

2. Effluent pumping is based on a peak flow of 12.5 MGD at the wastewater treatment plant and 150 feet of total head. Power is assumed to cost $0.07/kwh.

3. The storage volume required is based on 8 weeks of storage time being required. The storage reservoir is assumed to be divided into multiple cells, be 12 feet deep, have bentonite lining, have dikes that are formed from native material, and have embankment protection consisting of riprap.

4. Site clearing is based on the original condition of the site being heavily wooded. The site will be cleared and grubbed with the debris disposed of offsite. Terracing of the fields would be necessary for the proper levelling of the application fields.

5. The infiltration basins are multiple unit basins with dikes formed from native excavated material.

6. Distribution pumping is based on 150 feet of total head and consists of pumping equipment and standby facilities, piping and valves within structures, controls, electrical work, and an intake structure being built into the dike of the storage reservoir.

7. The administrative and laboratory facilities at the wastewater treatment plant will be used for land application as well. Separate operation and maintenance costs for land application appear on the cost comparison tables.

8. 25 monitoring wells for 2.2 MGD and 35 monitoring wells for 4.2 MGD, each 100 feet deep, are assumed. The wells are assumed to be 4 inch drilled wells complete with pump, controls, and electrical work.

9. The service roads are assumed to be 12 feet wide with gravel surface and are located around the perimeter of the area and within larger fields. A four foot high stock fence is located around the perimeter of the area.

10. Land costs are based on the selling price of $100,000 per 2 acre house lot for house lots in the area near Site V.

11. Costs for ultimate disposal via the existing ocean outfall are based on the summary and conclusions section of the Ocean Outfall Study (see Appendix A) which recommends that no construction or modifications of the underwater facilities is necessary.

TABLE 5-1

*** SCHEME I ***
COSTS FOR RAPID INFILTRATION OF 2.2 MGD
AND OCEAN DISPOSAL OF 2.0 MGD *

Item	Total Project Cost	Ave. Annual O & M
LAND APPLICATION		
Force Main - 20"		
$100/l.f. x 5.7 mi. x 5280	$3,010,000	
$1540/mi./yr. x 5.7 mi.		$8,800
Effluent Pumping	$293,000	$51,300
peak flow = 12.5 MGD		
150 ft. total head		
Storage Reservoir - lined	$1,190,000	$7,500
cap. 123 million gallons (8 wks storage)		
Site Clearing	$282,000	
65 ac., heavily wooded, cleared & grubbed		
offsite disposal of material		
Land Leveling	$51,000	
Infiltration Basins	$423,000	$40,300
multiple unit basins with 4 ft. dike		
Distribution Pumping	$423,000	$61,400
peak flow = 4 MGD		
50 ft. total head		
Admin. & Lab. Facilities	$0	$33,800
assume admin. & lab. facilities at		
WWTP expansion will be used		
Monitoring Wells - 100 ft. deep		
$4225/well x 25 wells	$106,000	
$440/well/yr. x 25 wells		$11,000
Service Road & Fencing	$108,000	$2,800
65 ac. - field area		
Land		
245 ac. - incl. buffer zone	$12,250,000	
salvage value	($4,039,000)	
OCEAN DISPOSAL (2 MGD)	$0	$55,500
Subtotals	$14,097,000	$272,400
Present Worth O & M		$2,509,000
Comparative Total	$16,606,000	

* Costs are from EPA Technical Report "Costs of Wastewater Treatment by Land Application" and are updated to Aug. 1990 (ENR=5212) for total project costs and June 1991 (ENR=5457) for O & M costs

TABLE 5-2

*** SCHEME II ***
COSTS FOR
RAPID INFILTRATION OF 4.2 MGD*

Item	Total Project Cost	Ave. Annual O & M
Force Main - 20"		
$100/l.f. x 5.7 mi. x 5280	$3,010,000	
$1540/mi./yr. x 5.7 mi.		$8,800
Effluent Pumping	$293,000	$92,800
peak flow = 12.5 MGD		
150 ft. total head		
Storage Reservoir - lined	$2,291,000	$11,100
cap. 235 million gallons (8 wks storage)		
Site Clearing	$535,000	
130 ac., heavily wooded, cleared & grubbed		
offsite disposal of material		
Land Leveling	$93,000	
Infiltration Basins	$761,000	$72,100
multiple unit basins with 4 ft. dike		
Distribution Pumping	$479,000	$112,200
peak flow = 6 MGD		
50 ft. total head		
Admin. & Lab. Facilities	$0	$42,800
assume admin. & lab. facilities at		
WWTP expansion will be used		
Monitoring Wells - 100 ft. deep		
$4225/well x 35 wells	$148,000	
$440/well/yr. x 35 wells		$15,400
Service Road & Fencing	$155,000	$4,200
130 ac. - field area		
Land		
360 ac. - incl. buffer zone	$18,000,000	
salvage value	($5,935,000)	
Subtotals	$19,830,000	$359,400
Present Worth O & M		$3,310,000
Comparative Total	$23,140,000	

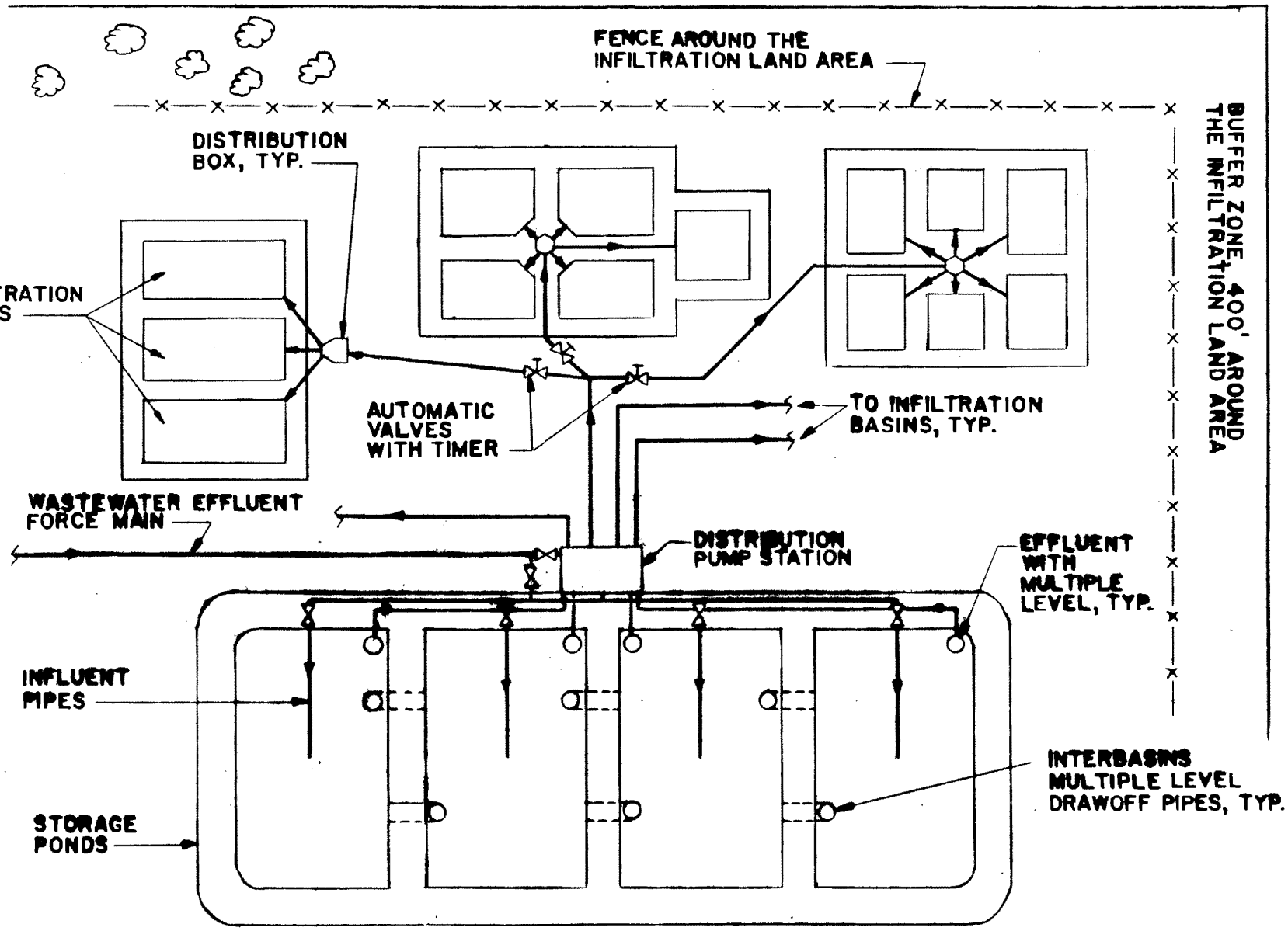
* Costs are from EPA Technical Report "Costs of Wastewater Treatment by Land Application" and are updated to Aug. 1990 (ENR=5212) for total project costs and June 1991 (ENR=5457) for O & M costs

TABLE 5-3

*** SCHEME III ***
COSTS FOR OCEAN DISPOSAL OF 4.2 MGD *

Item	Total Project Cost	Ave. Annual O & M
Ocean Outfall ** continued used of existing structure with no modifications or new construction (includes larger effluent pumps to pump the increase in flow from 2.0 to 4.2 MGD)	$188,000	$101,600
Subtotals	$188,000	$101,600
Present Worth O & M		$936,000
Comparative Total	$1,124,000	

* Costs are from EPA Technical Report "Costs of Wastewater Treatment by Land Application" and are updated to Aug. 1990 (ENR=5212) for total project costs and June 1991 (ENR=5457) for O & M costs



LAND APPLICATION - RAPID INFILTRATION SCHEME

NOT TO SCALE

FAY, SPOFFORD & THORNDIKE, INC.

FIGURE 5-1

From Tables 5-1, 5-2, and 5-3 it can be concluded that Scheme III, use of ocean outfall for the full 4.2 MGD, is the most cost effective ultimate disposal method. The comparative present worth costs for the alternatives are:

Scheme	Effluent Distribution Site V Land Application (MGD)	Outfall (MGD)	Present Worth Cost Construction & O&M
I	2.2	2.0	$16,606,000
II	4.2	0	23,140,000
III	0	4.2	1,124,000

6. RECOMMENDED PLAN

CHAPTER 6 - RECOMMENDED PLAN

A. Land Application vs. Ocean Outfall

The detailed cost comparison of the preferred land application alternative vs. the continued use of the ocean outfall for all or a portion of the design flow of 4.2 MGD appears in Chapter 5. The total present worth cost for Scheme I - rapid infiltration of 2.2 MGD and ocean disposal of 2.0 MGD is $16,606,000; Scheme II - rapid infiltration of 4.2 MGD is $23,140,000; and Scheme III - ocean disposal of 4.2 MGD is $1,124,000. Therefore, the most cost effective ultimate disposal method is Scheme III - ocean disposal of 4.2 MGD. The cost for Schemes I and II are much, much higher due to the cost to obtain land and construct the necessary land application facilities.

Chapter 4 summarizes the impacts of increasing the flow through the existing outfall on the receiving waters of Buzzards Bay. Extensive studies around the outlet conclude that the additional 4.2 MGD will have no significant impact on the environmentally sensitive area. The public beaches and aquatic life will not be hurt. The existing outlet structure is properly sited and can be used "as is" for the projected average daily wastewater effluent flow of 4.2 MGD.

B. Recommended Plan for Ultimate Disposal

The recommended cost effective, environmentally sound plan for ultimate disposal is the continued use of the existing ocean outfall without modifications or new construction. The existing 6 mile outfall discharges into Buzzards Bay, approximately 3400 feet south southeasterly of Salter's Point. The

receiving waters in Buzzards Bay are of the highest water quality class for saltwater, Class SA, and will remain the same under this recommended plan.

The design flow for the year 2010 of 4.2 MGD (average daily flow) consists of 1.17 MGD of domestic flow, 1.13 MGD of commercial/industrial flow, and 1.90 MGD of infiltration. A peak hourly flow of 10.33 MGD is projected for the design year.

The upgraded wastewater treatment facility will give the influent secondary treatment by the activated sludge method, with diffused aeration followed by chlorination. The proposed method of sludge disposal consists of stabilization of the dewatered sludge cake by composting followed by utilization of the compost as cover for the town landfill. Modifications to the existing wastewater treatment facility include: new wastewater influent pumps, new septage receiving facilities, new preliminary treatment units, two new primary settling tanks, one new aeration tank, conversion of existing aeration tanks from mechanical aeration to fine bubble diffused air, two new final settling tanks, new chlorination facilities, new wastewater effluent pumps, new thickening units, new belt filter presses, and new composting facilities. The treatment facilities will be designed to meet the Class I Reliability Guidelines as set forth in "The Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability", published by the U.S.E.P.A.

7. IMPLEMENTATION

CHAPTER 7 - IMPLEMENTATION

A. Institutional Responsibilities

The Town of Dartmouth, Massachusetts, which maintains the existing sewage works, has the legal authority to implement the recommended plan.

B. Financial Requirements

No funding is necessary for the recommended plan, since no modifications are required in the existing ocean outfall. Local funding will, however, be necessary to pay the annual operation and maintenance (O&M) costs for the ocean outfall. Local funds for O&M costs will be raised through a system of general taxation (50%) and "sewer-user charges" (50%).

C. Implementation Schedule

For timely completion of the project and to provide sewerage facilities for the needs of the community, the following implementation schedule is recommended:

1. Submit draft of Supplement to Facility Plan for Ultimate Disposal Alternatives, as well as, final Step 1 - Facility Plan for Expansion of Wastewater Treatment Facility and Collection System to the State in July, 1988.

2. Hold a public meeting to discuss recommendations of the Supplement to the Facility Plan for Ultimate Disposal

Alternatives and Step 1 - Facility Plan for Expansion of Wastewater Treatment Facility and Collection System in August, 1988.

3. Submit final Supplement to Facility Plan for Ultimate Disposal Alternatives for approval by end of September, 1988.

4. Continue with the design of the recommended wastewater treatment facilities and proceed with construction of these facilities as soon as funds are appropriated by the State Legislature.

APPENDIX A

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Water Pollution Control
One Winter Street, Boston, Mass. 02108

Thomas C. McMahon
Director

October 19, 1987

Marc F. Gracie
Board of Public Works
759 Russells Mills Road
Dartmouth, MA 02748

Re: Dartmouth, MA
WPC-MASS-739
Supplement to Facility
plan for Ultimate Disposal
Alternatives.
Surface Water Discharge

Dear Mr. Gracie:

The Division of Water Pollution Control is writing to you in response to a letter submitted by your consultant Fay Spofford and Thorndike on your behalf to the Division's Technical Services Branch (TSB) dated April 1, 1987 requesting our response as to the feasibility of a 2.2 million gallons per day (MGD) discharge to the Paskamansett River being approved for Dartmouth by DEQE. Fay Spofford & Thorndike, Inc. also asked that if a river discharge could be approved in Dartmouth, what would be the required level of treatment prior to river discharge?

In response to your request our technical services branch has reviewed your proposal and the Division makes the following comments:

The Paskamansett is a slow moving meandering river with a drainage area of approximately 26 square miles. The river drains large tracts of wetlands along much of its length which contribute to its characteristic dark color, low PH and dissolved oxygen levels. Comparable stations sampled during the summers of 1975 and 1986 show consistent D.O. readings in the low 5 to 4 mg/l range. Nutrient levels, however, were considerably higher in 1986.

Flow data is limited but estimates for the 7Q10 at 2 and 10 year intervals are 1.5 and 0.7 cfs respectively. It should also be noted that the river flow is also reported to be affected by groundwater withdrawals upstream of the treatment facility.

Roughly one mile below the facility, the river is dammed at Russell's Mills Pond. Below the dam the river is tidal and is named the Slocums River. Open productive shellfish beds and a state beach (DeMarest Lloyd State Park) are located 2 and 3 miles respectively downstream of the faciity.

As a consequence of the low flow characteristics the Paskamansett/Slocums River comes under the antidegradation provisions of 314 CMR 4.04:(3).

Because of the conditions discussed above, TSB does not believe that the Paskamansett River could accept a discharge of this magnitude using conventional treatment methods.

If you have questions or comments regarding this matter please contact Robert M. Cady, Southeast Program Manager of my staff at (617) 292-5713.

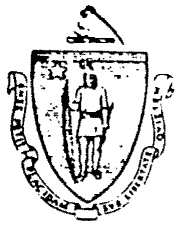
Very truly yours,

Paul A. Taurasi, P.E.
Chief Engineer

PAT/JMO/bb

cc: Carolyn Loomis- Ray Spofford & Thorndike, Inc.
Manuel Branco, Superintendent Board of Public Works
Deborah Graham- Dept. of Environmental Management
Mr. Henry Lesser-Division of Capital Planning and Operations
Mr. Richard J. Correia-Division of Capital Planning and Operations
Lawrence W. Gil - DWPC - TSB, Westborough
Steve Bliven - Coastal Zone Management
Phillip Coates -Division of Marine Fisheries

APPENDIX B



U. S. Environmental Protection Agency
Region I
John F. Kennedy Federal Building
Boston, Massachusetts 02203

The Commonwealth Of Massachusetts
Water Resources Commission
Division of Water Pollution Control
Leverett Saltonstall Building
Boston, Massachusetts 02202

DISCHARGE PERMIT

Name and Address of Applicant: Town of Dartmouth; 759 Russells Mills Rd.; South Dartmouth, Massachusetts 02748

Application No. - Federal MA0101605

- State M-137

Date of Reapplication October 11, 1978

Permit No. - Federal MA0101605

- State M-35

Date of Reissuance

Date of Expiration May 31, 1984

AUTHORITY FOR ISSUANCE

Pursuant to Section 402(a)(1) of the Federal Water Pollution Control Act, as amended (Public Law 92-500) and pursuant to authority granted by Chapter 21, Sections 26-53 of the Massachusetts General Laws, as amended, the following permit is hereby issued to:

The Town of Dartmouth

(hereinafter called the "permittee"),

authorizing discharges from the Dartmouth Water Pollution Control Facility (WPCF) to Buzzards Bay

such authorization being expressly conditional on compliance by the permittee with all terms and conditions of the permit hereinafter set forth.

This Discharge Permit is issued jointly by the U.S. Environmental Protection Agency and the Division of Water Pollution Control under Federal and State law, respectively. Each Agency shall have the independent right to enforce the terms and conditions of this Permit. Any modification, suspension, or revocation of this Permit shall be effective only with respect to the Agency taking such action, and shall not affect the validity or status of this Permit as issued by the other Agency, unless and until each Agency has concurred in writing with such modification, suspension, or revocation. In the event any portion of this Permit is declared invalid, illegal or otherwise issued in violation of State law, such permit shall remain in full force and effect under Federal law as an NPDES Permit issued by the U.S. Environmental Protection Agency. In the event this Permit is declared invalid, illegal or otherwise issued in violation of Federal law, this Permit shall remain in full force and effect under State law as a Permit issued by the Commonwealth of Massachusetts.

I. SPECIAL CONDITIONS

A. Effluent Limits

From effective date until expiration date, the permittee is authorized to discharge from the Dartmouth WPCF to Buzzards Bay an effluent whose characteristics shall not exceed the values listed below.

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Monthly Average	Weekly Average	Maximum Day	Discharge Limitations (specify units) Monthly Average	Weekly Average	Maximum Day
Flow, cu. M/day (MGD)	* *	* *	* *	7570(2.0)	* *	* *
Biochemical Oxygen Demand, 5-day, 20°C	227(500)	-	-	30 mg/l	45 mg/l	50 mg/l
Total Suspended Solids	227(500)	-	-	30 mg/l	45 mg/l	50 mg/l
Settleable Solids	-	-	-	0.1 ml/l	0.1 ml/l	0.3 ml/l
Fecal Coliform Bacteria	-	-	-	200/100ml	400/100ml	400/100
Total Coliform Bacteria	-	-	-	1,000/100ml	2,000/100ml	2,000/100
Cl_2	-	-	-	-	-	1.5 mg/l

a. The pH of the effluent shall not be less than 6.0 nor greater than 9.0 at any time, unless these values are exceeded due to natural causes or as a result of the approved treatment processes.

b. The total chlorine residual of the effluent shall not result in any demonstrable harm to acquatic life or violate any water quality standard which has been or may be promulgated. Upon promulgation of any such standard, this permit may be revised or amended in accordance with such standards, the permittee being so notified.

c. The discharge shall not cause visible discoloration of the receiving waters.

d. The discharge shall not cause a violation of the water quality standards of the receiving waters.

e. The monthly average concentration of BOD and total suspended solids in the discharge shall not exceed 15 percent of the monthly average concentrations of BOD and total suspended solids in the influent into the permittee's wastewater treatment facilities.

f. When the effluent discharged for a period of 90 consecutive days exceeds 80 percent of the permitted flow limitation, the permittee shall submit to the permitting authorities projected loadings and a program for maintaining satisfactory treatment levels consistent with approved water quality management plans.

B. Monitoring and Reporting

1. The permittee shall monitor and record the quality and quantity of discharge from the Dartmouth WPCF according to the following schedule and other provisions:

Parameter	Minimum Frequency of Analysis	Sample Type
Until expiration date		
Flow	continuous recording	daily avg., max., min.
BOD	monthly	24-hour Composite
TSS	monthly	24-hour Composite
Settleable Solids	daily	grab
pH	daily	grab
Cl_2	daily	grab
Total Coliform Bacteria	monthly	grab

2. Any grab sample or composite sample required to be taken less frequently than daily shall be taken during the period of Monday through Friday inclusive. Eight hour composites and grab samples shall be taken between 8:00 a.m. and 6:00 p.m.

3. The permittee shall submit all reports on a form acceptable to the Regional Administrator and Director, properly filled in and signed, on the fifteenth on every month, beginning immediately.

C. Reporting and Non-Compliance

1. Where a specific action is required in B above to be taken by a certain date, the permittee shall submit to the Regional Administrator and the Director a written notice of compliance or non-compliance with each of the above scheduled dates, postmarked no later than 14 days following each elapsed date. Each notice of non-compliance shall include the following information:

   a. A short description of the non-compliance;

   b. A description of any actions taken or proposed by the permittee to comply with the elapsed schedule requirement without further delay;

   c. A description of any factors which tend to explain or mitigate the non-compliance; and

   d. An estimate of the date the permittee will comply with the elapsed schedule requirement and an assessment of the probability that the permittee will meet the next schedule requirement on time.

   Compliance shall be reported by:

   a. Submitting the required documents on schedule; or

   b. Indicating in writing that the required action has been taken.

2. Where monitoring data is to be submitted in B above, the appropriate monitoring report form shall be submitted to the Regional Administrator and the Director at the following addresses:

   U.S. Environmental Protection Agency
   Region I - Permits Branch
   P. O. Box 8127
   Boston, MA 02114

   Massachusetts Division of Water Pollution Control
   Southeastern Regional Office
   P. O. Box 537
   North Pembroke, MA 02358

   Any violations of effluent limits shall be accompanied by a written explanation and the steps taken to prevent recurrence of the violation.

3. See General Conditions, Part II, Items 7, 12, 13, and 17 for specific information on reporting and non-compliance.

II. General Conditions

1. a. All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant more frequently than, or at a level in excess of, that identified and authorized by this permit shall constitute a violation of the terms and conditions of this permit. Such a violation may result in the imposition of civil and/or criminal penalties as provided for in Section 309 of the Federal Act or Section 42 of the State Act. Facility modifications additions, and/or expansions that increase the plant capacity must be reported to the Regional Administrator and the Director, and this permit then modified or reissued to reflect such changes. No change in the facility discharge, including any new significant industrial discharge or any significant change in the quality or quantity of an existing industrial discharge to the treatment system, that will result in new or increased discharges of pollutants from such treatment system may be made unless reported to the Regional Administration and approved by Director. This permit may be modified accordingly. In no case are new connections, increased flows, or significant changes in influent quantity or quality permitted that will cause violation of the effluent limitations specified herein.

2. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

   a. Violation of any terms or conditions of the permit;

   b. Obtaining a permit by misrepresentation or failure to disclose fully all relevant facts; and

   c. A change in conditions or the existence of a condition which requires either a temporary or permanent reduction or elimination of the authorized discharge.

3. The permittee shall permit the Regional Administrator, Director, and other duly authorized Environmental Protection Agency and Division personnel upon the presentation of proper credentials:

   a. To enter upon permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit;

   b. To have access to and copy any records required to be kept under the terms and conditions of this permit;

   c. To inspect any monitoring equipment or monitoring method required in this permit; or

   d. To sample at any intake, wastewater treatment facility, and/or outfall.

4. In the event of any change in control or ownership of facilities from which the authorized discharges originate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Regional Administrator and the Director. Succeeding owners or controllers shall be bound by all the conditions of this permit, unless and until a new or modified permit is obtained.

5. All waste collection, control, treatment, and disposal facilities shall be operated in a manner consistent with the Division's "Rules and Regulations for Operation and Maintenance of Sewerage Systems and Waste Treatment Facilities," as most recently amended, and any applicable Federal Regulations and Guidelines, which regulations are hereby incorporated into and made a part of this permit. The permittee shall at all times maintain in good working order and operate as efficiently as possible any facilities or system of control installed or utilized to achieve compliance with the terms and conditions of this permit.

6. The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges; nor does it authorize or relieve the permittee of any liability for any

injury to private property or any invasion of personal rights; nor any infringement of Federal, State, or local laws or regulations; nor does it waive the necessity of obtaining any local assent required by law for the discharge authorized herein.

7. This permit shall be subject to such monitoring requirements as may be reasonably required by the Regional Administrator and Director, including the installation, use, and maintenance of monitoring equipment or methods (including, where appropriate, biological monitoring methods). The permittee shall provide the Regional Administrator and the Director with periodic reports on the proper reporting form of monitoring results obtained by a permittee pursuant to the monitoring requirements contained herein. The permittee shall maintain records of all information resulting from any monitoring activities required herein. Any records of monitoring activities and results shall include for all samples:

   a. The date, exact place and time of sampling;

   b. The dates and times analyses were performed;

   c. Who performed the sampling and analyses;

   d. The analytical techniques/methods used, including sampling, handling, and preservation techniques; and

   e. The results of each such analysis. Any records of monitoring activities and results including all original strip chart recordings for continuous monitoring instrumentation and calibration and maintenance records, shall be retained for a minimum of three years. This period shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee or when requested by the Regional Administrator or the Director.

8. All information and data provided by an applicant or a permittee identifying the nature and frequency of a discharge shall be available to the public without restriction. All other information (other than effluent data) which may be sumitted by an applicant in connection with a permit application or which may be furnished by a permittee in connection with required periodic reports shall also be available to the public unless the applicant or permittee is able to demonstrate that the disclosure of such information or particular part thereof to the general public would divulge methods or processes entitled to protection as trade secrets in accordance with Federal regulations contained in 40 CFR Part 124.35. Where the applicant or permittee is able to so demonstrate, the Director and the Regional Administrator shall treat the information or the particular part (other than effluent data) as confidential and not release it to any unauthorized person. Such information may be divulged to other officers, employees, or authorized representatives of the Commonwealth or the United States Government concerned with carrying out water pollution control laws.

9. All reports and communications required hereunder are to be made or sent to the Director of the Division of Water Pollution Control and the Regional Administrator of the Environmental Protection Agency.

10. Notwithstanding 2 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Federal Act for a toxic pollutant which is present in the discharge authorized herein and such standard or prohibition is more stringent than any limitation upon such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition, and the permittee shall be so notified.

11. The provisions of this permit are severable, and the invalidity of any condition or subdivision thereof shall not make void any other condition or subdivision thereof.

12. Reporting and Monitoring

   a. Quality Control

The permittee shall calibrate and perform maintenance procedures on all monitoring and analytical instrumentation at regular intervals to ensure accuracy of measurements or shall ensure that both activities will be conducted. Samples shall be representative of the volume and quality of effluent discharged over the sampling and reporting period.

   (1) The permittee shall provide the above records and shall demonstrate the accuracy of the flow measuring device upon request of the Director and the Regional Administrator. The permittee shall identify the effluent sampling point used for each discharge.

   (2) The permittee shall analyze any additonal samples as may be required by the Director and the Regional Administrator to ensure analytical quality control.

   (3) If this permittee monitors any pollutant more frequently than is required by this permit, he shall also provide the results of such monitoring to the Director and Regional Administrator.

   b. Sampling and Analysis

The sampling, preservation, handling, and analytical methods used must conform to the test procedures guidelines prepared under Section 304(g) of the Federal Act.

c. Reporting

The results of the above mentioned requirements shall be reported as required in Special Condtion C. The permittee shall include in this report any previously approved non-standard methods used. Permanent elimination of a discharge should be brought to the attention of the Director and the Regional Administrator within 15 days by a special written notification. A written report should be submitted if there have been any modifications in the waste collection, treatment, and disposal facilities; changes in operational procedures; or other significant activities which alter the nature and frequency of the discharge or otherwise concern the conditions of this permit.

13. Certification of Reports

All reports shall be signed by the chief operator of the treatment facility and

a. In the case of corporations, by a principal executive officer of at least the level of vice president, or his duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge described in the NPDES form originates;

b. In the case of a partnership, by a general partner;

c. In the case of a sole proprietorship, by the proprietor;

d. In the case of a municipal, State, or other public facility, by either a principal executive officer or ranking elected official.

14. Oil Discharges

There shall be no discharge of harmful quantities of oil, as defined pursuant to 40 CFR 110 and Massachusetts Water Quality Standards, including (1) any subsequent amendments or revisions made thereto, or (2) any more restrictive limitations which may be imposed otherwise by law or regulation. The authorization of this permit does not preclude the institution of any legal action nor relieve the permittee from any liabilities, penalties, or responsibilities established by Section 311 of the Federal Act, by Massachusetts General Laws c. 21, §§27(14), and 42 as amended, and the Massachusetts Rules for the Prevention and Control of Oil Pollution in the Waters of the Commonwealth by any subsequent amendments thereto, or by any superseding Federal or State legislation.

15. Other Materials

Other materials ordinarily produced or used in the operation of this facility, which have been specifically identified in the application, may be discharged at the maximum frequency and maximum level identified in the application, provided:

a. They are not

(1) Designated as toxic or hazardous under provisions of Sections 307 and 311, respectively, of the Federal Water Pollution Control Act, or the Massachusetts General Laws c. 21, §§57, 58 and the Division of Water Pollution Control Hazardous Waste Regulations

(2) Known to be hazardous or toxic by the permittee, except that such materials may be discharged in certain limited amounts with the written approval of, and under special conditions established by the Director and the Regional Administrator or their designated representatives, if the substance will not pose any imminent hazard to the public health or safety;

b. The discharge of such materials will not violate applicable water quality standards; and

c. The permittee is not notified by the Director and the Regional Administrator to eliminate or reduce the quantity of such materials entering the watercourse.

16. Solids Disposal

Collected screenings, sludges, and other solids removed from liquid wastes shall be disposed of in such a manner as to prevent entry of such materials or leachate therefrom into navigable waters or their tributaries.

17. Non-Compliance

In the event the permittee is unable to comply with any of the conditions of this permit, due, among others reasons, to:

a. breakdown or maintenance of waste treatment equipment (biological and physical-chemical systems including, but not limited to, all pipes, transfer pumps, compressors, collection ponds or tanks from the segregation of treated or untreated wastes, ion exchange columns, or carbon absorption units),

b. accidents caused by human error or negligence, or

c. other causes, such as act of nature,

the permittee shall provide the Regional Administrator and the Director with the following information in writing within five days after commencement of such occurrence:

(1) cause of non-compliance;

(2) a description of the non-complying discharge including its impact upon the receiving waters;

(3) anticipated time the condition of non-compliance is expected to continue, or if such condition has been corrected, the duration of the period of non-compliance;

(4) steps taken by the permittee to reduce and eliminate the non-complying discharge; and

(5) steps to be taken by the permittee to prevent reoccurrence of the condition of non-compliance.

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from non-compliance with any effluent limitation specified in this permit, including, such accelerated or additional monitoring as necessary to determine the nature and impact of the non-complying discharge.

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for non-compliance, whether or not such non-compliance is due to factors beyond his control, such as equipment breakdown, electric power failure, accident, or natural disaster.

~~18. Emergency Action -- Electric Power Failure~~

~~The permittee shall indicate in writing to the Regional Administrator and the~~ Director within 30 days of the effective date of this permit that, in the event the primary source of electric power fails, the permittee will provide, as a minimum, primary treatment (or its equivalent) plus disinfection for all wastes discharged into the waste treatment facility. If the permittee does not so indicate to the Regional Administrator and the Director, it shall provide an alternative source of power for the operation of its treatment facilities in accordance with a schedule to be established by the Regional Administrator and the Director which will become part of this permit. The alternate power supply, whether from a generating unit located at the plant site or purchased from an independent source of electricity, must be separate from the existing power source used to operate the waste treatment facilities. If a separate facility located at the plant site is to be used, the permittee shall certify in writing to the Regional Administrator ~~and the Director when the facility is completed and prepared to generate power.~~

19. Bypasses

a. The diversion or bypass of any discharge from waste treatment facilities utilized by the permittee to maintain compliance with the terms and conditions of this permit is prohibited, except

(1) where unavoidable to prevent loss of life or severe property damage, or

(2) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the terms and conditions of this permit.

The permittee shall immediately notify the Regional Administrator and the Director in writing of each such diversion or bypass in accordance with the procedure specified above for reporting non-compliance.

b. Pollutant discharges resulting from bypass flows and overflows of the permittee's sewerage system are subject to this permit. Such discharges (such as those attributable to combined sewers) could cause serious problems in the receiving waters. Prior to setting specific effluent limitations on such discharges, additional information is required. The permittee shall submit such information to the Regional Administrator and the Director as specified in Special Condition B. The submittal shall identify and locate such discharges and shall, as a minumum, describe the extent and causes of such discharges, estimate the frequency and duration of such discharges, describe the effect on the receiving waters, and contain such additional data as is available to the applicant. The permittee shall also submit its preliminary long-range plan of abatement for these discharges. This permit condition shall not abrogate responsibility of the permittee to supply additional information requested in any federal permit application form.

The Regional Administrator and the Director reserve the right to make appropriate revisions to this permit in order to establish any appropriate effluent limitations, schedules of compliance, or other provisions which may be authorized under the Federal and State Acts in order to bring all such discharges into compliance with these Acts.

20. Sewer Ordinances

The permittee shall have in effect (as specified in Special Condition B), a sewer use ordinance and/or Rules and Regulations, pursuant to Section 10 of Chapter 83 of the Massachusetts General Laws, acceptable to the Regional Administrator and the Director which, as a minumum:

a. Prohibits the introduction by any discharger into the permittee's sewerage system or treatment facilities of any pollutant which

(1) is a toxic pollutant in toxic amounts, as defined in standards issued from time to time under Section 307(a) of the Federal Act or any applicable State Act;

(2) creates a fire or explosion hazard in permittee's treatment works;

(3) causes corrosive structural damage to permittee's treatment works, including all wastes with pH lower than 5.0;

(4) contains solid or viscous substance in amounts which would cause obstruction to the flow in sewers or other interference with proper operation of the permittee's treatment works; or

(5) in the case of a major contributing industry, as defined herein, contains an incompatible pollutant, as further defined herein, in an amount or concentration in excess of that allowed under standards or guidelines issued from time to time pursuant to Sections 304, 306 and/or 307 of the Federal Act, or pursuant to any applicable State Act; or

(6) has not been subjected to any pretreatment that may be required under Federal or State law.

b. Requires 45 days prior notification to the permittee by any person or persons of a

(1) proposed substantial change in volume or character of pollutant over that being discharged into the permittee's treatment works at the time of issuance of this permit,

(2) proposed new discharges into the permittee's treatment works of pollutants from any source which would be a new source as defined in Section 306 of the Federal Act, if such source were discharging pollutants, or

(3) proposed new discharge into the permittee's treatment works of pollutants from any source which would be subject to Section 301 of the Federal Act if it were discharging such pollutants.

c. Requires any industry discharging into the permittee's treatment works to perform such monitoring of its discharges as the permittee may reasonably require, including the installation, use, and maintenance of monitoring equipment methods, to keep records of the results of such monitoring, and to report the results of such monitoring to the permittee. Such records shall be made available by the permittee to the Regional Administrator and the Director upon request.

d. Authorizes the permittee's authorized representative to enter into, upon, or through the premises of any industry discharging into the permittee's treatment works to have access to and copy any records, to inspect any monitoring equipment or method required under subsection (c) above, and to sample any discharge into the permittee's treatment works.

21. Changes in Discharges to Treatment Facilities

The permittee shall notify the Regional Administrator and the Director of any discharge specified in General Condition 20(b) hereof within 30 days of the date on which it comes to the attention of the permittee. This permit may be modified accordingly.

22. Reapplication

If the permittee desires to continue to discharge after the expiration of this permit, it shall reapply on the application forms then in use at least 180 days before this permit expires.

23. Definitions

For purposes of this permit, the following definitions shall apply:

Regional Administrator - Regional Administrator, Region I, Environmental Protection Agency, John F. Kennedy Federal Building, Government Center, Boston, Massachusetts 02203
Attention: Permits Branch

Director - Director of the Massachusetts Division of Water Pollution Control

Division - Massachusetts Water Resources Commission, Division of Water Pollution Control, Leverett Saltonstall Building, 100 Cambridge Street, Boston, Massachusetts 02202

Mean - The mean value is the arithmetic mean unless used for fecal or total coliform, which would be a geometric mean.

National Pollutant Discharge Elimination System Permit (NPDES) - A permit issued under authority of §402 of the Federal Water Pollution Control Act, as amended (Public Law 92-500).

Grab Sample - An individual sample collected in a period of less than 15 minutes.

Composite Sample - A sample consisting at a minimum of grab samples taken hourly during the period specified in the section on Monitoring and Reporting and combined proportional to flow, or a sample continuously collected proportional to flow over that same time period.

Weekly Average - The average of a minimum of three composite samples taken on three separate days, or at least one grab sample per day, taken on three separate days, as required for the parameter being reported within a week.

Monthly Average - The average of a minimum of twelve composite samples taken on twelve separate days, or at least one grab sample per day, taken on twelve separate days, as required for the parameter being reported within a calendar month.

Maximum Day - A value not to be exceeded by any composite or grab sample, as appropriate.

Instantaneous Maximum - A value not to be exceeded in any grab sample.

Average - The arithmetic mean of values taken at the frequency required for each parameter over the specified period. For total and/or fecal coliforms, the average shall be computed as the geometric mean.

Incompatible Pollutant - Any pollutant, other than biochemical oxygen demand, suspended solids, pH, fecal coliform bacteria, or additional pollutants identified in the permit, which the treatment works was not designed to treat and does not remove to a substantial degree.

Major Contributing Industry - One that:

1. Has a flow of 50,000 gallons or more per average work day;
2. Has a flow greater than five percent of the flow carried by the municipal system receiving the waste;
3. Has in its wastes a toxic pollutant in toxic amounts as defined in standards issued under Section 307(a) of the Act; or
4. Has a significant impact, either singly or in combination with other contributing industries on a publicly owned treatment works or on the quality of effluent from that treatment works.

The following abbreviations, when used, are defined below:

Cu. M/day or M^3/day	cubic meters per day
mg/l	milligrams per liter
ug/l	micrograms per liter
kgpd or kg/day	kilograms per day
Temp. °C	temperature in degrees Centigrade
Temp. °F	temperature in degrees Fahrenheit
TNFR or TSS	total nonfilterable residue or total suspended solids
DO	dissolved oxygen
BOD	five-day biochemical oxygen demand unless otherwise specified
TKN	total Kjeldahl nitrogen as nitrogen
NH_3-N	ammonia nitrogen as nitrogen
lb/day	pounds per day
Total P	total phosphorus as phosphorus
COD	chemical oxygen demand
TOC	total organic carbon
Surfactant	surface-active agent
pH	a measure of the hydrogen ion concentration
PCB	polychlorinated biphenyl
CFS	cubic feet per second
MGD	million gallons per day
Oil & Grease	hexane extractable material
Total Coliform	total coliform bacteria
Turb.	turbidity measured in Jackson Candle Units (JTU)

Fecal Coliform	total fecal coliform bacteria
ml/l	milliliter(s) per liter
ml	milliliter(s)
SU	standard units
NO_3-N	nitrate nitrogen as nitrogen
NO_2-N	nitrite nitrogen as nitrogen
NO_2&NO_3	combined nitrite and nitrate nitrogen as nitrog
Cl_2	total residual chlorine

Note: Average pounds of pollutant per day equals the average concentration in (mg/l) times 8.34 times the average flow in million gallons (MGD).

Example: 30 mg/l x 8.34 x 2.0 MGD = 500 lbs/day

This permit shall become effective 45 days after the date ~~of the signature~~ of the signatories listed below and shall expire on May 31, 1984.

Thomas C. McMahon, Director
Division of Water Pollution Control
Commonwealth of Massachusetts

Date

Leslie Carothers, Director
Enforcement Division
Environmental Protection Agency

Date

APPENDIX C

S 2322

Chapter 369

THE COMMONWEALTH OF MASSACHUSETTS

In the Year One Thousand Nine Hundred and Eighty-four

AN ACT AUTHORIZING THE INCREASE OF OCEAN DISCHARGE OF WASTEWATER BY THE TOWN OF DARTMOUTH AND PROVIDING FOR A STUDY OF THE OCEAN DISCHARGE OF WASTEWATER BY THE EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

SECTION 1. Notwithstanding the provisions of sections thirteen through eighteen, inclusive, of chapter one hundred and thirty-two A of the General Laws, the town of Dartmouth is hereby authorized to improve its municipal wastewater treatment facility and appurtenances thereto, and, as a result of such improvement, to increase its ocean discharge of wastewater subject to the regulations and restrictions established by the department of environmental management; provided that said department determines that there is no other disposal method, including land application, that may be approved by federal and state agencies; that such improvement and increase are otherwise consistent with the provisions and intent of said sections thirteen through eighteen, inclusive, of said chapter one hundred and thirty-two A and are of equal or greater effectiveness in avoiding degradation of the water quality of the affected ocean sanctuary and the surface and ground waters of the area for which the facility is providing wastewater treatment; and that such discharge shall have, at a minimum, secondary treatment.

SECTION 2. This act shall be applicable for any single project of improvement of the wastewater treatment facility and appurtenances referred to in section one or resulting increase of ocean discharge approved within six years after the effective date of this act.

SECTION 3. The executive office of environmental affairs is hereby authorized and directed to study and investigate the consequences of, and alternatives to, ocean discharge of wastewater into the ocean sanctuaries of the commonwealth and shall report the results of such study and investigation to the General Court by filing the same with the clerks of the senate and

house of representatives no later than July first, nineteen hundred and eighty-five. Said study and investigation shall be conducted in cooperation with representatives of the department of environmental quality engineering, the office of coastal zone management and the department of environmental affairs, together with such representatives of affected communities or other interested parties as the secretary of said executive office shall designate.

House of Representatives, December 12, 1984.

Passed to be enacted, Thomas W. McGee, Speaker.

In Senate, December 14, 1984.

Passed to be enacted, William M. Bulger, President.

December 19, 1984.

Approved,

Michael S. Dukakis Governor.

cc. DPW

APPENDIX D

APPENDIX E

The Commonwealth of Massachusetts

OFFICE OF THE SECRETARY
STATE HOUSE, BOSTON, MASS.

Rules and Regulations filed in this Office under the provisions of CHAPTER 30A as amended.

Filed by DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

OCEAN SANCTUARIES

Date Filed July 10, 1978

Date Published July 20, 1978

Chapter 233, sec. 75

Printed copies of rules and regulations purporting to be issued by authority of any department, commission, board or Officer of the Commonwealth or any city or town having authority to adopt them, or printed copies of any ordinances or town by-laws, shall be admitted without certification or attestations, but if this genuineness is questioned, the court may require such certifications or attestations thereof as it deems necessary.

Attested as a true copy
PAUL GUZZI

Paul Guzzi

SECRETARY OF THE COMMONWEALTH

PUBLICATION OF THIS DOCUMENT APPROVED BY ALFRED C. HOLLAND, STATE PURCHASING AGENT.

(38-1) $.30

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Management
Leverett Saltonstall Building, Government Center
100 Cambridge Street Boston 02202

44

DALL

July 7, 1978

Honorable Paul H. Guzzi
Secretary of the Commonwealth
State House
Boston, Massachusetts 02133

Re: Regulations on the Ocean Sanctuaries

Dear Secretary Guzzi:

In accordance with the provisions of G.L. c. 30, s. 37, I am enclosing regulations adopted by me as Commissioner of the Department of Environmental Management pursuant to the authority of G.L. c. 132A, ss. 13-16 and 18 and G.L. c. 21A, s. 2 entitled "Ocean Sanctuaries Regulations." Public hearings on these regulations were held in Boston on June 21, 1978. Please find enclosed one original and two attested copies. The effective date of this Regulation is July 14, 1978.

The purpose of these regulations is to amplify and clarify the provisions of the Ocean Sanctuaries Act. It is estimated that the net fiscal effect will be zero or positive.

In taking this action I am using all feasible means and measures to minimize and avoid environmental impact, and I so find, as required by G.L. c. 30, s. 61. An environmental assessment form was prepared for this project and the project has been determined to cause no significant damage to the environment.

Sincerely,

Richard E. Kendall

Richard E. Kendall
Commissioner

REK:kc
enclosures

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

OCEAN SANCTUARIES REGULATIONS

G. L. C. 132A, SECTIONS 13-16 AND 18

TABLE OF CONTENTS

1.0 Authority - These regulations are promulgated by the Department of Environmental Management pursuant to G.L. c. 21A, ss. 2(2), (5),(9),(10),(11),(13),(15),(16) and (28) in order to carry out the provisions of G. L. c. 132A, ss. 13-16 and 18, the Ocean Sanctuaries Act (hereinafter "the Act").

2.0 Purpose - These regulations are promulgated in order to (a) define and explain the language of the Act, (b) set out the procedural means by which the Department will exercise its responsibilities under the Act, (c) explain the responsibilities of other state agencies under the Act, and (d) detail how the Department intends to ensure the inter-agency cooperation mandated by Section 18 of the Act.

It is the intent of the Department that these regulations be consistent with and form a part of the Commonwealth's Coastal Zone Management Program (hereinafter "CZM Program") as it has been promulgated and defined by the regulations issued pursuant to G. L. c. 21A and entitled "Establishment of the Coastal Zone Management Program by the Executive Office of Environmental Affairs" (hereinafter "CZM Regulations"). Those regulations establish the CZM policies, which are part of the CZM Program, as state environmental policy, and the Department shall carry them out in accordance with G. L. c. 21A, s.2. See Section 5.2 of these regulations for a statement of those policies as they relate to the Act. Furthermore, the Department shall interpret its statutory authorities and implement its administrative procedures, policies and actions so as to be consistent with the CZM Program, except when (a) to do so would require an action impermissible at law, or (b) the Secretary, pursuant to the conflict resolution procedures of G. L. c. 21A, s.4 and Sections 6.20 - 6.28 of the CZM Regulations, has resolved any conflict and has determined that the CZM policies should or should not apply. These regulations, however, are adopted independently under the Act and would remain in full force and effect in the absence of the CZM Program or the CZM Regulations.

In accordance with Section 18 of the Act, these regulations do not require any permits other than those already required by law, but they do explain the responsibilities of other state agencies to make their policies, permits, licenses or any other action conform to the Act, as Section 18 requires.

3.0 Jurisdiction - The provisions of these regulations shall be effective on July 14, 1978 in the five ocean sanctuaries defined in G. L. c. 132A, s. 13(a)-(e), a copy of which is attached to these regulations as Appendix A.

4.0 Definitions

4.1 "Agency" means any board, body, commission, corps, council, department, division, office or administrative unit, however labeled, and any authority of any political subdivision which is specifically created as an authority under special or general law.

4.2 "Cape Cod National Seashore" means the area defined in Section 1 (a) of P. L. 87-126, 75 Stat. 284.

4.3 "Care and control" means management and shall have the same meaning as the phrase "general care and oversight" in G. L. c. 21, s. 1, which provides that DEM shall have general responsibility for the "general care and oversight of the environmental management of the Commonwealth and of its adjacent waters" and that DEM has a mandate "to propose and carry out measures for the protection, conservation, control, use, increase and development thereof." "Care and control" shall also mean trusteeship in the sense of fiduciary protection. See Section 9.0 for a description of how DEM intends to exercise its "care and control" responsibility.

4.4 "Commercial or industrial wastes" means any useless, unwanted, discarded or environmentally harmful solid, liquid or gaseous materials resulting from commercial or industrial activities, including, but not limited to, garbage, rubbish, thermal discharges and sewage.

4.5 "Department" means the Department of Environmental Management, which is located on the 19th floor of 100 Cambridge Street, Boston 02202, telephone (617) 727-8893.

4.6 "Extension of the lateral boundary of New Hampshire and Massachusetts" means the lateral seaward boundary between the two states that is established by interstate compact, agreement, judicial decision, or as otherwise provided by law.

4.7 "Extension of the lateral boundary of Rhode Island and Massachusetts" means the lateral seaward boundary between the two states that is established by interstate compact, agreement, judicial decision, or as otherwise provided by law.

4.8 "Marine boundary map" means the Marine Boundary Map of the Commonwealth prepared pursuant to Chapter 810 of the Acts of 1970 and Chapter 1035 of the Acts of 1971 by the Department of Public Works, Division of Waterways, dated December 1971.

4.9 "Mean low water line" means the arithmetic mean of the low water heights observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch) and shall be determined using the nautical charts, harbor charts series (1:50,000 and larger), prepared by the National Ocean Survey, U. S. Department of Commerce. For those coastal areas not covered by such published harbor charts, the mean low-water line shall be determined using hydrographic survey data obtainable from the National Ocean Survey. For the inland boundaries of the ocean sanctuaries, see the official maps of the ocean sanctuaries that are available for inspection at the office of the Ocean Sanctuaries Coordinator in the Department.

4.10 "Miles" means nautical miles.

4.11 "Offshore" means seaward of the mean low water line.

4.12 "Only feasible alternative" means that, other than the proposed discharge, there is no method of solving the particular water pollution problem, including land application, that:
(a) will be approved by the appropriate federal and state agencies;
(b) is consistent with the intention and purposes of the Act; and
(c) is of equal or greater effectiveness in avoiding degradation of the water quality of the affected ocean sanctuary.

4.13 "Public necessity and convenience" means necessary to the public interest. This standard shall be administered by the applicable state agency otherwise involved in approving the project, subject to the general oversight function of the department described in Section 9.0. In applying this standard the applicable state agency shall consider the following factors: the financial and/or technical ability of the person proposing the project to build and maintain the project properly; whether the facility or use, if any, existing at the time the agency approval is requested is inadequate; whether either the public, which may be represented by several individuals or a representative group, demonstrates a need for the facility or use or that appropriate state or local public officials deem the facility or use necessary for the public's safety or welfare; whether the proposed facility or use will serve the public interest; whether the proposed facility or use will seriously alter or otherwise endanger the ecology or appearance of the ocean, the seabed or subsoil thereof, or the Cape Cod National Seashore; and the extent to which existing uses or facilities will be affected by the proposed facility or use. In all cases the agency shall act pursuant to the statutory policy expressed in Section 14 of the Act and shall consider these regulations and any determinations made by the Commissioner in determining whether the public necessity and convenience standard has been met.

4.14 "Refuse" means any useless unwanted, discarded or environmentally harmful solid material, whether combustible or non-combustible, and including, but not limited to, garbage, rubbish or sludge resulting from any activity.

4.15 "Seriously alter" includes, but is not limited to, one or more of the following actions:
(a) removing, excavating, or dredging any soil, sand, gravel or other minerals or aggregate material of any kind in any significant amounts;
(b) changing drainage or flushing characteristics, salinity distribution, sedimentation or flow patterns, flood storage areas or the water table, to more than a negligible extent;
(c) dumping, discharging, or filling with any material of any kind that could significantly degrade water quality;

(d) driving pilings or erecting buildings, structures or obstructions of any kind of any significant size or quantity, whether or not they interfere with the flow of water;
(e) destroying or adversely affecting in more than a negligible way any plant or animal life, including shellfish and fisheries;

(f) changing the temperature, biochemical oxygen demand (BOD) or other natural characteristics of the water so that there is a more than negligible adverse effect on the marine environment;
(g) significantly increasing the development of already developed areas;
(h) developing any previously undeveloped or natural areas.

4.16 "Solid waste material" has the same meaning as refuse.

4.17 "Sound conservation practices" means practices designed to maintain, increase or restore existing finfish or shellfish stocks by the management of resources.

4.18 "Structure" means any man-made object of any kind that is not temporarily fixed to the seabed, or temporarily moored in the waters above.

See Section 5.2 of these regulations regarding additional definitions.

5.0 Environmental Policies

5.1 Insofar as they relate to the responsibility of the Department to protect the ocean sanctuaries from any exploitation, development or activity that would seriously alter or otherwise endanger their ecology or appearance, or the Cape Cod National Seashore, the environmental policy of the Department shall include, but not be limited to, the following policies:

a. Protecting ecologically significant resource areas (salt marshes, shellfish beds, dunes, beaches, barrier beaches, and salt ponds) for their contribution to marine productivity and value as natural habitats and storm buffers. (CZM Policy No. 1).

b. Protecting complexes of marine resource areas of unique productivity (Areas for Preservation or Restoration (APR's)/Areas of Critical Environmental Concern (ACEC's)); ensuring that activities in or impacting such complexes allowed by Sections 8.1-8.9 are designed and carried out to minimize adverse effects on marine productivity, habitat values, water quality and storm buffering of the entire complex. (CZM Policy No. 2).

c. Supporting the attainment of the national water quality goals for all waters within the ocean sanctuaries through coordination with existing water quality planning and management activities; ensuring that all activities in the ocean sanctuaries allowed by Sections 8.1-8.9 are consistent with federal and state effluent limitations and water quality standards. (CZM Policy No. 3).

d. Ensuring that construction in the ocean sanctuaries allowed by Sections 8.1-8.9 is conditioned so as to minimize interference with water circulation and sediment transport and to preserve water quality and marine productivity; ensuring that flood or erosion control projects allowed by Sections 8.1-8.9 are issued permits only after it has been determined by the permitting agency that there will be no significant adverse effects on the project site or adjacent or down coast areas. (CZM Policy No. 4).

e. Ensuring that dredging and disposal of dredged material allowed by Sections 8.1-8.9 minimize adverse effects on water quality, physical processes, marine productivity and public health. (CZM Policy No. 5).

f. Accommodating off-shore sand and gravel mining needs allowed by Sections 8.1-8.9 in areas and in ways that will not adversely affect marine resources and navigation. (CZM Policy No. 6).

g. Encouraging the location of maritime commerce and development allowed by Sections 8.1-8.9 in segments of urban waterfronts designated as port areas by the Division of Waterways and preventing the exclusion of maritime dependent industrial uses within those areas that require the use of lands subject to tidelands licenses. (CZM Policy No. 7).

h. Accommodating the exploration, development and production of off-shore oil and gas resources while ensuring that any agency issuing a permit for any such activity allowed by Sections 8.1-8.9 requires such exploration, development or production to minimize impacts on the environment, especially with respect to fisheries, water quality and wildlife and on the recreational values of the

coast, and to minimize conflicts with other maritime-dependent uses of coastal waters or lands: encouraging maritime-dependent facilities serving supply, support or transfer functions to locate in existing developed ports. (CZM Policy No. 9a).

i. Ensuring that any agency issuing a permit for any development in an ocean sanctuary allowed by Sections 8.1-8.9 in or near a designated or registered historic district or site within any ocean sanctuary requires such development to respect the preservation intent of such areas and to minimize adverse impacts. (CZM Policy No. 12).

j. Ensuring that any agency issuing a permit for and development in an ocean sanctuary allowed by Sections 8.1-8.9 near a public recreation site within any ocean sanctuary requires such development to minimize adverse impacts. (CZM Policy No. 13).

k. Ensuring that state and federally funded public works projects proposed in any ocean sanctuary and allowed by Section 8.1-8.9 shall:
   1. not exacerbate existing hazards or damage natural buffers,
   2. be reasonably safe from flood and erosion related damage, and
   3. not promote growth and development in damage prone or buffer areas, especially in undeveloped areas of critical environmental concern. (CZM Policy No. 15)

l. Emphasizing for federally or state-funded activities allowed by Sections 8.1-8.9 the use of non-structural measures for protection from tidal flooding and erosion when feasible. (CZM Policy No. 17).

m. Promoting the widest possible public benefit from channel dredging allowed by Sections 8.1-8.9; ensuring that designated ports and developed harbors are given highest priority in the allocation of federal and state dredging funds; ensuring that this dredging is consistent with marine environment policies. (CZM Policy No. 19).

n. Increasing the capacity of existing recreation areas by facilitating multiple use and by improving management, maintenance and public support facilities to the extent permitted by Sections 8.1-8.9; resolving conflicting uses whenever possible through improved management rather than through exclusion of uses. (CZM Policy No. 22).

o. Expanding existing recreation facilities to the extent permitted by Sections 8.1-8.9 and acquiring and developing new public areas for coastal recreational activities; giving highest priority to expansions or new acquisitions in regions of high need or where site availability is now limited: assuring that both transportation access and the recreational facilities are compatible with social and environmental characteristics of surrounding communities. (CZM Policy No. 24).

p. Ensuring that state and federally funded transportation and wastewater projects permitted by Sections 8.1-8.9 primarily serve existing developed areas; assigning highest priority to projects which meet the needs or urban and community development centers. (CZM Policy No. 26).

5.2 The Department hereby adopts and incorporates in these regulations the following definitions contained in the CZM Regulations: "coastal zone," "salt marshes," "barrier beach system," "port area," "salt marsh," "salt pond," "shellfish bed," "dune," "beach" and "area of critical environmental concern."

5.3 The Department hereby adopts and incorporates in these regulations the Policy Appendix described in Section 5.4 of the CZM Regulations to the extent that the Policy Appendix applies to the policies set out in Section 5.1 of these regulations.

6.0 Miscellaneous Provisions

6.1 Severability - If any provision of these regulations is held to be invalid by a competent court of law, such invalidity shall not affect the application of any part of these regulations not specifically held invalid.

6.2 Amendments - These regulations may be amended from time to time by the Department in accordance with the applicable provisions of G. L. c. 30A.

6.3 Number and Gender - When appropriate words imparting the singular number may extend and be applied to several persons or things, words imparting the masculine gender may include the feminine and neuter, words imparting the feminine gender may include the masculine and neuter and words imparting the neuter gender may include the masculine and feminine.

7.0 Prohibited Activities

7.1 In all of the five ocean sanctuaries the following activities are prohibited, except as they may specifically be allowed under Sections 8.1-8.9:

a. the building of any structure on the seabed or under the subsoil;
b. the construction or operation of off-shore or floating electric generating stations;
c. the removal of any minerals, such as sand or gravel, and the drilling for oil or gas;
d. the dumping or discharge of any commercial or industrial wastes;
e. commercial advertising by any means, including, but not limited to, structures or vessels or boats of any size;
f. incineration of solid waste material or refuse on or in any vessel or boat of any size. The cooking of food by means of charcoal on any such vessel or boat shall not be considered such incineration.

8.0 Allowed Activities

8.1 Except in the Cape Cod Ocean Sanctuary, and provided that all applicable certificates, licenses, permits and approvals required by federal, state or local law have been obtained and provided further that such activities, uses and facilities shall not be undertaken or located except in compliance with any applicable general or special statutes, rules, regulations or order lawfully promulgated, the planning, construction, reconstruction, operation or maintenance of an industrial liquid coolant discharge or intake system and any activity, use or facility associated with the generation, transmission or distribution of electrical power shall be permitted. All such activities shall be prohibited in the Cape Cod Ocean Sanctuary.

8.2 With the exception of municipal wastewater treatment facilities and discharges (see Section 8.9 below), the operation and maintenance of any municipal, commercial or industrial facility or discharge existing as of the following dates, which are the effective dates of the applicable original ocean sanctuaries acts, shall be allowed so long as such facility or discharge has been approved and licensed by the appropriate federal and state agencies:

Cape Cod Ocean Sanctuary	July 15, 1970
Cape Cod Bay and Cape and Islands Ocean Sanctuaries	December 8, 1971
North Shore Ocean Sanctuary	June 27, 1972
South Essex Ocean Sanctuary	December 30, 1976

No municipal, commercial or industrial facility or discharge built or occurring in any ocean sanctuary after those dates shall be permitted, except as specifically allowed elsewhere in Sections 8.1-8.9.

8.3 The laying of any electric or telephone cable shall be allowed if approved by the Department of Public Utilities.

8.4 Any project authorized under G.L. c. 91, including channel and shore protection projects and navigation aids, shall be allowed, but only if it is not otherwise prohibited by these regulations, if it has received all required federal and/or state approvals and if the approving agency also finds that the project is one of public necessity and convenience.

8.5 Any improvement to permitted structures or uses that is not specifically prohibited by Sections 14, 15 and 18 of the Act shall be allowed so long as it does not change or extend such structures or uses and it is otherwise approved by appropriate state and federal agencies. Such an improvement may change or extend such structures or uses if it is specifically permitted by Sections 8.1-8.9 and may include maintenance and repairs to such structures or uses. Any such improvements shall be consistent with Sections 14, 15 and 18 of the Act.

9.0 Oversight by the Department

9.1 The Responsibility of the Department - In accordance with Section 14 of the Act, the Department shall have the responsibility of exercising the "care and control" of the ocean sanctuaries. Because the Act states in Section 18 that the Department "shall not require any additional permits," the Department shall act as a trustee of the resources of the ocean sanctuaries rather than as a permitting agency for specific activities. In that role as trustee the Department shall ensure that the ocean sanctuaries shall be protected from any exploitation, development, or activity that would seriously alter or otherwise endanger the ecology or the appearance of the ocean, the seabed, or subsoil thereof, or the Cape Cod National Seashore. In carrying out this fiduciary responsibility, the Department shall aggressively seek to restrain any prohibited activity by whatever means it has available, including assistance from the Attorney General pursuant to Section 18 of the Act.

9.2 Review by the Department - In carrying out its "care and control" responsibility, the Department shall examine at least annually the permitting procedures and other activities of all other state agencies insofar as they relate to the ocean sanctuaries. Such activities shall include, but not be limited to, the granting of permits or the construction or funding of any project. Such procedures and activities shall be evaluated in terms of whether all reasonable measures have been taken by the agency to permit, condition, or prohibit activities in order to protect the ocean sanctuaries from activity that would seriously alter or otherwise endanger the ecology or the appearance of the ocean, the seabed, or subsoil thereof, or the Cape Cod National Seashore. If the Department finds that such procedures are inadequate for protecting the ocean sanctuaries in accordance with the provisions of the Act, it shall initiate informal discussions with the licensing or permitting agency in an attempt to reconcile any differences. If the Department finds that such informal discussions fail to reconcile any differences, it shall pursue any other means available to it to resolve the conflict. If the other agency is within the Executive Office of Environmental Affairs (EOEA), the Department shall ask the Secretary of EOEA to resolve the conflict pursuant to G. L. c. 21A, s. 4(3), if applicable, and applicable regulations. If the agency is not within EOEA, the Department shall act pursuant to G. L. c. 30, s. 5.

It shall be the responsibility of all state agencies to issue, deny or condition permits or licenses or to conduct their activities consistently with the provisions of the Act. In addition, pursuant to Section 18 of the Act, such agencies shall confer and consult with the Department's Ocean Sanctuaries Coordinator to ensure such consistency. An agency shall consult with the Department's Ocean Sanctuaries Coordinator whenever it has any question about the interpretation of the Act or those regulations, or whether a proposed activity is consistent with the Act.

9.3 Ocean Sanctuaries Coordinator - The Department shall designate an Ocean Sanctuaries Coordinator who shall be thoroughly familiar with the Act, these regulations, the CZM Program and the applicable statutes and regulations governing the activities of other state and/or federal agencies in the ocean sanctuaries. The Ocean Sanctuaries Coordinator shall be responsible, under the direction of the Commissioner of the Department, for carrying out the Department's responsibilities under Sections 9.1-9.2.

The Ocean Sanctuaries Coordinator may perform or cause to be performed any further studies or site investigations that may be required to determine whether a proposed action is consistent with the Act. The Ocean Sanctuaries Coordinator shall consult the Coastal Zone Management Office whenever a question regarding a CZM policy arises. He may consult the applicable regional chapter of the CZM Program and/or contact the applicable regional advisory council for guidance in the application of the CZM policies to the region and to the site.

The Department shall, in appropriate cases, intervene in any adjudicatory hearing relating to an ocean sanctuary.

9.4 The Commissioner of the Department may, in consultation with the Ocean Sanctuaries Coordinator or any state or federal agency, make a determination regarding an interpretation of the Act or these regulations or their applicability to a particular situation. Such a determination may be distributed to other state agencies when the issue is one of broad public interest. Such determinations shall form a body of administrative decisions for use in applying the provisions of the Act and these regulations consistently, but they shall not be binding on any other agency.

A true copy:

ATTEST: Catherine Farrell
Catherine Farrell
General Counsel

OCEAN SANCTUARIES—ACTIVITIES

CHAPTER 897.

An Act further regulating activities with ocean sanctuaries.

Be it enacted, etc., as follows:

SECTION 1. Chapter 132A of the General Laws is hereby amended by striking out sections 13 to 16, inclusive, and inserting in place thereof the following four sections:

Section 13.

There are hereby established the following ocean sanctuaries:

(a) The Cape Cod Ocean Sanctuary is described as follows: Beginning at a point three miles west of the mean low-water line along the Bay Closing Line between Brant Rock in the town of Marshfield and Race Point in Provincetown as established on the Marine Boundary Map of the Commonwealth (prepared by the Department of Public Works, Division of Waterways, December, 1971, pursuant to Chapter 810 of the Acts of 1970 and Chapter 1035 of the Acts of 1971); thence swinging in a clockwise arc along a line three miles offshore and parallel to the mean low-water line of the northerly extremity of Cape Cod to the point of intersection with the Exterior Line of the Commonwealth as established on the aforementioned Marine Boundary Map; thence in a generally easterly and then southerly direction along said Exterior Line to the intersection with a line running due east (90 Degrees True) from a point three miles due south (180 Degrees True) of the mean low-water line at the southernmost point of Monomoy Point in the town of Chatham; thence westerly on said line to the point three miles due south (180 Degrees True) of the mean low-water line of the southernmost point of Monomoy Point; thence running due north (0 Degrees True) to the mean low-water line at Monomoy Point; thence along the mean low-water line of the eastern side of Monomoy Island and thence by the shortest distance to the seaward boundary of the Cape Cod National Seashore, as established by Act of Congress (1961, P.L. 87-126); thence easterly, northerly, westerly, and finally southwesterly along the seaward boundary of said Cape Cod National Seashore to the point of intersection with the aforementioned closing line, then westerly along said closing line to the point of beginning; and meaning and

intending to include Town Cove and Nauset Harbor and portions of the Atlantic Ocean.

(b) The Cape Cod Bay Ocean Sanctuary is bounded and described as follows: That body of water known as Cape Cod Bay and lying southerly of the Bay Closing Line between Brant Rock in the Town of Marshfield and Race Point in the town of Provincetown as established on the aforementioned Marine Boundary Map of the Commonwealth, and lying seaward of the mean low-water line; meaning and intending to include: all of that water area and seabed lying in a southerly direction from the aforementioned closing line; all of Provincetown Harbor including portions which may be easterly or northerly of the aforementioned closing line, Wellfleet, Plymouth, and Barnstable Harbors; Plymouth, Kingston, and Duxbury Bays; and the Cape Cod Canal Northerly of the Bourne-Sandwich town boundary, and excluding the water area and seabed of the Cape Cod National Seashore as established by Act of Congress (1961, P.L. 87-126).

(c) The Cape and Islands Ocean Sanctuary is bounded and described as follows: Beginning at a point on the mean low-water line at the southernmost point of Monomoy Point; thence due south to a point in the Atlantic Ocean three miles due south (180 Degrees True) of the mean low-water line at the southernmost point of Monomoy Point; thence due east (90 Degrees True) to the Exterior Line of the Boundary of the Commonwealth as established on the aforementioned Marine Boundary Map; thence in a generally southerly and then westerly direction along said Exterior Line to the point of intersection with the extension of the lateral boundary of Rhode Island and Massachusetts; thence northerly along said lateral boundary to the mean low-water line near Quicksand Point; thence following the mean low-water line around Buzzards Bay, the Cape Cod Canal to the Bourne-Sandwich town boundary, and the southern portion of Cape Cod to the point of intersection in Pleasant Bay with the western boundary of the Cape Cod National Seashore; thence southerly along said boundary; thence by the shortest distance to the mean low-water line of Monomoy Island; thence to the point beginning by following the mean low-water line of the western side of Monomoy Island; and meaning and intending to include the area seaward of the mean low-water lines of Nantucket, Martha's Vineyard, Elizabeth and other islands; and meaning and intending to include the following bodies of water: Nantucket Sound, Vineyard Sound, Buzzards Bay, the Cape Cod Canal, Pleasant Bay, and portions of the Atlantic Ocean.

(d) The North Shore Ocean Sanctuary is bounded and described as follows: Beginning at the mean low-water line at the southeasternmost point of Pickworth Point in the town of Manchester; thence by a line bearing (150 Degrees True) (South-southeasterly) seaward to a distance of three miles to a point (42 Degrees 31.-13' north, 70 Degrees 43.87' west); thence due east (90 Degrees True) to the point of intersection (42 Degrees 31.13' north, 70 Degrees 36.70' west) with the Exterior Line of the Marine Boundary of the Commonwealth as established on the aforementioned Marine Boundary Map; thence northerly, northeasterly, northwesterly, westerly, southwesterly, and northerly along said Exterior Line to the point of intersection with the extension of the lateral boundary of New Hampshire and Massachusetts; thence westerly along said lateral boundary to the line of mean low-water; thence southerly, northeasterly, southeasterly, southerly, and southwesterly, along the line of mean low-water to the point of place of beginning; and meaning and intending to include Gloucester Harbor; Ipswich and Essex Bays; Plum Island Sound; the Merrimack River Estuary; and portions of the Atlantic Ocean.

(e) The South Essex Ocean Santuary is bounded and described as follows: Beginning at the mean low-water line at the southeasternmost point of Pickworth Point in the town of Manchester; thence by a line bearing (150 Degrees True) (South-southeasterly) seaward to a distance of three miles to a point (42 Degrees 31.-13' north, 70 Degrees 43.87' west) thence due east (90 Degrees True) to the point of intersection (42 Degrees 31.13' north, 70 Degrees 36.70' west) with the Exterior Line of the Boundary of the Commonwealth as established on the aforementioned Marine Boundary Map; thence southerly along said Exterior Line to a point (42 Degrees 26.10' north, 70 Degrees 38.42' west) thence due west (270 Degrees True) along a line a point (42 Degrees 26.10' north, 70 Degrees 52.02' west) which is three miles from the mean low-water line on a line which is the extension of the boundary line

between the city of Lynn and the town of Swampscott thence northwesterly along said boundary extension to the mean low-water line; t. nce easterly, northeasterly, northwesterly, southwesterly, northeasterly, northwesterly, and northeasterly along the line of line of mean low-water of the commonwealth to the point or place of beginning; and meaning and intending to include Marblehead Harbor, Salem Harbor, Beverly Harbor, Salem Sound, Manchester Bay, and parts of Massachusetts Bay.

"Miles", as used in this section, means nautical miles. "Mean low-water line" shall mean the arithmetic mean of the low-water heights observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch) and shall be determined using the nautical charts, harbors charts series (1:50,000 and larger) prepared by the National Ocean Survey, U.S. Department of Commerce. For those constal areas not covered by such published harbor charts, the mean low-water line shall be determined using hydrographic survey data obtainable from the National Ocean Survey. Save for the degree bearings given herein, the compass directions provided in this act are general approximations of the directions of the boundaries of the sanctuaries; in all cases the mean low-water line shall follow the mean low-water line as determined from said charts or data, however it may wend or meander. Such Ocean Sanctuaries shall include all islands lying within the aforedescribed boundaries seaward of the mean low-water lines of each such island.

[1] 16 U.S.C.A. § 459b et seq.

Section 14.

All ocean sanctuaries as described in section thirteen shall be under the care and control of the department of environmental management and shall be protected from any exploitation, development, or activity that would seriously alter or otherwise endanger the ecology or the appearance of the ocean, the seabed, or subsoil thereof, or the Cape Cod National Seashore.

Section 15.

Except as otherwise provided herein, the following activities shall be prohibited in an ocean sanctuary: the building of any structure on the seabed or under the subsoil; the construction or operation of offshore or floating electric generating stations; the drilling or removal of any sand, gravel or other minerals, gases or oils; the dumping or discharge of commercial or industrial wastes; commercial advertising; the incineration of solid waste material or refuse on, or in, vessels moored or afloat within the boundaries of an ocean sanctuary.

Section 16.

Nothing in sections fourteen, fifteen and section eighteen is intended to prohibit the following activities, uses or facilities: In all ocean sanctuaries except the Cape Cod Ocean Sanctuary the planning, construction, reconstruction, operation and maintenance of industrial liquid coolant discharge and intake systems and all other activities, uses and facilities associated with the generation, transmission, and distribution of electrical power, provided that all certificates, licenses, permits and approvals required by law are obtained therefor, and provided, further, that such activities, uses and facilities shall not be undertaken or located except in compliance with any applicable general or special statutes, rules, regulations or orders lawfully promulgated; the operation and maintenance of existing municipal, commercial or industrial facilities and existing municipal, commercial or industrial discharges where such discharges and facilities have been approved and licensed by appropriate federal and state agencies; the laying of cables approved by the department of public utilities; channel and shore protection projects, navigation aids, projects authorized under chapter ninety-one, deemed to be of public necessity and convenience, contingent upon obtaining the required approval wherever applicable by the United States Army Corps of Engineers, the division of water pollution control, the department of environmental quality engineering, or the department of environmental management; other improvements not specifically prohibited by sections fourteen, fifteen and section eighteen which are approved by appropriate federal and state agencies and which are consistent with said sections, including the maintenance and repair of existing structures or uses, but not any change or extension of such structures or uses unless otherwise permitted by said sections; the

harvesting and propagation of fish and shellfish in all forms, so long as the department of environmental management and the department of fisheries, wildlife and recreational vehicles are satisfied that such activities are carried on in accordance with sound conservation practices; temporary educational and scientific activities jointly permitted by appropriate state agencies; and the extraction of sand and gravel from the seabed and subsoil of a sanctuary for the purposes of shore protection or beach restoration, provided that such shore protection or beach restoration is approved by the department of environmental quality engineering.

Except in the Cape and Islands Ocean Sanctuary, the Cape Cod Ocean Sanctuary, and the Cape Cod Bay Ocean Sanctuary nothing is intended to prohibit municipal wastewater treatment discharges and municipal wastewater treatment facilities if such discharge into the ocean sanctuary is the ony fensible alternative to existing water pollution problems, if it is consistent with the intention and purposes of this chapter, and it is approved and licensed by appropriate federal and state agencies. In the North Shore Ocean Sanctuary, discharges shall be permitted from municipal waste treatment facilities if construction is commenced prior to January first, nineteen hundred and seventy-eight or if a city or town has been awarded a federal or state grant for construction of a wastewater treatment facility prior to January first, nineteen hundred and seventy-eight, if the waste has been treated by the best practical means, if such a discharge is in accordance with plans developed under the provisions of clause (10) of section twenty-seven of chapter twenty-one, and such plans are subject to the approval of the division of water pollution control after a public hearing conducted by said division.

SECTION 2. Said chapter 132A is hereby further amended by striking out section 18 and inserting in place thereof the following section:

Section 18.

All departments, divisions, commissions, or units of the executive office of environmental affairs and other affected agencies or departments of the commonwealth shall issue permits or licenses for activities or conduct their activities consistently with sections thirteen to sixteen, inclusive, and shall not permit or conduct any activity which is contrary to the provisions of said sections. The provisions of said sections thirteen to sixteen, inclusive, shall not require any additional permits from the department of environmental management under said sections, but said departments, divisions, commissions, units, or other agencies shall confer and consult with the department of environmental management to insure compliance with said sections. The attorney general or the appropriate state agency shall take such action as may be necessary from time to time to enforce the provisions of said sections, and the superior court shall have jurisdiction to enforce the provisions thereof.

SECTION 3. The executive office of environmental affairs shall prepare an official map of the ocean sanctuaries, established by section thirteen of chapter one hundred and thirty-two A of the General Laws, as amended by section one of this act, and shall file such with the clerk of the house of representatives and the state secretary within six months of the effective date of this act.

Approved December 30, 1977.

UNIFORM FILING FORM

This form has been prepared to simplify & make uniform the procedure for submitting materials with the Rules & Regulations Division. You may find it helpful in completing this form to refer to your enabling legislation & to M. G. L. Chapter 30A, as amended by Chapter 459 of the Acts of 1976, which set forth the basic filing requirements.

1 - Date July 7, 1978

2 - Cabinet Environmental Affairs Department Environmental Management Division _____

Contact Katherine Farrell Phone 727-3159

Address 19th floor, 100 Cambridge St., Boston, Ma. 02202

3 - Descriptive title of document: Ocean Sanctuaries Regulations

4 - Estimate the number of copies that will be purchased in the next six months: By your agency 100 By the public 100

(Note: If you need bulk quantities for your agency, please submit a purchase order form or call 727-2834 to place your order for printing.)

5 - The document attached is best classified as a:

[XX] Ch. 30A Regulation

[ ] Ch. 30A Emergency Regulation - If this box is checked, state nature of emergency.

[ ] Other - If this box is checked, do not complete the rest of the form.

6 - List statutory and/or regulatory authority for this promulgating action: G.L. c. 132A, ss. 13-16 and 18

Was a public hearing required? Yes [XX] No [ ]

If approval of other agencies was required, list approvals & date obtained: none required

(OVER)

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7 - Date of public hearing (Ch. 30A/2): June 21, 1978 ; or

Date of "action" (Ch. 30A/3)_____

Was notice of the regulatory proceeding filed in the office of the Secretary of the Commonwealth & published in appropriate newspaper (s) 21 days prior to the public hearing or regulatory action?

Yes [xx] No [ ]

If "no", list the chapter & section of the General Laws under which notice was given:_____

8 - Regulation will be effective:

[xx] as of date of publication pursuant to M. G. L. Ch. 30A

[ ] as an emergency regulation as of filing date pursuant to M. G. L. Ch. 30A

[ ] as of_____pursuant to M. G. L. Ch._____

Section(s)_____

9 - The enclosed regulation relates to other regulations already filed as follows:

Supersedes regulation(s)_____filed_____
_____filed_____
_____filed_____
_____filed_____
_____filed_____

Amends regulation(s)_____filed_____
_____filed_____
_____filed_____
_____filed_____

APPENDIX F

APPENDIX F
LAND APPLICATION SITES
DESCRIPTION OF SITE INVESTIGATIONS

General

The sites considered for land application in Dartmouth fall into two distinct categories: those being considered for slow rate irrigation (Sites I, II, and III) and those being considered for rapid infiltration (Sites IV, V, and VI).

Slow Rate Irrigation

During the site investigations in March of 1986, Site I was penetrated on foot while Sites II and III were observed from a car. Rain was received less than 24 hours before the site investigations, which took place on April 23 & 25, 1986. The investigations in April of 1986 were made by our resident soils engineer to observe any changes in surface water as compared to the investigations that were made five weeks earlier. Site I was not visited during the investigations which took place in November 1986. The attached plan shows the paths traveled at each site.

SITE I

Site I investigation - March 20, 1986 - by C.J. Loomis and W.W. Read

(Refer to path 1 in Figure F-1)

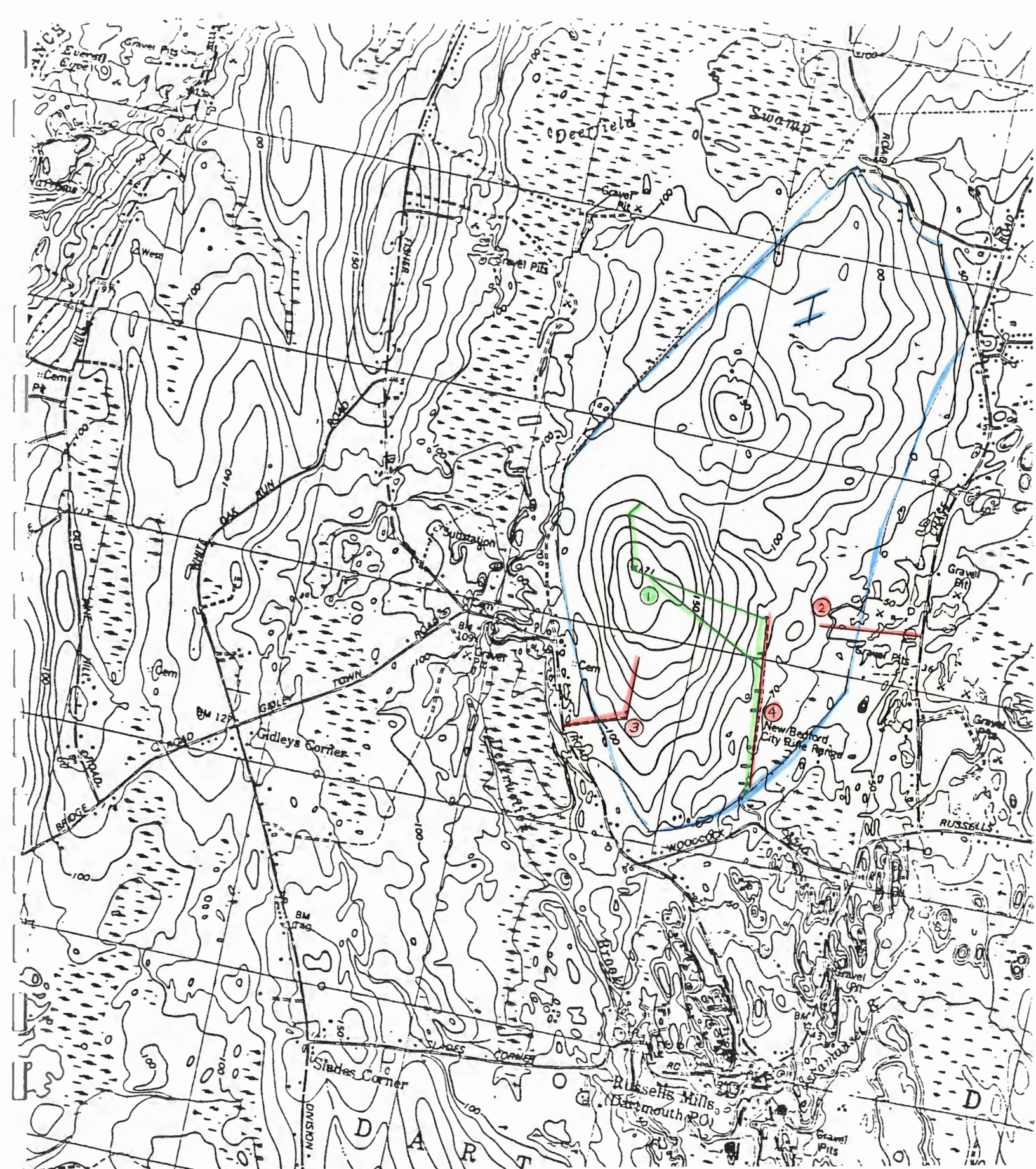

FIGURE F-1

SITE 1 - FIELD INVESTIGATIONS

SCALE 1" = 2000' JANUARY 1988

FAY, SPOFFORD & THORNDIKE, INC.

After traversing the site perimeter via automobile at a time when all streams were observed to be running full, the site was entered on foot from the New Bedford City Rifle Range. Surface water flooded parts of the lower range and was observed along both sides of the overgrown roadway, which is raised about one to two feet above the adjacent land. The roadway runs northerly into the site about 3500 feet. Just beyond the open range bedrock, outcrops could be seen running in a north northeasterly to south southwesterly direction on both sides of the road. Some outcroppings extended nearly ten feet above the adjacent ground. (The larger outcrops are also visible on the aerial photo of the site.) At about the mid-point of the road, the groundwater no longer stands at the surface, but can be easily found by turning over a rock. Rocks constitute a large portion of the visible surface. Observation of the cavities left by numerous, overturned trees from Hurricane Gloria showed groundwater not more than a foot below the surface. The root systems were shallow and the exposed underlying soils were mostly boulders.

Leaving the roadway at the last abandoned World War II ammunition bunker and traveling nearly westerly about 2300 feet to the summit of the southernmost hill, the surface conditions vary considerably. Adjacent to the road, visible rocks, as well as those barely covered by a thin layer of organic deposits, constitute a majority of the surface. This rocky surface condition diminishes as the ground rises. At about the mid-point between the roadway and the summit of the southernmost hill, numerous large exposed boulders (about ten foot on center) are evident and the organic surface cover is thicker, but overturned trees still show a high water table and numerous boulders.

was observed on the southern side of Pembroke Drive. A running stream and numerous boulders were observed in the woods at the end of Pembroke Drive. With the exception of the sand and gravel noted above, the soils along this path are sandy silt or silty sand. Exit from the site was along the same route taken to enter the site.

2. (Refer to path 3 in Figure F-1)

The site was entered at the extreme southwesterly corner on Gregory Lane. Gregory Lane was followed in a east northeasterly direction for approximately 1000 feet before taking a northerly bearing for another 1000 feet into the interior of the site. After leaving Gregory Lane, boulders were observed frequently. Surface material consists mainly of leaves, loam, or peat. The soil adjacent to this path was generally sandy silt. Standing water was observed approximately 1.5 feet below the ground surface in a cavity left by an overturned tree. An examination of the root clump from the overturned tree revealed shallow roots which extend approximately 1 to 1.5 feet into the soil. The shallow root systems are normally caused by a high water table or shallow earth cover or combination of both. Exit from the site was along the same route taken to enter the site.

3. (Refer to path 4 in Figure F-1)

The site was entered in a northerly direction from the New Bedford City Rifle Range. The roadway was followed approximately 3500 feet into the site. The soils at the rifle range are silty sands and gravel. Standing water and numerous ledge outcrops were observed, indicating that bedrock is close to the surface in most of the area. Normal vegetation expected in standing water was not observed, indicating that the area is probably not continuously wet, but rather seasonally wet. Exit from the site was along the same route taken to enter the site.

SITE II

Perimeter site II investigation - March 20, 1986 - by C.J. Loomis and W.W. Read

This site was also wet. Standing water could be seen in many areas, including parts of cultivated fields. The wooded areas were generally low, and based on preliminary observations, are wet, impervious, and rocky. Cultivated fields cover a significant portion of the higher ground in the area. The predominant crop is fodder corn.

Site II investigation - April 25, 1986 - H.H. Stoller

As observed from Slades Corner Road at the northern end of the site, many stone walls can be seen, indicating that boulders will be encountered in this area. The soil as observed from Slades Corner Road was sandy silt or silty sand. Development was observed to be taking place along Slades Corner Road. Driveways cut into the site from the road indicate that there is some sand and gravel here. Some standing water was observed from Slades Corner Road.

1. (Refer to path 5 in Figure F-2)

The site was entered along a path from Horseneck Road, about midway between Slades Corner Road and Barneys Joy Road. The path was followed in a westerly direction for about 1200 feet to a corn field. The soil in the corn field was fairly tight, rocky, somewhat moist, but not very wet and was either sandy silt or silty sand. The groundwater level was at least 2 feet below the surface in this area, since a reinforcing rod inserted 2 feet into the soil did not encounter water. Exit from the site was along the same route taken to enter the site.

FIGURE F-2

SITES II & III - FIELD INVESTIGAT

SCALE 1" = 2000' JANUARY 1

FAY, SPOFFORD & THORNDIKE, I

2. (Refer to path 6 in Figure F-2)

The site was entered from its midpoint along Division Road, on a cart path which is shown on the attached topography plan. At the end of the path, an easterly bearing was followed for another 1000 feet. Exit from the site was along the same route taken to enter the site. Along the path, which ran in an easterly direction, an overturned tree showed soil with some stone in it, however, not nearly as much stone and boulders as in the root clump of the overturned trees in site II.

Site II investigation - November 3, 1986 - by C.J. Loomis and W.W. Read

(Refer to path 7 in Figure F-2)

Site II was entered from about its midpoint along Division Road, by way of the cart path shown on the topography map. This cart path heads generally east northeasterly about 600 feet before turning in a south southeasterly direction and traversing the ridge of high ground for about another 3000 feet. Exit from the site was made over this same cart path.

At the point 600 feet from Division Road, the smaller of several corn fields was crossed in a northeasterly direction. This course was continued for about 2800 feet. The soil in the corn field was light brown. When rolled into a ball and shook in the palm of the hand, this soil flattened out, with water appearing at the surface of the soil. Crossing the broken stone wall along the easterly side of the corn field, the ground drops abruptly, about ten feet, into a wide, rocky swamp where nearly every step is on rocks covered by a light organic

growth. The four foot wide brook winds its way between, over, and under the rocks. Gradually, the ground rises and soil cover increases, with only a few boulders visible. The soils are very damp underfoot and the trail crossing through the area is visibly soft and muddy in spots. This area is moderately wooded, with heavy undergrowth.

Just beyond the high points of land to the northwest and southeast, a southeasterly bearing is taken for about 1700 feet. Commencing within the first 500 feet, the surface is heavily covered with rock, and standing water was observed at the surface among the rocks. This wet, rocky condition continues nearly to the point where a more south southeasterly bearing is taken to the cultivated fields 1200 feet ahead. The woods in this area continue to be damp, but not as rocky as in the opposite direction. A massive stone wall protects the northerly edge of the corn field. Skirting the edge of the farm in a west to southwesterly direction, the land soon rises to a pine grove. The soils and overturned trees here show no indication of high groundwater or excessive rocks.

Within 200 feet, a rutted cart path, not shown on the topography map, was encountered. This was followed in an arc westerly for about 1200 feet down grade across wood lots and open woods, where the ground abruptly drops into a wide swampy area. Leaving the cart path at the abrupt drop, a south south westerly bearing is selected and followed for about 1000 feet. The swamp is typical of the upper site. Two streams traverse the swamp following rocky courses. The larger of the two shallow streams lies to the westerly edge of the swamp and is about 8 feet wide. Continuing along the south southwesterly course beyond the brook, the ground rolls up rather quickly about ten feet, where a trail is encountered. The trail is located just easterly of a stone wall, which extends south southeasterly

along the contour for about 1500 feet. The trail generally parallels the wall. The soils here are firm and reasonably rock free. This area, as well as the pine grove near the farm, are probably suited for slow rate irrigation. A side trail turns southwesterly and soon joins the cart path back to Division Road. Both sides of the cart path are heavily wooded and show no signs of being wet. Quite a few boulders, however, are evident.

A windshield survey indicates that all the farms were active during the year, with fodder corn being the prime crop. The ground in the lower areas next to the road is not nearly as wet as in the spring. It is estimated that a third of this site might be suitable for limited spray irrigation during the drier parts of the year, if it were not for the very high number of boulders which would make preparation extremely difficult.

SITE III

Preliminary site III investigation - March 20, 1986
- by C.J. Loomis and W.W. Read

As observed from a windshield survey after viewing aerial photography, the drier areas within the site are developed as farms, while the wet areas were generally rocky and forested. This is not the case along Potomska Road. The clear fields are bordered by piles of stones and walls. Dairy farming is the primary industry and fodder corn the principal crop. Considerable development has occurred around the perimeter, with several other occupied dwellings well into the remote areas. Some sand and gravel was observed near the junction of Rock O'Dundee and Potomska Roads, as well as along Potomska Road.

Site III investigation - April 25, 1986 - by H.H. Stoller

1. (Refer to path 8 in Figure F-2)

The site was entered from an access road to a farm off Rock O'Dundee Road. Corn fields were located on either side of the access road. Boulders were piled along the access road, however, no standing water was seen. The soils in this areas were sandy silt and fewer boulders were evident at the surface than in sites I and II. A small, existing excavation, approximately 2.5 feet deep, showed no standing water in this area.

2.(Refer to path 9 in Figure F-2)

The site was entered from a newly constructed road which ran in a northeasterly direction for approximately 1000 feet off Potomska Road. Soils in this area are sandy silt and not well drained, however, no standing water was observed, indicating that the soils are slowly drained. It was determined that the groundwater in this area is at least 2 feet below the surface, since a reinforcing rod inserted into the ground approximately two feet did not encounter water.

3. (Refer to path 10 in Figure F-2)

The site was entered along a path on the southwesterly corner of the site. The route walked followed a path in a northeasterly direction for approximately 1000 feet. The same route was used to exit the site. Soils in this area are sandy silt with some gravel. The area was undeveloped woodland and rocky at the surface.

Site III investigation - November 3, 1986 - by C.J. Loomis and W.W. Read

(Refer to path 11 in Figure F-2)

The site was entered from Rock O'Dundee Road at the extreme northeasterly corner of the site, proceeding in a general southerly direction approximately 2300 feet along a cart path. Along the path entering the site, gravel was observed on either side. An abandoned gravel pit on the westerly side of the path was surrounded by piles of boulders, and contained standing water. The land was gradually falling off to the marshland and a stream was crossed approximately 1100 feet in from the road. For over a hundred feet on either side of the stream, the groundwater was visible at the surface.

On the easterly side of the path as you approached the marsh, there was evidence of a survey being conducted. A stone wall was observed, indicating that the land had been cleared at one time. The ground appeared drier as the marsh was approached. A nearly westerly bearing was taken for approximately 800 feet to cross a drained marsh to the high ground on the westerly side. Upon reaching the high ground, a southwesterly bearing was taken for approximately 800 feet to a cart path. Numerous exposed rocks were encountered. The cart path was followed southeasterly onto a peninsula with a shelter campsite located on it. Then returning to the point where the cart path was first encountered, a southwesterly bearing was followed for 1200 feet. After the first 200 feet of this leg, which was laden with rock and old foundations, the ground slopes up gently and continues for the remainder of the leg as open dry woodland. This area appears to be quite suitable for spray irrigation. Very few boulders were either visible or found at the surface. However, because of the old foundations, an archeological survey should be conducted.

The next leg was in a generally northwesterly direction for approximately 1200 feet. After crossing several formal stone walls, the ground dropped into a wet swale before rising to the

abandoned farmhouse and intersecting the cart path running in a general north/south alignment. Following the cart path northerly through several active woodlots, the path abruptly ends in a huge pile of boulders which was at least 40 feet wide and hundreds of feet long. The boulders had been removed from the corn fields, which lay immediately ahead. Other similar piles surround several other fields in the vicinity. These boulders are indicative of what we find if we make any attempt to clear the upland areas for slow rate irrigation.

An inspection of the corn field indicates that the soils are wet. The basic corn stalks are suspended about two inches above the ground by six to eight fingerlike roots. From here, the route followed runs in a northerly direction, crossing the corn fields to the farm house situated 2000 feet in from the nearest road. A brook running southerly through the site and several small ponds were observed.

Field observations of this site indicate that it would be unacceptable for spray irrigation due to the high groundwater table covering about 40 percent of the area, the high boulder content of most upland areas,and the large amount of development around the perimeter. The only area acceptable for spray irrigation is in the south central section of the site, consisting of about 80 acres, which may have some historical significance.

Rapid Infiltration

Sites V and VI were penetrated on foot by representatives of Fay, Spofford & Thorndike, Inc., the DEQE, and the Town of Dartmouth. At the time of this visit the snow cover had virtually disappeared and recent weather conditions were dry.

SITE V

Site V investigation - March 18, 1987 - by C.J. Loomis, W.W. Read, DEQE (J. O'Brien & R. Cady), DPW (R. Richard)

(Refer to path 12 in Figure F-3)

The site was entered from Barneys Joy Road, approximately 700 feet east of the intersection of Barneys Joy Road and Allens Neck Road. A northerly route was followed along the westerly side of a corn field for about 300 feet. The route then continued in a northeasterly direction for approximately 150 feet along the northern side of the field following the property line, where a pond was observed. It was observed that the pond floods the corner of the corn field during high groundwater periods. A northerly route was then taken along the fence line (i.e. property line) of the adjacent property for approximately 1100 feet to a corn field. This area is used as cattle pasture, with many exposed boulders and piles of stones. The soils in this area appeared to have some gravel in them, with no evidence of water at the surface.

A side route was taken by W.W. Read into the property on the westerly side of the fence line in the northeasterly corner of the property. The majority of this lot is wooded, with oak and considerable underbrush. His route followed a generally westerly direction for approximately 450 feet, then followed a northerly direction for approximately 150 feet. This area is heavily piled with stones, apparently from the adjacent corn field. The route then ran easterly for about 150 feet, then northerly for another 150 feet to the stone wall (i.e. property line) on the northerly side of the property. His route then followed an easterly direction, about 300 feet, rejoining the rest of the site investigation party at the corner of the corn field.

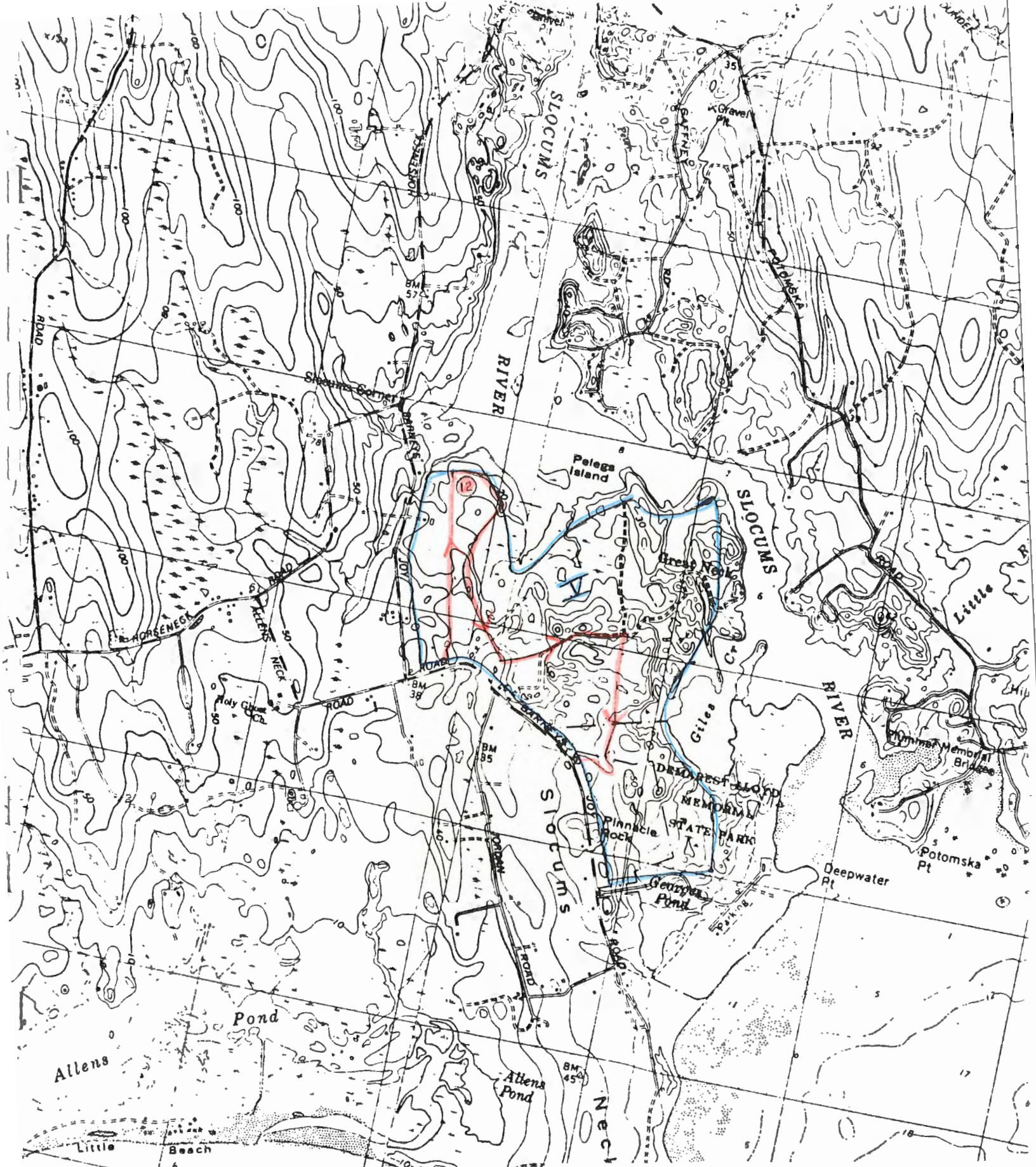

FIGURE F-3

SITE V - FIELD INVESTIGATIONS

SCALE 1" = 2000' JANUARY 1988

FAY, SPOFFORD & THORNDIKE, INC.

The route then followed a northerly direction for about 1800 feet through the center of the corn field to a bluff overlooking Slocums River. The soils in the corn field consist of a clay and gravel topsoil, underlain with clay, which was exposed by the winter's erosion. Drainage across the fields was generally in a northeasterly direction. The field in a north/south direction was generally level, falling off on either side. This corn field is approximately 45 acres in area. The route then followed an easterly direction along the bluff adjacent to Slocums River at the northerly end of the corn field for about 600 feet. The route then followed a southeasterly direction for another 600 feet, through a meadow to the high point in the area. The soils in this area appeared to be primarily clean gravel and sand, which was evident by the holes dug by numerous woodchucks.

For the next 1200 feet, a south southwesterly route crossing the salt march was taken to the southeasterly corner of the corn field. The soils in this area were coarse sand and medium gravel. A southerly route was followed for approximately 300 feet, crossing the fence and stone wall to a sidehill area that had the topsoils stripped several years previous, exposing medium gravel. A pond was observed at the bottom of the hill. The route then turned to a southeasterly direction, across a drainage easement for approximately 1500 feet to the northerly side of a corn field. This area has been used to dispose of dead cattle. The soils in this area appeared to be sand and gravel. The water table was at least five feet below the surface, since no water could be seen in a recent excavation (approximately 5 feet deep) in this area. The northerly side of the corn field, at the southeasterly corner of the sidehill, is located approximately 800 feet northeasterly of Barneys Joy Road. Crossing the fence to the dirt road, the route then followed the northerly side of a corn field for about 200 feet

before entering the woods. The cart path follows an east northeasterly route approximately 3300 feet, to a house on Slocums River.

The route traveled followed a cart path for about 2100 feet in a generally east northeasterly direction, to a point opposite a marsh on the southerly side of the path. Along this route the area is heavily treed. The ground rises and is well drained. The growth is primarily oak. After retracing the same path for about 500 feet, a path in a southerly direction was followed for approximately 1000 feet to the easterly side of a 2.5 acre corn field. The easterly side of the corn field was followed for about 300 feet before reentering the woods and following along the westerly side of the stone wall in a generally southerly direction, for about 500 feet, to the northerly side of the middle field of three corn fields.

The perimeter of the corn field was followed for about 300 feet in a east southeasterly direction and 200 feet in a southerly direction. The easterly corn field was separated by a heavy hedge row and stone wall. The southern edge of the middle corn field was very damp. The middle corn field and the adjacent corn field to the west were traversed in a generally northwesterly direction to the westerly side of the third field, about 1200 feet away. The latter is located about 350 feet east of Barneys Joy Road. It should be noted that a large outcrop of bedrock was observed while crossing the center corn field. The westerly side of the corn field was followed for about 200 feet in a southerly direction, at which point a path was followed which ran in a generally southwesterly direction for about 100 feet to Barneys Joy Road, a point about 2500 feet southeasterly of the beginning point.

In conclusion, there appear to be areas along the route traveled where the soils are very pervious and well above the groundwater table. Although not contiguous, enough acreage appears suitable for rapid infiltration of 2.2 MGD of disposed effluent. It should be noted, however, that most of this land is not level and will require extensive site preparation. It is recommended that a limited number of borings be taken to confirm the types and depths of soils and groundwater elevations in the areas which appear more suitable.

SITE VI

Site VI investigation - March 18, 1987 - by C.J. Loomis, W.W. Read, DEQE (J. O'Brien & R. Cady), DPW (M. Branco & R. Richard)

(Refer to path 13 in Figure F-4)

The site was entered by car from Smith Neck Road, along a driveway located about 950 feet north of Hetty Green Street. The driveway ran generally in a westerly direction about 1750 feet to the easterly side of a corn field. On either side of the driveway, the ground was wet with many large surface boulders. The driveway crosses a stream just before reaching the fields. This driveway is access for three newly constructed homes. Power to these homes is located underground. On foot, the route traveled started at the northeasterly corner of the southernmost field and followed a westerly direction on the driveway along the perimeter of the field for about 200 feet. The route then followed a generally southerly route for about 450 feet, traversing one half the width of the field. The field is essentially flat in both directions, the surface free of stone.

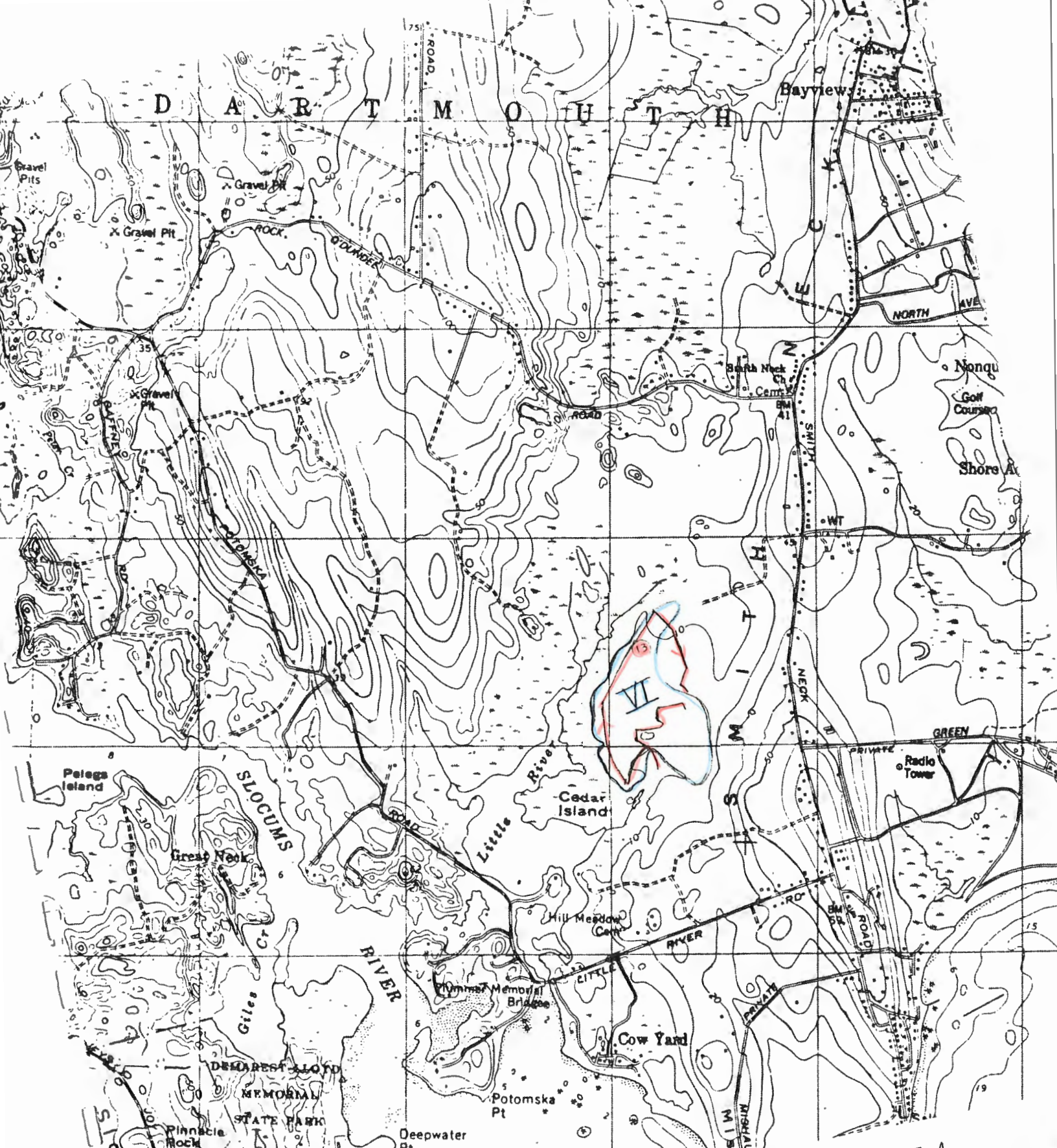

FIGURE F-4

SITE VI - FIELD INVESTIGATIO

SCALE 1" = 2000' JANUARY

FAY, SPOFFORD & THORNDIKE,

The route then turned in a southeasterly direction about 250 feet to the easterly edge of the field. Surface water could be seen standing several feet away. It is estimated that the water table is 18 inches below ground. The route then traversed the edge of the field in a southwesterly direction to the southerly edge of the field. The southerly edge of the field was followed about 500 feet to a small pond. The surface water of the pond was estimated to be about four feet below the corn field. However, one would anticipate that the groundwater in the corn field would be somewhat higher than the water level of the pond.

The woods were entered in a generally southerly direction about 400 feet to a point directly southerly of the pond. The land in this area is at about the same level as the corn field, and lightly wooded with small oak trees. Retracing our steps about 350 feet, the route then proceeded in a generally south southwesterly direction for about 600 feet. The woods consisted mainly of hardwoods, with a good, sandy soil. At the end of this route a rabbit hole further indicates the presence of good, sandy soil in the area. The route then followed a generally north northwesterly direction for about 700 feet to the southwesterly corner of the corn field. The woods here are typical of the area. Crossing a stone wall, the route followed a northerly direction about 900 feet along the driveway at the westerly side of the field to the southwesterly corner of the northerly field, where the driveway turns easterly. This driveway serves three homes near the marsh to the west. The three foot deep utility service trench at the site of a newly constructed house showed topsoils and subsoils with some evidence of clay. No gravel was observed.

The northerly field was entered along a northeasterly route for about 1800 feet at the northerly edge of the field. Numerous woodchuck holes in this area of the field indicated the presence of sand and gravel, with a water table at least four feet below the surface. This ground is approximately ten feet above the marsh.

The route then followed an east southeasterly direction for about 400 feet along the northerly side of the field. The route then turned to a south southeasterly direction about 500 feet to a man-made drainage swale. The path then followed along the swale in a south southwesterly direction 400 feet before turning southeasterly 300 feet to the easterly edge of the field. At the easterly edge of the field, an open excavation showed water not more than four inches below the surface. The route then turned 200 feet to the point of beginning.

In conclusion, the water table in the majority of the area traversed is too high to allow the construction of rapid infiltration facilities. It is doubtful that the groundwater is more than four feet below the ground, except in that area paralleling the cove, 400 - 500 feet back from the cove. Approximately 20 percent of this area is occupied by existing dwellings. Furthermore, the Planning Board has indicated that a subdivision is in the planning stages for 40 percent of the available area. It is recommended that no further investigations be made and the site be dropped from further consideration for ultimate disposal of effluent by rapid infiltration.

APPENDIX G

314 CMR 6.00: MASSACHUSETTS GROUND WATER QUALITY STANDARDS

Section

6.01: Purpose and Authority

314 CMR 6.00 establishes the Massachusetts Ground Water Quality Standards pursuant to the provisions of M.G.L. c. 21 ss. 27(5), 27(6), and 27(12). These standards consist of ground water classifications, which designate and assign the uses for which the various ground waters of the Commonwealth shall be maintained and protected; water quality criteria necessary to sustain the designated uses; and regulations necessary to achieve the designated uses or maintain the existing ground water quality.

6.02: Definitions

As used in 314 CMR 6.00, the following words have the following meanings:

(1) Aquifer - a geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

(2) Consolidated Rock or Bed Rock - any solid hard rock exposed at the surface of the earth or overlain by unconsolidated deposits.

(3) Degraded - a change in ground water quality from local natural background ground water quality which is determined by the Division to be deteriorating in terms of the magnitude of the change and the importance of the parameters describing ground water quality.

(4) Department - the Massachusetts Department of Environmental Quality Engineering, as established by M.G.L. c. 21A, s. 7.

(5) Director - the Director of the Division of Water Pollution Control or his designee.

(6) Discharge or Discharge of Pollutants - any addition of any pollutant or combination of pollutants to waters of the Commonwealth from any source, including but not limited to, discharges from surface runoff which is collected or channelled by man; discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to a POTW and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works. This term does not include an addition of pollutants by any indirect discharger.

(7) Disposal System - a system for disposing of sewage, industrial waste or other wastes, and including sewer systems and treatment works.

(8) Division - the Division of Water Pollution Control of the Department, established pursuant to M.G.L. c. 21, s. 26.

6.02: continued

(9) Effluent - a discharge of pollutants into the environment, whether or not treated.

(10) Effluent Limitation or Effluent Limit - any requirement, restriction, or standard imposed by the Director on quantities, discharge rates, and concentrations of pollutants which are discharged from point sources into waters of the Commonwealth or to publicly owned treatment works.

(11) Environmental Protection Agency or EPA - the United States Environmental Protection Agency.

(12) Existing Ground Water Quality - characteristics of the physical, biological, chemical, and radiological parameters representative of the ground water quality at a site at the time of permit issuance, permit renewal or nonpermitted discharge as determined by an accepted hydrogeologic study.

(13) Federal Act - the Clean Water Act, P.L. 92-500 as amended by P.L. 95-217 and P.L. 95-576, 33 U.S.C. 125.

(14) Fresh Water - water having a chloride concentration equal to or less than 250 mg/l, or a total dissolved solids concentration equal to or less than 10,000 mg/l.

(15) Ground Water - water below the land surface in a saturated zone, including perched ground water.

(16) Health Advisory - the level of a pollutant in water at which, with a margin of safety, adverse health effects would not be anticipated, as determined by the Department or EPA.

(17) Industrial Waste - any liquid, gaseous, or solid waste substance or a combination thereof resulting from any process of industry, manufacturing, trade, or business or from the development or recovery of any natural resources.

(18) Leachate - any liquid, including any suspended or dissolved components in the liquid, that has percolated through or drained from a landfill or other solid waste disposal site.

(19) Massachusetts Water Quality Standards - the Massachusetts Surface Water Quality Standards (314 CMR 4.00) and the Massachusetts Ground Water Quality Standards (314 CMR 6.00).

(20) Milligrams Per Liter or mg/l - the weight in milligrams of any specific substance or substances contained in one liter of solution.

(21) Monitoring Well - a well that is specifically designed, constructed, emplaced and located to measure the impact of a subsurface discharge.

(22) Natural Background Condition - the chemical, physical or biological characteristics of surface or ground waters unaltered by human activity.

(23) Observation Well - a well that is used to determine existing hydrogeological conditions.

(24) Other Wastes - all liquid discarded matter other than sewage or industrial waste which may cause or might reasonably be expected to cause pollution of the waters of the Commonwealth in contravention of adopted standards.

6.02: continued

(25) Outlet - the terminus of a sewer system, or the point of emergence of any wastewater or effluent into the waters of the Commonwealth or onto the land surface.

(26) Pathogenic Organism - any disease-producing organism.

(27) Perched Ground Water - unconfined ground water separated from an underlying body of ground water by an unsaturated zone.

(28) Permit - an authorization issued pursuant to M.G.L. c. 21, ss. 43 and 314 CMR 2.00 and 3.00, 5.00, or 7.00, to implement the requirements of the State and Federal Acts and regulations adopted thereunder.

(29) Person - any agency or political subdivision of the Commonwealth, the federal govenment, any public or private corporation or authority, individual, partnership or association, or other entity, including any officer of a public or private agency or organization, upon whom a duty may be imposed by or pursuant to any provisions of M.G.L. c. 21, ss. 26 - 53.

(30) Pollutant - any element or property of sewage, agricultural, industrial or commercial waste, runoff, leachate, heated effluent, or other matter, in whatever form and whether originating at a point or major non-point source, which is or may be discharged, drained or otherwise introduced into any sewerage system, treatment works or waters of the Commonwealth.

(31) Pollution - the presence in the environment of pollutants in quantities or characteristics which are or may be injurious to human, plant or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property throughout such areas as may be affected thereby.

(32) Potable Waters - fresh waters usable for drinking, culinary or food processing purposes.

(33) Quality Standard - the assigned level of purity or quality for any waters in relation to their designated usage.

(34) Saline Water - water having a chloride concentration of more than 250 mg/l or a total dissolved solids concentration of more than 10,000 mg/l.

(35) Saturated Zone - any portion of the earth below the land surface where every available opening (pore, fissure, joint, or solution cavity) is filled with water.

(36) Sewage - the water-carried human or animal wastes from residences, buildings, industrial establishments or other places, together with such ground water infiltration and surface water as may be present.

(37) Septage - the liquid and solid wastes, primarily of sewage origin, that are removed from a cesspool, septic tank or similar receptacle.

(38) State Act - the Massachusetts Clean Waters Act, as amended, M.G.L. c. 21, ss. 26 - 53.

(39) Subsurface Sewage Disposal System - a disposal system which discharges sewage onto or beneath the surface of the ground.

(40) Toxic Pollutants- those pollutants identified in 314 CMR 3.16, or any other pollutants or combination of pollutants, including disease-

6.05: continued

tributary and downgradient ground waters and surface waters and the most sensitive designated uses thereof will not be impaired by such classification.

(2) No Class III classification shall be made if there is no existing or proposed discharge to the ground water requiring such a classification. If the discharge is to be made by means of injection into a well, no Class III classification shall be made except in compliance with the provisions of 310 CMR 27.07 and 40 CFR 144.7.

(3) A Class III classification shall only be considered for the following cases:

(a) The ground water impacted by the classification is under single ownership by the discharger proposing the classification; or

(b) The ground water impacted by the classification does not currently serve, and will not in the future serve, as a source of drinking water because:

1. The ground water is situated at a depth or location that makes recovery of water for drinking water purposes economically or technologically infeasible; or

2. The ground water is contaminated or degraded to the point that recovery of water for drinking water purposes is economically or technologically infeasible; or

3. The discharge of the person proposing the classification is located over a federally defined Class III well mining area subject to subsidence or catastrophic collapse; or

(c) The ground water impacted by the classification currently serves as a drinking water source, or could potentially serve as a drinking water source, but an alternate source of drinking water is available and will be provided by the discharger proposing the classification to all existing and potential users of the aquifer impacted by the discharge.

(4) Where it can be demonstrated that 314 CMR 6.05(3) has been satisfied, the following potential adverse effects on hydraulically connected surface and ground waters shall be evaluated in a classification proceeding under 314 CMR 6.04:

(a) The volume and physical, chemical and biological characteristics of the waste in the discharge to the proposed Class III ground waters, including the potential for migration;

(b) The hydrogeologic characteristics of the disposal site and the area immediately surrounding the proposed Class III area;

(c) The existing quantity and quality of ground water within the proposed Class III area, and the direction of ground water flow into and out of the proposed Class III area;

(d) The proximity of the disposal system to the proposed Class III area and hydraulically connected ground waters and surface waters;

(e) The proximity and withdrawal rates of ground water users in relation to the proposed Class III area;

(f) The potential for health risks caused by human exposure to waste constituents within the proposed Class III ground waters;

(g) The current and future uses of surface waters and ground waters in the areas adjacent to the proposed Class III area and the water quality standards established for those waters;

(h) The existing quality of surface waters and ground water adjacent to the proposed Class III area including other sources of contamination and the cumulative impact on water quality;

(i) The potential damage to wildlife, crops, vegetation, and physical structures caused by the pollutants; and

(j) The persistence and permanence of the potential adverse effects.

6.06: Minimum Ground Water Quality Criteria

(1) Class I and Class II Ground Waters. The following minimum criteria are applicable to all Class I and Class II ground waters:

Parameter	Criteria
(a) Pathogenic Organisms	Shall not be in amounts sufficient to render the ground waters detrimental to public health and welfare or impair the ground water for use as source of potable water.
(b) Coliform Bacteria	Shall not exceed the maximum contaminant level as stated in the National Interim Primary Drinking Water Standards.
(c) Arsenic	Shall not exceed 0.05 mg/l
(d) Barium	Shall not exceed 1.0 mg/l
(e) Cadmium	Shall not exceed 0.01 mg/l
(f) Chromium	Shall not exceed 0.05 mg/l
(g) Copper	Shall not exceed 1.0 mg/l
(h) Fluoride	Shall not exceed 2.4 mg/l
(i) Foaming Agents	Shall not exceed 0.5 mg/l
(j) Iron	Shall not exceed 0.3 mg/l
(k) Lead	Shall not exceed 0.05 mg/l
(l) Manganese	Shall not exceed 0.05 mg/l
(m) Mercury	Shall not exceed 0.002 mg/l
(n) Nitrate Nitrogen (as Nitrogen)	Shall not exceed 10.0 mg/l
(o) Total Trihalomethanes	Shall not exceed 0.1 mg/l
(p) Selenium	Shall not exceed 0.01 mg/l
(q) Silver	Shall not exceed 0.05 mg/l
(r) Sulfate	Shall not exceed 250 mg/l
(s) Zinc	Shall not exceed 5.0 mg/l
(t) Endrin (1,2,3,4,10, 10-hexachloro-1,7-epoxy-1, 4,4a,5,6,7,8,9a-octahydro-1,4-endo,endo-5,8-dimethano naphthalene)	Shall not exceed 0.0002 mg/l
(u) Lindane (1,2,3,4,5, 6-hexachlorocyclohexane, gamma isomer)	Shall not exceed 0.004 mg/l
(v) Methoxychlor (1,1,1-Trichloro-2, 2-bis (p-methoxyphenyl) ethane)	Shall not exceed 0.1 mg/l
(w) Toxaphene ($C_{10}H_{10}Cl_8$, Technical Chlorinated Camphene, 67-69 percent chlorine)	Shall not exceed 0.005 mg/l
(x) Chlorophenoxys: 2,4-D,(2,4-Dichlorophenoxyacetic acid)	Shall not exceed 0.1 mg/l
2,4,5-TP Silvex (2,4, 5-Trichlorophenoxypropionic acid)	Shall not exceed 0.01 mg/l
(y) Radioactivity	Shall not exceed the maximum radionuclide contaminant levels as stated in the National Interim Primary Drinking Water Standards.

6.06: continued

Parameter	Criteria
(z) pH	Shall be in the range of 6.5-8.5 standard units or not more than 0.2 units outside of the naturally occurring range.
(aa) All Other Pollutants	None in such concentrations which in the opinion of the Director would impair the waters for use as a source of potable water or to cause or contribute to a condition in contravention of standards for other classified waters of the Commonwealth.

(2) Class III Ground Waters. The following minimum criteria are applicable to all Class III ground waters:

Parameter	Criteria
(a) Pathegenic Organisms	Shall not be in amounts sufficient to render the ground waters detrimental to public health, safety or welfare.
(b) Radioactivity	Shall not exceed the maximum radionuclide contaminant levels as stated in the National Interim Primary Drinking Water Standards.
(c) All Other Pollutants	None in concentrations or combinations which upon exposure to humans will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions or physical deformations or cause any significant adverse effects to the environment, or which would exceed the recommended limits on the most sensitive ground water use.

6.07: Application of Standards

(1) Ground Water Discharge Permits. No person shall make or permit an outlet for the discharge of sewage or industrial waste or other wastes or the effluent therefrom, into any ground water of the Commonwealth without first obtaining a permit from the Director of the Division of Water Pollution Control pursuant to 314 CMR 5.00. Said permit shall be issued subject to such conditions as the Director may deem necessary to insure compliance with the standards established in 314 CMR 6.06. Applications for ground water discharge permits shall be submitted within times and on forms prescribed by the Director and shall contain such information as he may require.

(2) Establishment of Discharge Limits. In regulating discharges of pollutants to ground waters of the Commonwealth, the Division shall limit or prohibit such discharges to insure that the quality standards of the receiving waters will be maintained or attained. The determina-

6.07: continued

tion by the Division of the applicable level of treatment for an individual discharger will be made in the establishment of discharge limits in the individual ground water discharge permit. In establishing effluent limitations in the individual permits, the Division must consider natural background conditions, must protect existing adjacent and downgradient uses and must not interfere with the maintenance and attainment of beneficial uses in adjacent and downgradient waters. Toward this end, the Division may provide a reasonable margin of safety to account for any lack of knowledge concerning the relationship between the pollutants being discharged and their impact on the quality of the ground waters.

(3) For purposes of determining compliance with 314 CMR 6.06(1)(aa) for toxic pollutants in Class I and Class II ground waters, the Division shall use Health Advisories which have been adopted by the Department or EPA. Generally, the level of a toxic pollutant which may result in one additional incident of cancer in 100,000 given a lifetime exposure (10^{-5} Excess Lifetime Cancer Risk) will be used in determining compliance with that section of the regulations.

(4) Coordination with Federal Criteria. The Division may use available published water quality criteria documents as guidance in establishing case-by-case discharge limits on specific pollutants to ground waters including but not limited to EPA guidance published in accordance with Section 304(b) of the Federal Act.

6.08: Monitoring

(1) Collection of Samples. The determination of compliance or non-compliance of sewage, industrial waste or other waste discharges with the requirements of 314 CMR 6.00 shall be made through tests or analytical determinations of ground water or effluent samples collected, transported and stored in such manner as is approved by the Division. The location at which ground water samples are collected shall be determined by the Division. In selecting or approving such locations, the Division shall consider all relevant facts including, but not limited to:

(a) The mobility of pollutants in the unsaturated zone and the pollutant attenuation mechanisms in this zone.
(b) Attenuation mechanisms which may remove potential pollutants in passage through the soil.
(c) The relative thickness of the unsaturated zone.
(d) Attenuation of pollutant concentrations with distance which may occur in the saturated zone, as a result of attenuation processes occurring below the water table.

The location at which effluent samples are collected shall be at a point where the effluent emerges from a treatment works, disposal system, outlet or point source and prior to being discharged to the ground.

(2) Number of Monitoring Wells. The Division shall determine the number of observation and and monitoring wells necessary for the determination of compliance with 314 CMR 6.00.

(3) Tests or Analytical Determinations. Test or analytical determinations to determine compliance or non-compliance with standards shall be made in accordance with:

(a) the latest edition of Standard Methods for the Examination of Water and Wastewater prepared by the Ammerican Public Health Association, American Water Works Association, and Water Pollution Control Federation;
(b) the latest edition of Methods for Chemical Analysis of Water and Wastes prepared by the Environmental Protection Agency;

6.08: continued

(c) the latest edition of Water Standards of The American Society for Testing and Materials; or
(d) other methods approved by the Director as giving results equal to or superior to methods listed above.

(314 CMR 6.09: Reserved)

6.10: Interim Provisions

(1) Ground water classifications will be assigned state-wide by the Division on or after June 1, 1985. Any person desiring an initial assignment of a specific classification for particular ground waters as part of the state-wide classifications should submit the information specified in 314 CMR 6.04 to the Division prior to January 1, 1985. All ground waters for which no petition for consideration of a specific classification is filed with the Division prior to January 1, 1985 will be proposed by the Division for assignment as Class I. The Division may consider individual petitions for Class III assignment on a case-by-case basis at any time, such petitions shall comply with the provisions of 314 CMR 6.04.

(2) In the absence of a classification all ground waters will be protected for the most sensitive of the uses designated in 314 CMR 6.03, that is as a source of potable water supply. All ground water discharge permits issued after October 1, 1983, but prior to the classification of the ground waters receiving the discharge, shall contain such special conditions necessary to protect the ground waters for use as a source of potable water supply, including but not limited to the applicable Class I effluent limitations contained in 314 CMR 5.10(3).

REGULATORY AUTHORITY

314 CMR 6.00: M.G.L. c. 21, ss. 27(5) and 28(12).

APPENDIX H

314 CMR 4.00: MASSACHUSETTS SURFACE WATER QUALITY STANDARDS

Section

4.01: General Provisions

(1) Title. 314 CMR 4.00 shall be known as the "Massachusetts Surface Water Quality Standards."

(2) Organization of Standards. These standards comprise five (5) units: General Provisions (314 CMR 4.01), Application of Standards (314 CMR 4.02), Water Quality Criteria (314 CMR 4.03), Antidegradation Provisions (314 CMR 4.04), and Basin Classifications and Maps (314 CMR 4.05).

(3) Authority. The Massachusetts Surface Water Quality Standards are adopted by the Division pursuant to the provisions of M.G.L. c. 21, s. 27.

(4) Purpose. The Massachusetts Act charges the Division with the duty and responsibility to enhance the quality and value of the water resources of the Commonwealth and directs the Division to take all action necessary or appropriate to secure to the Commonwealth the benefits of the Federal Act. The objective of the Federal Act is the restoration and maintenance of the chemical, physical and biological integrity of the Nation's waters. To achieve the foregoing requirements the Division has adopted the Massachusetts Water Quality Standards which designate the uses for which the various waters of the Commonwealth shall be enhanced, maintained and protected; which prescribe the water quality criteria required to sustain the designated uses; and which contain regulations necessary to achieve the designated uses and maintain existing water quality including, where appropriate, the prohibition of discharges.

(5) Definitions. As used in these standards, the following words have the following meanings:

Artificial conditions - Those conditions resulting from human alteration of the chemical, physical or biological integrity of waters.

Beneficial use - Any use not impairing the most sensitive use designated in the classification tables contained in 314 CMR 4.05; except that in no case shall the assimilation or transport of pollutants be deemed a beneficial use.

Cold water fishery - Waters whose quality is capable of sustaining a year-round population of cold water trout (salmonidae).

Division - The Massachusetts Division of Water Pollution Control, as established by M.G.L. c. 21, s. 26.

Discharge - Any addition of any pollutant to the waters of the Commonwealth.

EPA - The United States Environmental Protection Agency.

Federal Act - The Federal Water Pollution Control Act, as amended, 33 U.S.C. s. 1251, et seq.

4.01: continued

Massachusetts Act - The Massachusetts Clean Waters Act, as amended, M.G.L. c. 21, ss. 26 - 53.

Pollutant - Any element or property of sewage, agricultural, industrial or commercial waste, runoff, leachate, heated effluent, or other matter, in whatever form and whether originating at a point or major nonpoint source, which is or may be discharged, drained or otherwise introduced into any sewerage system, treatment works or waters of the Commonwealth.

Primary contact recreation - Any recreation or other water use, such as swimming and water skiing, in which there is prolonged and intimate contact with the water sufficient to constitute a health hazard.

Seasonal cold water fishery - Waters whose quality is capable of sustaining only an extremely limited cold water population on a year-round basis, with cold-water fish in these streams provided largely by stocking.

Secondary contact recreation - Any recreation or other water use in which contact with the water is either incidental or accidental, such as fishing, boating and limited contact incident to shoreline activities.

Segment - A finite portion of a water body established by the Division for the purpose of classification.

Warm water fishery - Waters whose quality is not capable of sustaining a year-round cold water or seasonal cold water fishery.

Waters of the Commonwealth - All waters within the jurisdiction of the Commonwealth, including, without limitation, rivers, streams, lakes, ponds, springs, impoundments, estuaries and coastal waters, but not including groundwaters.

(6) Severability. If any provision of these standards is held invalid, the remainder of these standards shall not be affected thereby.

(7) Repealer. The "Rules and Regulations for the Establishment of Minimum Water Quality Standards and for the Protection of the Quality and Value of Water Resources" filed with the Secretary of the Commonwealth on May 2, 1974 and the "River Basin Classifications" filed with the Secretary of the Commonwealth on July 21, 1967 are hereby repealed, except that all permits, orders, determinations or other actions of the Division, based upon such standards and river basin classifications, and any court actions seeking to enforce such standards, permits, orders and determinations shall remain in full force and effect until modified, amended, revoked or reissued by the Division and/or the courts of the Commonwealth, as appropriate.

(8) Effective Date. These standards shall become effective upon publication by the Secretary of the Commonwealth pursuant to the provisions of M.G.L. c. 30A, s. 6.

4.02: Application of Standards

(1) Establishment of Effluent Limitations. In regulating discharges of pollutants to waters of the Commonwealth, the Division will limit or prohibit such discharges to insure that the water quality standards of the receiving waters will be maintained or attained. The determination by the Division of the applicable level of treatment for an individual discharger will be made in the establishment of effluent limitations in the individual discharge permits in accordance with 314 CMR 3.10(3), (4), (5) and (6). In establishing water quality based effluent limitations, the Division must consider natural background conditions, exist-

4.02: continued

ing discharges, must protect existing downstream uses, and not interfere with the maintenance and attainment of beneficial uses in downstream waters. Toward this end, the Division may provide a reasonable margin of safety to account for any lack of knowledge concerning the relationship between the pollutants being discharged and their impact on the quality of the receiving waters.

(2) Mixing Zones. In applying these standards, the Division may recognize, where appropriate, a limited mixing zone or zone of initial dilution on a case-by-case basis. The location, size and shape of these zones shall provide for the maximum protection aquatic resources. At a minimum, mixing zones must:

(a) Meet the criteria for aesthetics;

(b) Be limited to an area or volume that will minimize interference with the designated uses or established community of aquatic life in the segment;

(c) Allow an appropriate zone of passage for migrating fish and other organisms; and

(d) Not result in substances accumulating in sediments, aquatic life or food chains to exceed known or predicted safe exposure levels for the health of humans or aquatic life.

(3) Hydrologic Conditions. The Division will determine the most severe hydrologic condition at which water quality standards must be met. In classifying the inland waters of the Commonwealth and in applying these standards to such waters, the critical low flow condition at and above which these standards must be met is the average minimum consecutive seven day flow to be expected once in ten years, unless otherwise stated by the Division in these standards. In artificially regulated waters, the critical low flow will be established by the Division through agreement with the Federal, State or private interest controlling the flow. The minimum flow established in such agreement will become the critical low flow under 314 CMR 4.02 for those waters covered by the agreement.

(4) Procedures for Sampling and Analysis. For the purpose of collecting, preserving and analyzing samples in connection with these water quality standards, the fourteenth edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or Methods for Chemical Analysis of Water and Wastes published by the U.S. Environmental Protection Agency should be used. Where a method is not given in these publications, the latest procedures of the American Society for Testing Materials (ASTM) shall be used, or any other equivalent method approved by the Director.

4.03: Minimum Water Quality Criteria and Associated Uses

(1) Description of Contents. 314 CMR 4.03 sets forth the Classes to be used by the Division in classifying the waters of the Commonwealth according to the uses for which the waters shall be enhanced, maintained and protected. For each class, the most sensitive beneficial uses are identified and minimum criteria for water quality in the water column are established. In interpreting and applying the minimum criteria in 310 CMR 4.03(4), the Division shall consider EPA guidance established in accordance wth Section 304(b) of the Federal Act as it applies to local conditions including, but not limited to:

(a) the characteristics of the biological community;

(b) Temperature, weather, flow, and physical and chemical characteristics; and

(c) Synergistic and antagonistic effects of combinations of pollutants.

4.03: continued

(2) Coordination with Federal Criteria. The Division will use the EPA publication entitled Quality Criteria for Water, EPA-440/9-76-023 as guidance in establishing case-by-case discharge limits for pollutants not specifically listed in these standards but included under the heading "Other Constituents" in 314 CMR 4.03(4), for identifying bioassay application factors and for interpretations of narrative criteria. Where the minimum criteria specifically listed by the Division in 314 CMR 4.03 differ from those contained in the federal criteria, the provisions of the specifically listed criteria in 314 CMR 4.03 shall apply.

(3) Classes and Designated Uses. The waters of the Commonwealth will be assigned to one of the classes listed below. Each class is defined by the most sensitive, and therefore governing, uses which it is intended to protect. The classes are:

Classes for Inland Waters

Class A - Waters assigned to this class are designated for use as a source of public water supply.

Class B - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for primary and secondary contact recreation.

Class C - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for secondary contact recreation.

Classes for Coastal and Marine Waters

Class SA - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting without depuration in approved areas.

Class SB - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting with depuration (Restricted Shellfish Areas).

Class SC - Waters assigned to this class are designated for the protection and propagation of fish, other aquatic life and wildlife; and for secondary contact recreation.

(4) Minimum Criteria. The following minimum criteria are adopted and shall be applicable to all waters of the Commonwealth.

A. These minimum criteria are applicable to all waters of the Commonwealth, unless criteria specified for individual classes are more stringent.

Parameter	Criteria
1. Aesthetics	All waters shall be free from pollutants in concentrations or combinations that: (a) Settle to form objectionable deposits; (b) Float as debris, scum or other matter to form nuisances; (c) Produce objectionable odor, color, taste or turbidity; or (d) Result in the dominance of nuisance species.

4.03: continued

For Class SC waters:

Parameter	Criteria
1. Dissolved Oxygen	Shall be a minimum 85 percent of saturation at water temperatures above 77°F (25°C) and shall be a minimum of 6.0 mg/l at water temperatures of 77°F (25°C) and below.
2. Temperature	None except where the increase will not exceed the recommended limits on the most sensitive water use.
3. pH	Shall be in the range of 6.5-8.5 standard units and not more than 0.2 units outside the naturally occurring range.
4. Fecal Coliform Bacteria	Shall not exceed a log mean for a set of samples of 1000 MPN per 100 ml, nor shall more than 10% of the total samples exceed 2500 MPN per 100 ml during any monthly sampling period, except as provided in 314 CMR 4.02(1).

4.04: Antidegradation Provisions

(1) Protection of Existing Uses. In all cases, from and after the date these regulations become effective, the quality of the waters of the Commonwealth shall be maintained and protected to sustain existing beneficial uses.

(2) Protection of High Quality Waters. From and after the date these regulations become effective, waters designated by the Division in 314 CMR 4.05(5) whose quality is or becomes consistantly higher than that quality necessary to sustain the national goal uses shall be maintained at that higher level of quality unless limited degradation is authorized by the Division. Limited degradation may be allowed by the Division as a variance from this regulation as provided in 314 CMR 4.04(6).

(3) Protection of Low Flow Waters. Certain waters will be designated by the Division in 314 CMR 4.05(5) for protection under 314 CMR 4.04 due to their inability to accept pollutant discharges. New or increased discharges of pollutants to waters so designated are prohibited unless a variance is granted by the Division as provided in 314 CMR 4.04(6).

(4) National Resource Waters. Waters which constitute an outstanding national resource as determined by their outstanding recreational, ecological and/or aesthetic values shall be preserved. These waters shall be designated for preservation by the Division in 314 CMR 5.05(5). Waters so designated may not be degraded and are not subject to a variance procdure. New discharges of pollutants to such waters are prohibited. Existing discharges shall be eliminated unless the discharger is able to demonstrate that:

(a) Alternative means of disposal are not reasonably available or feasible; and

(b) The discharge will not affect the quality of the water as a national resource.

(5) Control of Eutrophication. The discharge of nutrients, primarily phosphorus or nitrogen, to waters of the Commonwealth will be limited or prohibited by the Division as necessary to prevent excessive eutrophicat of such waters. There shall be no new or increased discharges

4.04: continued

of nutrients into lakes and ponds, or tributaries thereto. Existing discharges containing nutrients which encourage eutrophication or growth of weeds or algee shall be treated. Activities which may result in non-point discharges of nutrients shall be conducted in accordance with the best management practices reasonably determined by the Division to be necessary to preclude or minimize such discharges of nutrients.

(6) Variances. A variance to authorize a discharge in water designated for protection under 314 CMR 4.04(2) may be allowed by the Division where the applicant demonstrates that:

(a) The proposed degradation will not result in water quality less than specified for the class; and

(b) The adverse economic and social impacts specifically resulting from imposition of controls more stringent than secondary treatment to maintain the higher water quality are substantial and widespread in comparison to other economic factors and are not warranted by a comparison of the economic, social and other benefits to the public resulting from maintenance of the higher quality water. In making such evaluation, the Division will apply, where appropriate, guidance documents published by EPA.

In addition to 314 CMR 4.04(6)(a) and (b), the applicant for a variance to authorize a discharge into waters designated for protection under 314 CMR 4.04(3) must demonstrate that:

(c) Alternative means of disposal are not reasonably available or feasible.

In any proceeding where such variance is at issue, the Division shall circulate a public notice in accordance with the procedures set forth in M.G.L. c. 30A, s. 3. Said notice shall state that a variance is under consideration by the Division, and indicate the Director's tentative determination relative thereto. To the extent feasible, the variance proceeding shall be conducted as part of any pending discharge permit proceedings pursuant to M.G.L. c. 21, s. 43. In any variance procedure, the burden of proof relative to justifying the variance shall be on the party requesting the variance. Any variance granted pursuant to this regulation shall not extend beyond the expiration date of the permit.

4.05: Basin Classifications and Maps

(1) Description of Contents. 314 CMR 4.05 sets forth the procedures and guidelines the Division must follow in classifying the waters of the Commonwealth, and the classifications themselves. The procedural rules for classifying are contained in 314 CMR 4.05(2) through 4.05(4). 314 CMR 4.05(5) contains maps and tabulations identifying the assignment by the Division of each segment to one of the classes set forth in 314 CMR 4.03(3), the designation of uses and associated criteria for that segment and the imposition of special limitations in 314 CMR 4.04(2) through 4.04(4) to that segment.

(2) Designation of Uses. In determining the appropriate classification for a particular water, the Division must fulfill its statutory mandate as set forth in 314 CMR 4.01(4). Wherever attainable, the Division shall designate the national goal uses of protection and propagation of fish, shellfish, aquatic life and wildlife and recreation in and on the waters in classifying the waters of the Commonwealth. In determining whether the national goal uses are attainable for a given water, the Division has considered limitations imposed by natural conditions, irreversible artificial conditions and the availability of feasible technological treatment methods and designated the optimum number of beneficial uses attainable in the circumstances.

(3) Other Applicable Standards. Waters classified by the Division in 314 CMR 4.05 may be subject to additional restrictions pursuant to

4.05: continued

Federal or Massachusetts statutes and regulations. Where such additional restrictions are known they are noted in the classifications in 314 CMR 4.05. Where these restrictions impose requirements more stringent than required under the Massachusetts or Federal Acts, e.g. public health restrictions relative to water supplies, such restrictions shall be considered and applied by the Division in classifying the waters to the extent authorized in the Massachusetts Act.

(4) Fisheries Designations. For inland waters certain specific criteria become applicable on the basis of their designation as a particular type of fishery. Therefore, inland segments are designated as cold water, seasonal cold water or warm water fisheries. In seasonal cold water fisheries criteria for cold water fisheries apply during the period of September 15 through June 30 annually, and criteria for warm water fisheries apply at all other times.

Where the Division determines that natural conditions prevent the attainment of water quality capable of supporting a warm water fishery, a use designation of aquatic life has been made. In each segment so designated in 314 CMR 4.05(5), the criteria for a warm water fishery apply for all constituents except those affected by the natural condition, which constituents shall be governed by the most sensitive resident species as determined by the Director in consultation with the Massachusetts Division of Fisheries and Game.

(5) Classifications. For the purpose of applying the Massachusetts Water Quality Standards, the waters of the Commonwealth are hereby classified as shown in the following tables which are a part of these regulations. Columns 1 and 2 of the tables describes the segment. Column 3 identifies the applicable classification of the segment. Column 4 identifies the use or uses for which the segment is designated; (P&S) means primary and secondary contact recreation, (Sn) means seasonal fishery, (O) means open shellfishing, (R) means restricted shellfishing. Column 5 identifies the applicable provisions of 314 CMR 4.04 and 314 CMR 4.05(3).

Segments and their classifications are shown on maps for general orientation. In case of inconsistancy between the tables and the maps, the data contained in the table shall control.

REGULATORY AUTHORITY

314 CMR 4.00: M.G.L. c. 21, ss. 27(5) and 27(12).