DRAFT
ENVIRONMENTAL IMPACT STATEMENT ON THE UPGRADING OF THE BOSTON METROPOLITAN AREA SEWERAGE SYSTEM

EXECUTIVE SUMMARY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY · REGION I
JOHN F. KENNEDY FEDERAL BUILDING · GOVERNMENT CENTER
BOSTON, MASSACHUSETTS · 02203

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PREPARED FOR

U. S. ENVIRONMENTAL PROTECTION AGENCY

REGION I

BOSTON, MASSACHUSETTS

BY

GREELEY AND HANSEN

AND

ENVIRONMENTAL ASSESSMENT COUNCIL, INC.

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Regional Administrator

4 Aug 1978

Date

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SUMMARY OF THE RECOMMENDED PLAN

The Recommended Plan of this Environmental Impact Statement (EIS) includes centralized treatment of the wastewaters from the entire MSD service area at Deer Island. The existing primary treatment plant at Deer Island will be expanded and upgraded to provide secondary treatment for an average daily wastewater flow of 586 mgd, which is estimated will require treatment in the design year of 2000.

The existing interceptor system which serves the southern MSD service area will be extended and relieved in order to accomodate the anticipated increased wastewater flows from its present tributary area and the possible addition of five communities. This interceptor system will transport the wastewaters from the southern service area to Nut Island, where the wastewater will receive preliminary treatment at a new headworks. The discharge from the headworks will flow through a submarine pipeline-tunnel across Boston Harbor to Deer Island for treatment.

The northern interceptor system will be extended and relieved to accomodate anticipated increased wastewater flows from its present tributary area and the possible addition of three communities. This wastewater will receive preliminary treatment at four existing headworks and will be transported to Deer Island for treatment.

The effluent from the secondary treatment plant at Deer Island will be discharged through an outfall system to Boston Harbor near President Roads. The existing Deer Island outfall system will be upgraded and an additional outfall will be constructed for this purpose.

The primary sludge resulting from the primary phase of treatment will be incinerated, and the resultant ash disposed of, at Deer Island in accordance with the recommendations of a separate Environmental Impact Statement which addressed the issue of primary sludge disposal. The secondary sludge will be disposed of by three methods, as follows:

1) Secondary sludge from the treatment of the northern service area wastewater will be dewatered and incinerated at Deer Island, and the resultant ash will be transported by barge to Squantum Point where an ash landfill will be located.

2) About half of the secondary sludge from the treatment of the southern service area wastewater will be dewatered at Deer Island and then transported to Squantum Point where it will be composted. The resulting compost product will be marketed or given away.

3) The remaining secondary sludge from the treatment of the southern service area wastewater will be digested and dewatered at Deer Island and then transported by barge to Squantum Point. At Squantum Point this sludge will be loaded onto trucks which will dispose of it at an MDC owned and operated sludge landfill.

The estimated construction cost of the Recommended Plan, based on May 1978 prices, is $770,700,000. Operation and maintenance costs are estimated to be $24,800,000 per year.

COST OF RECOMMENDED PLAN[1]

Wastewater Treatment Facilities[2]	404,290,900
Secondary Sludge Management	58,784,500
Interceptor System[3]	307,620,000
Total Capital Costs	770,695,400
Amortized Capital Costs[4]	59,782,800
Operation and Maintenance Costs	24,765,200
Total Annual Costs	84,548,000
Applicant's share of Cap. Cost (10%)	77,062,500
Applicant's Share of Amortized Cap. Cost	5,978,300
Applicant's Share of O & M Costs	24,765,200
Applicant's Share of Total Annual Cost	30,743,500

(1) Engineering News Record Construction Index = 2654
(2) Includes work at Nut Island and Outfall
(3) Includes submerged pipelines, tunnel and related pumping stations
(4) Assume average life of facilities = 30 years; Interest rate = 6-5/8 percent

RESOURCE REQUIREMENTS AND OPERATION AND MAINTENANCE COSTS OF THE RECOMMENDED PLAN

Resource Requirements	Wastewater Treatment Plant	Sludge Management Facility
Manpower	298	86
Chlorine-Tons/Year	7,135	-
Fuel Oil-Gallons/Year	706,000	224,214
Electric Power-Kwhr/Year	196,571,000	27,482,675
Lime-Tons/Year	-	14,600
Ferric Chloride-Tons/Year	-	3,504
Polymer-Tons/Year	-	113
Annual Operation & Maintenance Costs ($ Million)	$17.14	$6.31
Interceptor System & Related Pumping Stations Annual Operation & Maintenance Costs ($ Million)	$1.31	
Total Annual Operation & Maintenance Costs ($ Million)	$24.76	

Note: If it is necessary to purchase wood chips to serve as a bulking agent for the composting operation, approximately 9,000 cubic meters (12,000 cubic yards) of wood chips would be required per year. At a cost of $6.00 per cubic yard for wood chips, the resulting increase in the annual operation and maintenance costs for the sludge management facility would be about $72,000 per year.

I. INTRODUCTION

The purpose of this Environmental Impact Statement is to develop the most environmentally acceptable, cost effective wastewater management plan for the Eastern Massachusetts Metropolitan Area. The study addresses various phases of wastewater management including collection, treatment and disposal of wastewaters, and treatment and disposal of secondary sludge. Various wastewater management systems, including the plan proposed in the Wastewater Engineering and Management Plan for Boston Harbor-Eastern Massachusetts Metropolitan Area (EMMA Study), were evaluated. The study area includes those communities included in the enlarged MSD service area as described in the EMMA Study, and shown on Figure 1.

II. BACKGROUND

The Metropolitan District Commission presented a comprehensive plan for wastewater management in its report, Wastewater Engineering and Management Plan for Boston Harbor-Eastern Massachusetts Metropolitan Area (EMMA Study). The principal recommendations of that report to achieve clean water goals established for Boston Harbor and its tributary rivers are:

1) Upgrading the Deer Island and Nut Island treatment plants from primary to secondary treatment.

2) Sludge disposal by means of incineration as recommended in a 1973 report prepared for the MDC entitled A Plan For Sludge Management.

3) Alleviating combined stormwater-sewage overflows.

4) Construction of two advanced waste treatment plants on the Charles and Neponset Rivers.

5) Extension and improvement of the MDC's interceptor system.

The EMMA Study visualizes increasing the service area of the Metropolitan Sewerage District (MSD) through the addition of the towns of Lincoln, Lynnfield, and Weston*to the northern MSD service area, presently served by the Deer Island Treatment Plant, and the addition of Dover, Hopkinton, Sharon, Sherborn and Southborough to the southern MSD service area, presently served by the Nut Island Treatment Plant. The Deer Island Treatment Plant would be expanded and upgraded to provide secondary treatment for the increased flows from the northern service area.

*Weston has since voted not to join the MSD.

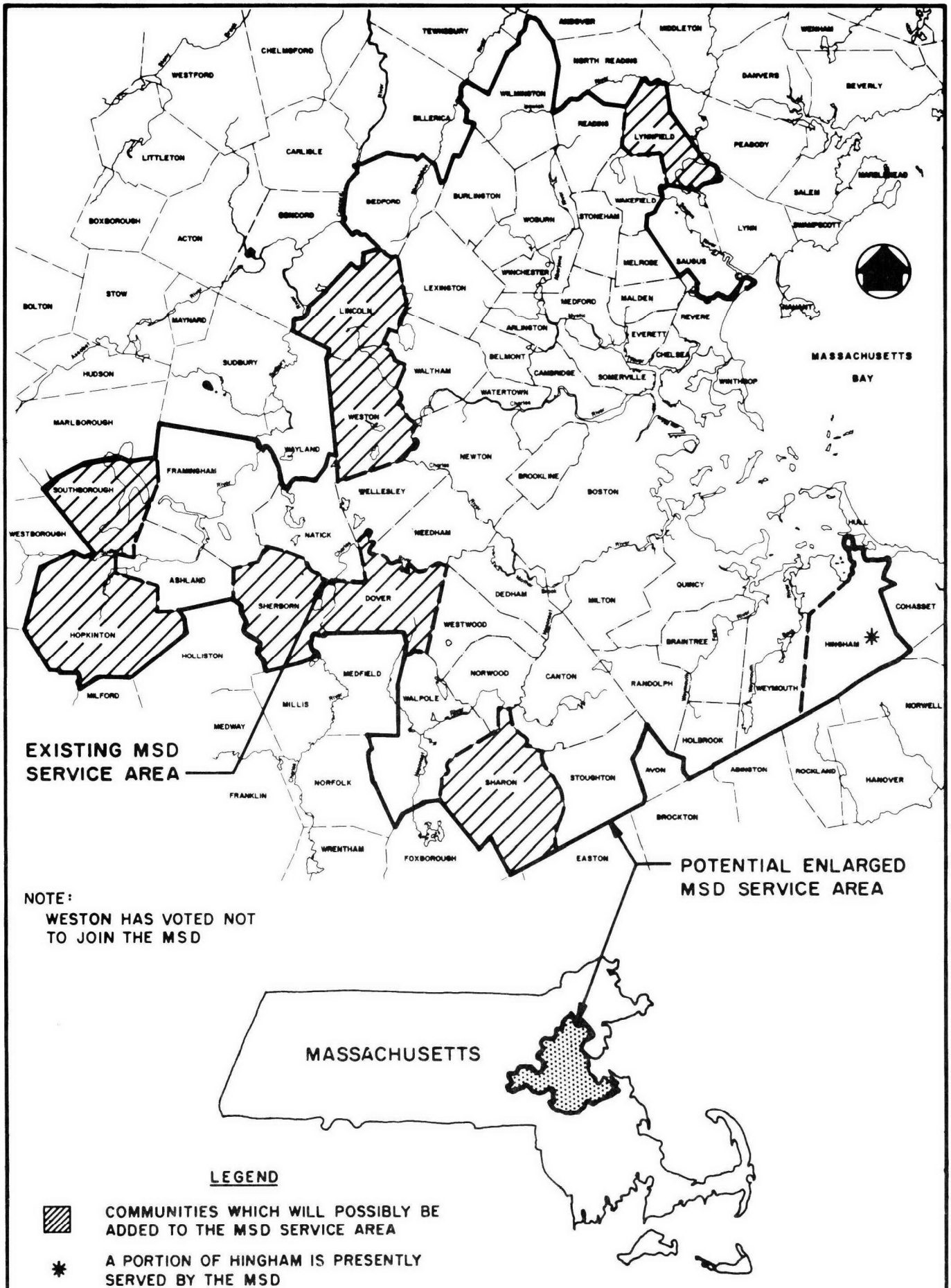


FIGURE 1 STUDY AREA LOCATION

Two inland advanced wastewater treatment plants, one discharging to the Charles River and the other to the Neponset River, would be constructed in the southern service area, thereby reducing the extent of the expansion required at Nut Island and providing low-flow augmentation for the rivers. The satellite plant that would discharge to the Charles River would serve Ashland, Framingham, Hopkinton, Natick, Sherborn and Southborough as well as parts of Dover and Wellesley. The other satellite plant would discharge to the Neponset River and serve Sharon, Stoughton and Walpole, as well as parts of Norwood and Canton. The remainder of the wastewater from the southern service area would receive secondary treatment at an expanded and upgraded Nut Island Treatment Plant.

The sludge generated at the Nut Island plant would be pumped across Boston Harbor to Deer Island, where it would be combined with the sludge from the Deer Island plant. The sludge from both plants would be incinerated at Deer Island.

Modifications to the interceptor system have been recommended to relieve existing overloaded conditions and to provide adequate capacity for future flows. The extent of this work is distributed throughout the service area, in urban as well as suburban areas. Also, renovation or replacement of each of the ten MDC pumping stations along the interceptor system has been recommended to replace existing worn-out equipment in order to provide efficient and adequate pumping capacity for future flows.

In September, 1976, EPA Region I contracted with the firms of Greeley and Hansen and Environmental Assessment Council, Inc. to assist in the preparation of an Environmental Impact Statement for the upgrading of the MDC's wastewater management system. Various wastewater management alternatives, in addition to the MDC's Recommended Plan, were to be considered.

The EMMA Study considered all aspects of wastewater management planning to provide recommendations for the construction and/or rehabilitation of facilities needed for effective wastewater management. This EIS is focused on those aspects of the MDC's Recommended Plan that deal with the transportation, treatment and ultimate disposal of municipal wastewaters. The factors considered are:

1) Interceptor system modifications required due to increases in wastewater flow volume and alternative treatment plant sites.

2) Environmental and engineering feasibility of constructing satellite treatment plants discharging to inland waterways.

3) Alternative treatment plant sites and treatment

facility configurations for the major wastewater treatment plants in the vicinity of Boston Harbor.

4) Alternative techniques for the treatment and disposal of secondary sludge.

5) Wastewater treatment plant effluent discharge locations.

This EIS does not address the following items which are included in the EMMA Study: Infiltration/Inflow analysis; combined sewer overflow regulation; and primary sludge disposal.

III. METHOD OF APPROACH

The method of approach used in this EIS was to divide the wastewater management system into major subsystems which would be further subdivided into major components. As an example, the major subsystem of wastewater treatment facilities was subdivided into facility locations, treatment processes and discharge locations. All reasonable alternatives for each of these subsystem components were then evaluated in the preliminary screening phase. The preliminary screening process eliminated all alternative components which were obviously infeasible because of severe environmental impacts, technical infeasibility or prohibitive costs.

The remaining alternative components were then combined to form feasible subsystem alternatives. These alternatives were then evaluated in the intermediate screening process. In this phase, preliminary design and evaluation of facilities and environmental assessments were used to eliminate the less feasible alternative subsystems from further consideration.

The remaining subsystems were then combined to form complete wastewater management systems which included wastewater collection, treatment and disposal and sludge treatment and disposal. In the final screening phase the alternative wastewater management systems were analyzed in detail in order to select the best alternative based on environmental, technical and economic factors.

IV. PRELIMINARY AND INTERMEDIATE SCREENING

Two basic wastewater management systems were considered; one which provides all wastewater treatment facilities in the vicinity of Boston Harbor and one which includes inland satellite plants on the Charles and Neponset Rivers in addition to harbor area plants.

During the preliminary and intermediate screening stages of this study, various alternative coastal area treatment plant sites, treatment plant discharge locations, wastewater treatment processes, and sludge treatment and disposal methods were investigated. During these screening stages, many alternatives were eliminated from further consideration due to one or more of the following factors: severe negative environmental impacts; technical infeasibility; and prohibitive costs. The results of the preliminary and intermediate screenings are summarized briefly below:

1) Coastal area treatment plant sites: Eleven sites were considered, and all but three were eliminated.

2) Coastal treatment plant discharge points: Of the four discharge points considered, three remained.

3) Satellite treatment plant sites: Over thirty sites were considered for the two satellite plants, and all but six were eliminated.

4) Satellite plant discharge points: Various discharge points were considered along the Charles and Neponset Rivers. It was determined that there was no feasible combination of degree of treatment and discharge location which would result in meeting water quality criteria. Therefore, the concept of satellite treatment systems was eliminated.

5) Wastewater treatment processes: Various methods of secondary treatment were considered. The air activated sludge process was selected for the purposes of this study.

6) Sludge treatment and disposal: Numerous processes for sludge thickening, stabilization, dewatering, conversion and ultimate disposal were considered. The preliminary and intermediate screenings resulted in the formulation of three possible sludge management alternatives.

V. FINAL SCREENING

The alternative wastewater management systems which included inland satellite treatment plants were eliminated from further consideration during the preliminary and intermediate screening stages of the study. The remaining non-satellite systems were: Treatment at Deer Island and Broad Meadows; treatment at Deer Island and Suantum Point; and all treatment at Deer Island. The secondary sludge management alternatives for non-satellite systems which survived the earlier screenings are:

Landfilling of chemically conditioned, digested, filter pressed secondary sludge.

Composting of chemically conditioned, undigested, filter pressed secondary sludge.

Incineration of chemically conditioned, undigested, filter pressed secondary sludge.

The least expensive of the remaining sludge disposal alternatives is landfilling digested, dewatered sludge at a landfill owned and operated by the MDC. Due to the nature of the sludge, particularly the presence of heavy metals, leachate from the landfill must be collected and treated. Landfilling of sludge is the most land intensive method, requiring about 370 acres of land to dispose of all the secondary sludge generated in the MSD service area.

Transporting all the dewatered secondary sludge to an inland sludge landfill requires considerable truck traffic from the treatment plants to the landfill. Truck traffic would have the greatest impact when transporting sludge from a plant on Deer Island, since from 16 to 43 trucks, depending on the size of the treatment plant and the capacity of trucks used, would have to pass through the residential areas of Point Shirley and Winthrop each day. The impact of truck traffic would not be as great when transporting sludge from a plant at either Squantum or Broad Meadows, where the number of trucks required is less, 13 to 19 per day, and the plants are located closer to major arteries.

Due to problems associated with leachate control, the large land area requirements and the heavy volume of truck traffic required, methods of sludge disposal other than landfilling should be used where possible. The remaining feasible sludge disposal options available are composting sludge to produce a marketable or "give-away" product, and sludge incineration with ash disposal in a controlled fill area.

Based on the experiences of other metropolitan areas and preliminary investigation in this EIS, it is estimated that, with an extensive promotional campaign, the MDC jurisdictional area could support a market for approximately 20,000 dry tons of compost per year. The compost production can be utilized as a soil conditioner and applied to parks, highway median strips, golf courses, cemeteries, residentaial lawns and other landscaped areas. Other possible outlets are commerical nurseries and landscape contractors in the area. In addition to existing park lands, the Boston Harbor Islands Comprehensive Plan (MAPC 1972) recommends the development of the Boston Harbor Islands into major recreation and conservation areas. The land area of these islands can provide an additional outlet for composted secondary sludge.

The estimated compost market of 20,000 dry tons per year would dispose of approximately 25 percent of the secondary

sludge generated at the MSD wastewater treatment plants. Based on estimated sludge characteristics, the sludge from the southern MSD service area wastewater will contain lower concentrations of heavy metals than the sludge from the northern MSD service area wastewater. Therefore, the compost should consist of sludge from the southern service area, since this sludge is of a better quality (lower heavy metals concentration) than the sludge from the northern service area. It is estimated that about half of the secondary sludge generated from the treatment of the wastewater from the southern MSD service area could be disposed of in the form of compost.

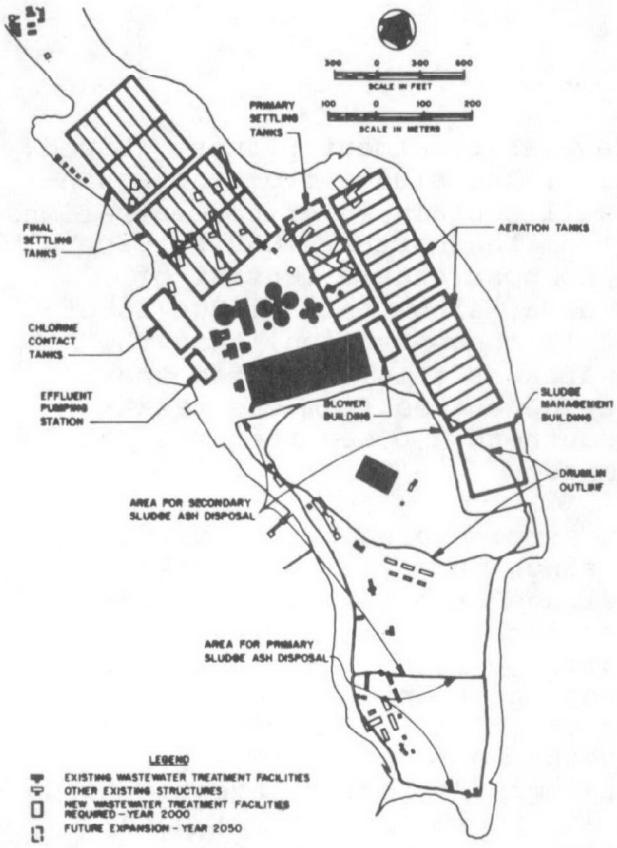
The sludge from the northern service area cannot be disposed of as a composted product, since the available market would be utilized to dispose of sludge from the southern service area. Also, as discussed previously, the trucking of sludge from Deer Island to a landfill will have a major negative impact on the residential areas adjacent to the Island. A third alternative for disposing of the northern service area sludge is incineration. Although the Boston Air Quality Region is in a status of "non-attainment", recent investigations by the Massachusetts Division at Air Pollution Control have determined that Deer Island is in a "clean zone" of the non-attainment area. The incineration of the secondary sludge from the northern MSD service area would produce approximately 125 cubic yards of ash residue per day. This residue, which must be disposed of, is about 25 percent of the volume of sludge which would require disposal under the landfill option. It is felt that incineration is the most practical method of disposing of the secondary sludge generated from the treatment of the wastewater from the northern MSD service area.

The remaining half of the southern service area secondary sludge still requires a method of disposal. Landfilling of this remaining sludge would not have as severe impacts as would the landfilling of all the secondary sludge generated from the treatment of wastewater from the entire service area or from the northern service area. A landfill area of about 84 acres would be required.

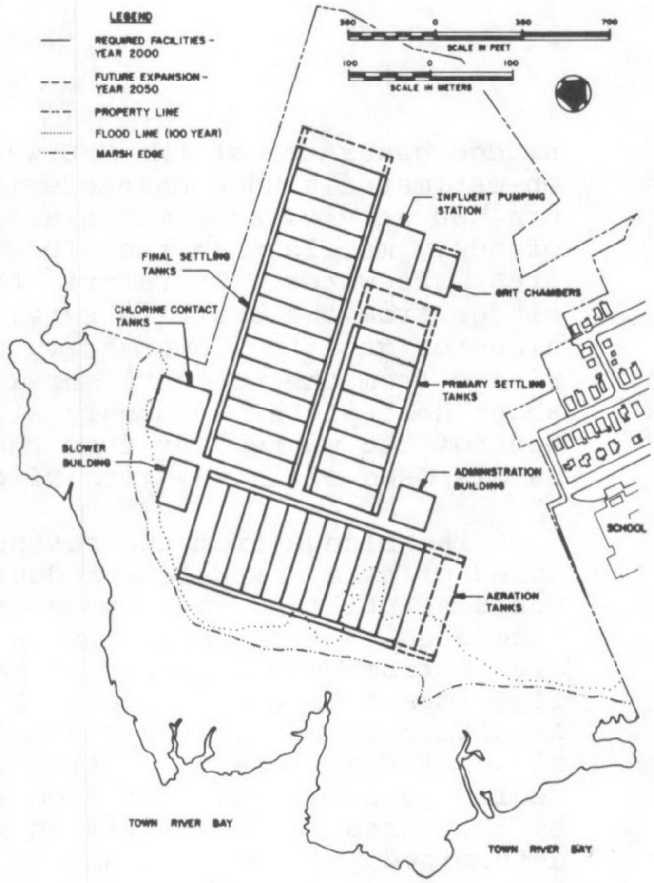
Following the intermediate screening process, three alternative wastewater treatment plant systems were developed for consideration during final screening.

A. Deer Island - Broad Meadows (See Figure 2)

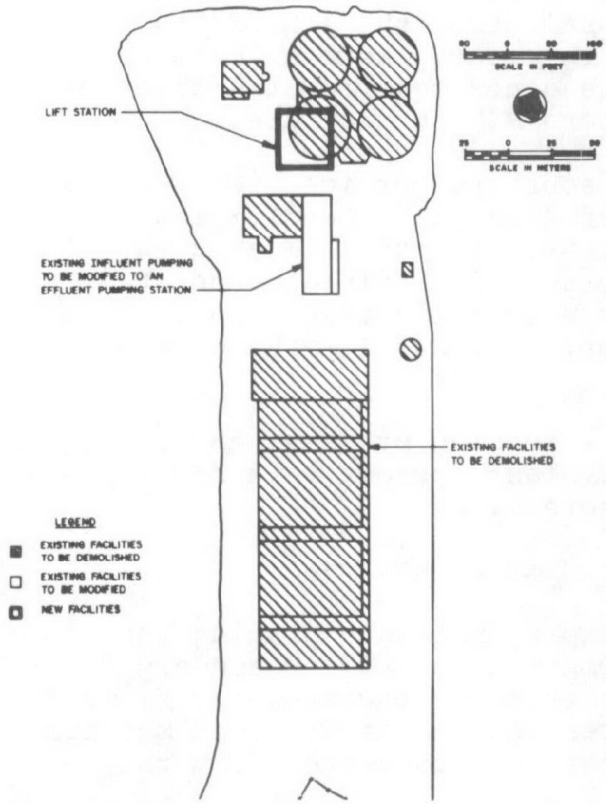
This alternative includes expanding and upgrading the existing Deer Island Treatment Plant to provide secondary treatment for the northern MSD service area wastewater flows, and the construction of a new treatment plant at Broad Meadows to provide secondary treatment for the wastewater from the southern MSD service area.



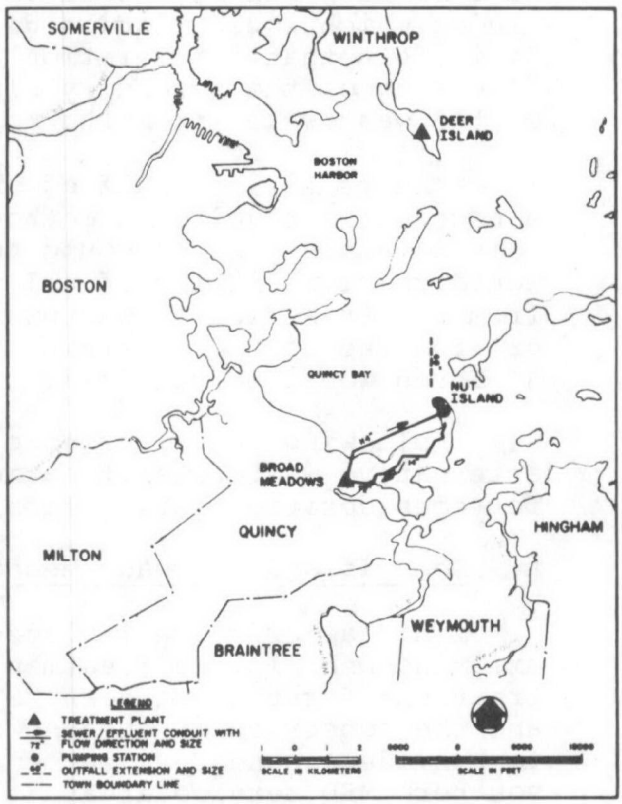
DEER ISLAND WASTEWATER TREATMENT PLANT



BROAD MEADOWS WASTEWATER TREATMENT PLANT



NUT ISLAND FACILITIES



COASTAL FACILITIES

FIGURE 2 DEER ISLAND - BROAD MEADOWS ALTERNATIVE

Sufficient land area is available on Deer Island to accommodate the expanded and upgraded treatment facility. The proposed plant expansion can be accomplished utilizing either the northern and central portions of the island, or the southern and central portions of the island. In addition, the selected sludge management plan for the sludge produced at this plant requires an ash disposal site. Adequate area is available for ash disposal in either treatment plant configuration. In both expansion schemes, the removal of both the prison and the drumlin are required to provide adequate area for the treatment and ash disposal facilities. It is recommended that for this plan, the northern plant expansion be used and the ash disposal site located at the southern end of the island. In this way the ash disposal site is located at the most remote location on Deer Island.

The Broad Meadows site has adequate area to accommodate the required treatment facilities and a composting operation to compost at least half of the secondary sludge generated at this treatment plant; however, an adequate buffer zone between the treatment facilities and the nearby residences and school could not be maintained. For this alternative, it is proposed that the northwest corner of Squantum Point be utilized for the composting operation. Composting half of the secondary sludge generated at the treatment facilities at Broad Meadows would require an area at Squantum Point of about 21 acres. The sludge would be transported from Broad Meadows to Squantum by barge or by truck. The remaining secondary sludge from the Broad Meadows facility would be trucked from the site to a landfill.

The primary sludge produced at the treatment plant serving the southern MSD service area would be pumped through a pipeline across Boston Harbor to Deer Island, where it would be dewatered and incinerated along with the primary sludge produced at the treatment plant at Deer Island, as is recommended in a separate primary sludge management EIS.

The effluent from the Deer Island treatment plant would discharge through the existing outfall system. The outfall system requires some repair work to restore it to its design capacity. Approximately 9,000 feet of force main and 4,000 feet of sewer would be required between Nut Island and the Broad Meadows site in order to transport wastewater from Houghs Neck and the Braintree-Weymouth pumping station to the treatment facilities at Broad Meadows. The wastewater from the High Level Sewer upstream of Broad Meadows would be diverted to the new treatment plant. The effluent from this plant would flow into the High Level Sewer downstream of the site, and would be transported to the outfall system at Nut Island. Since the High Level Sewer is not adequate to handle peak flows from this plant, a relief pipeline would be required. Preliminary analysis indicated that there is not adequate space to locate a relief pipeline parallel to the High Level Sewer through Houghs Neck, and therefore the required 114 inch

diameter relief pipeline would be routed under Quincy Bay.

The relief pipeline crossing Quincy Bay will reach Nut Island at a lower elevation than the High Level Sewer and, therefore, a pumping station would be required at Nut Island to lift the plant effluent from the relief pipeline to the outfall system. During periods of peak flow and high tide, the plant effluent from the High Level Sewer and the relief pipeline would require pumping in order to be discharged through the outfall system. Therefore, the existing raw sewage pumping station on Nut Island owuld be converted to an effluent pumping station. The existing Nut Island outfalls would be extended to a point in the harbor where the depth of water is about 45 feet. The remaining facilities of the existing Nut Island plant would be demolished.

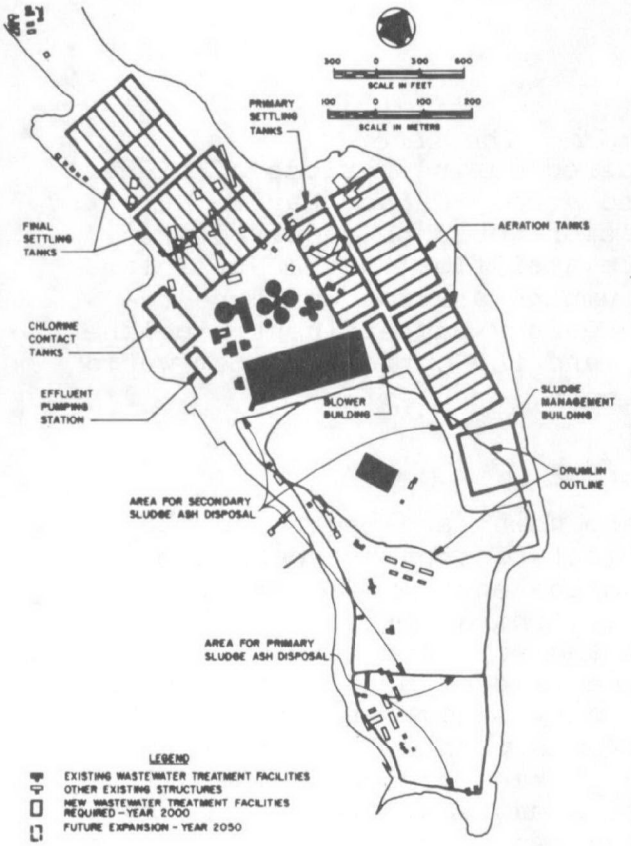
B. Deer Island - Squantum (See Figure 3)

This alternative includes expanding and upgrading the existing Deer Island treatment plant to provide secondary treatment for the northern MSD service area wastewater flows, and the construction of a new treatment plant at Squantum Point to provide secondary treatment for the wastewater from the southern MSD service area.

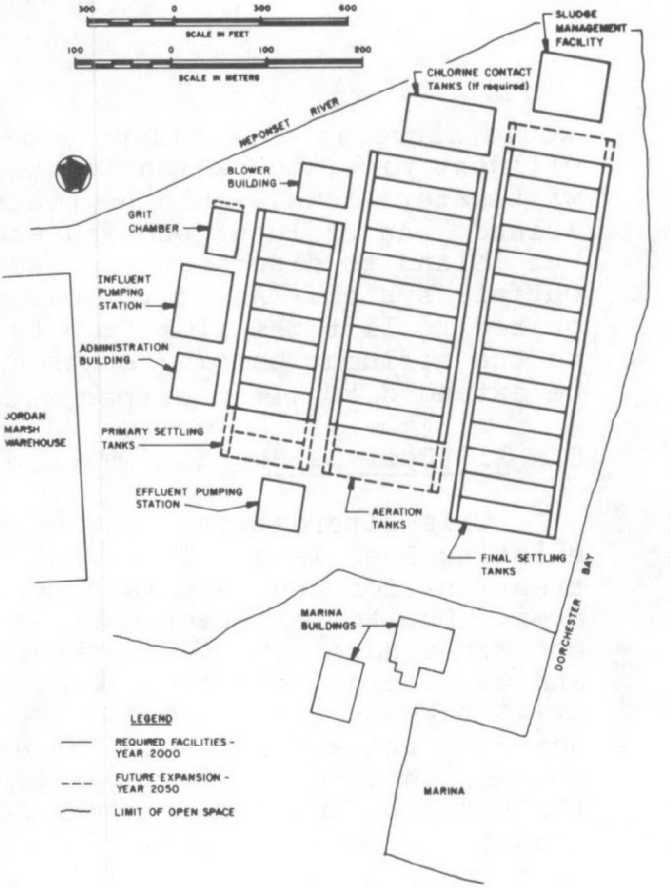
The wastewater treatment, sludge disposal, and outfall facilities for the northern service area are the same as discussed under Alternative A.

The Squantum Point site is large enough to accommodate a treatment plant to provide secondary treatment for the wastewater from the southern service area, but there is insufficient area for a composting operation. For this alternative, it is proposed that Broad Meadows be utilized for composting secondary sludge. The composting operation would be located in the southwest corner of Broad Meadows so that it is as far away from residential areas as possible. The sludge could be transported from Squantum to Broad Meadows either by barge or truck. The remaining secondary sludge generated at the Squantum Point treatment plant would be trucked to a landfill. The primary sludge would be pumped to Deer Island and incinerated as in Alternative A.

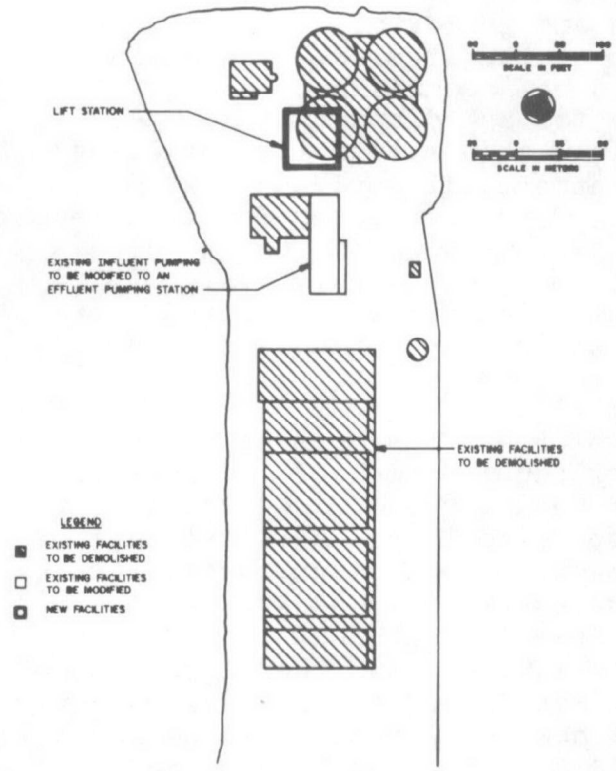
A new influent sewer would be required to transport the wastewater from the High Level Sewer to the treatment plant at Squantum Point. About 21,400 feet of influent sewer would be required. In order to transport wastewater from Houghs Neck and the Braintree-Weymouth Pumping Station to the new influent sewer, about 9,000 feet of force main and 6,000 feet of sewer would be required. The effluent from the Squantum Point treatment plant would leave the plant through two effluent pipelines. One effluent pipeline would connect to the High Level Sewer downstream of the influent sewer connection. From this point to Nut Island the High Level Sewer



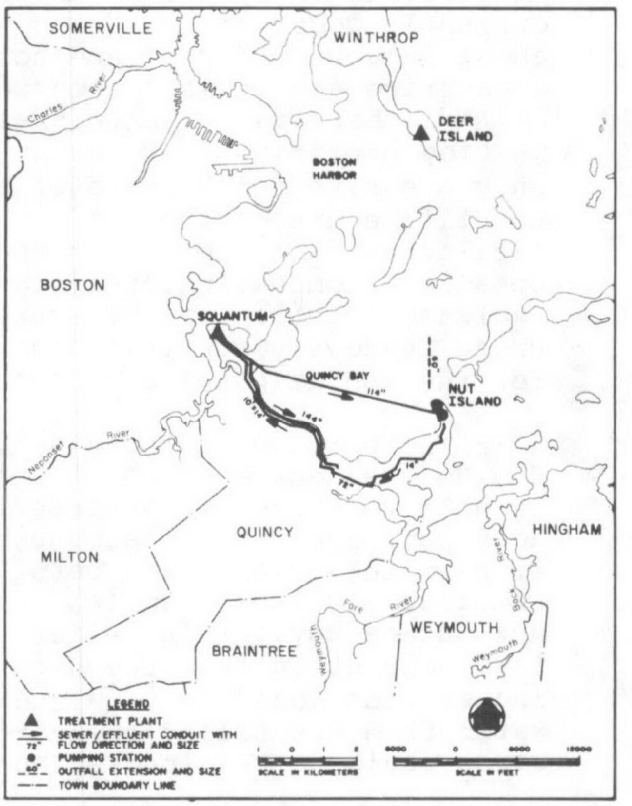
DEER ISLAND WASTEWATER TREATMENT PLANT



SQUANTUM WASTEWATER TREATMENT PLANT



NUT ISLAND FACILITIES



COASTAL FACILITIES REQUIRED

FIGURE 3 DEER ISLAND - SQUANTUM ALTERNATIVE

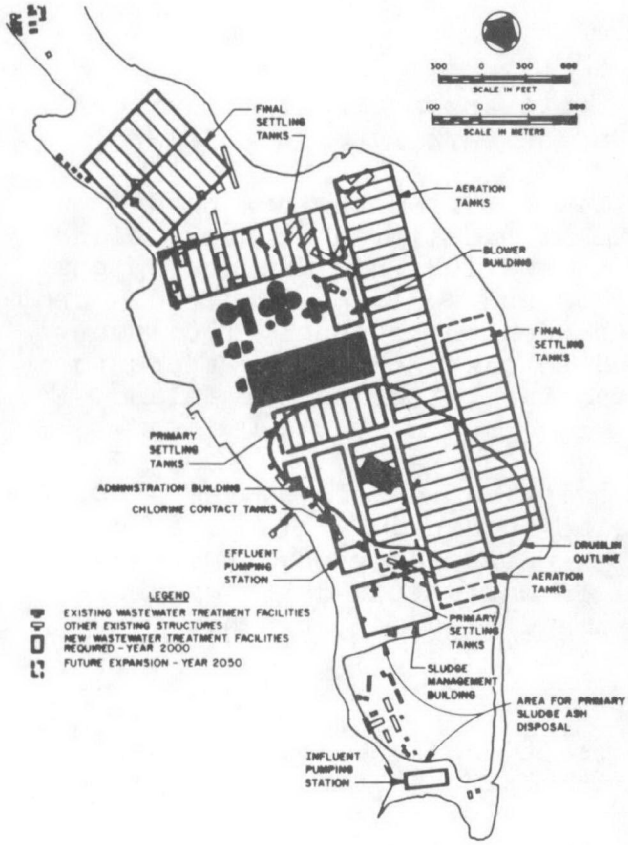
would serve as an effluent conduit. The second effluent pipeline, which is required during periods of high wastewater flows, would be routed across Quincy Bay to Nut Island. An effluent pumping station would be required at Nut Island to discharge the wastewater flow to the Nut Island outfall system. An additional pumping station would be required to lift the flow from the Quincy Bay effluent pipeline to the effluent pumping station, and the outfall system would be extended to reach deeper water.

C. All Deer Island (See Figure 4)

This alternative includes expanding and upgrading the existing Deer Island Treatment Plant to provide secondary treatment for the wastewater from the entire MSD service area. Due to different heavy metal characteristics of secondary sludge from the northern and southern service areas and the decision to dispose of the sludges by different methods, it is necessary to keep the secondary sludge from the northern and southern service areas separate. In order to accomplish this, it is necessary to keep the wastewaters from the northern and southern service areas separate and to process the secondary sludge from the two service areas separately.

Constructing the facilities which are required to provide secondary treatment for the wastewater from the entire MSD service area on Deer Island requires utilizing the areas currently occupied by the prison and the drumlin and all but about 18 acres of the land south of the drumlin. While sludge dewatering and incineration would be accomplished on Deer Island, there is not enough area for ash disposal and composting operations. However, since this alternative utilizes only one site for wastewater treatment, it would be possible to utilize one of the sites which were considered for treatment facilities in the previous two alternatives for the ash disposal and composting operations. Due to the relatively isolated location of the Squantum Point site as compared to Broad Meadows, Squantum Point would be the better location for the ash disposal and composting operations.

The portion of the High Level Sewer that passes through the Houghs Neck section of Quincy requires relief in order to be able to transport anticipated peak flows. Since there does not appear to be adequate space to locate a relief sewer parallel to the High Level Sewer through Houghs Neck, the required 114 inch diameter relief sewer would be routed under Quincy Bay. This relief sewer will reach Nut Island at a lower elevation than the High Level Sewer, and therefore a pumping station would be required at Nut Island to lift the wastewater from the relief sewer to a new headworks. This headworks would be required at Nut Island in order to provide



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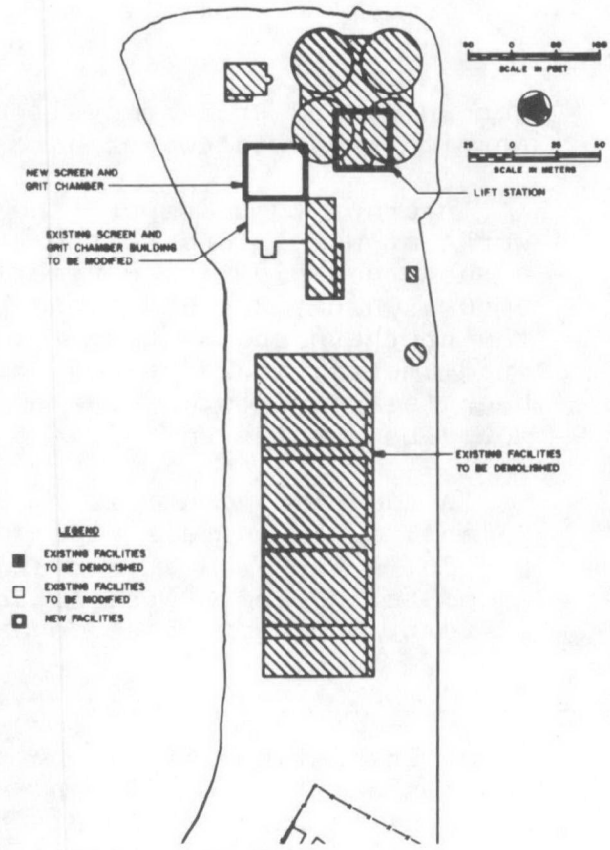
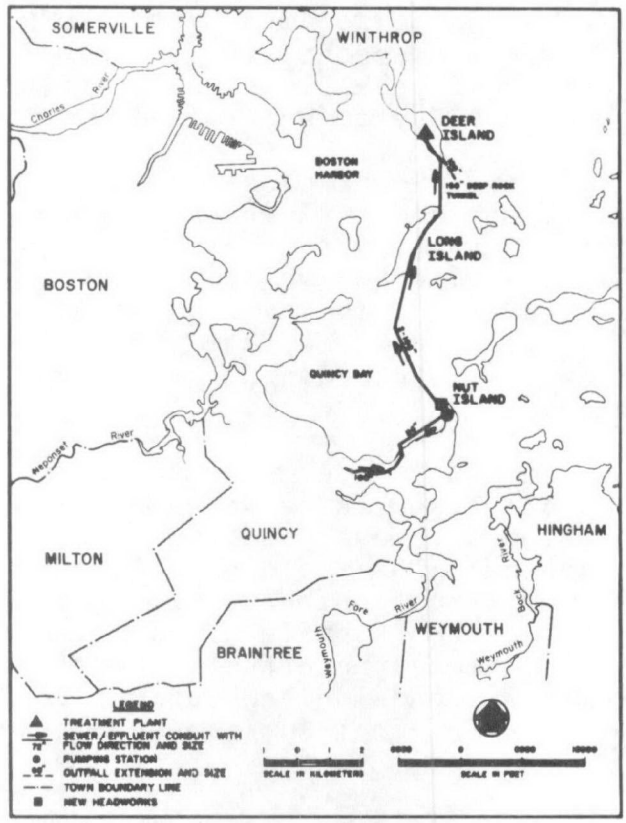


NUT ISLAND FACILITIES



COASTAL AREA FACILITIES

FIGURE 4 DEER ISLAND ALTERNATIVE

screening and grit removal prior to transporting the southern service area wastewater across Boston Harbor to Deer Island.

In order to transport the wastewater from the new headworks at Nut Island to the treatment facilities at Deer Island, a submerged pipeline consisting of two 108 inch diameter pipes across Quincy Bay and along Long Island would be required. From the northern end of Long Island a deep rock tunnel, 150 inches in diameter, would be constructed to carry the wastewaters to Deer Island. Most of the existing facilities on Nut Island would be demolished.

In addition to utilizing the existing outfall system at Deer Island, a new outfall pipe would be required. This pipe would be 120 inches in diameter and about 2100 feet long. Diffusers added to the end of the outfall, in water at a depth of about 60 feet, would provide adequate dispersion of effluent.

D. Comparative Analysis

On inspection, it can be seen that the Deer Island-Broad Meadows and the Deer Island-Squantum alternatives are similar. One area in which these alternatives differ greatly is the need for additional interceptor construction. The Deer Island-Squantum alternative requires an interceptor to convey wastewater from the High Level Sewer to the Squantum Point plant. This sewer is of substantial size, 10 feet by 14 feet, and is over 4 miles in length. In addition, a parallel 144 inch effluent pipeline would be required from the plant back to the High Level Sewer. A second effluent pipeline would be required for periods of peak flow. This effluent sewer would be routed under Quincy Bay to Nut Island.

Since the High Level Sewer passes adjacent to the Broad Meadows site, influent and effluent sewer requirements to connect this site to the sewer are minimal. For the Deer Island-Broad Meadows alternative, an effluent pipeline would also be required under Quincy Bay to transport peak flows. However, this pipeline would be less than half the length of the effluent pipeline required under the Bay from a treatment plant at Squantum.

A detailed field study undertaken to select the best route for the parallel sewers required between the High Level Sewer and Squantum and to evaluate the construction impacts on the surrounding areas. The field evaluation indicated that the effects of sewer construction between the High Level Sewer and Squantum would be severe in spite of all reasonable attempts to reduce impacts. Among the effects which are unavoidable are the removal of mature roadside vegetation, traffic disruption, and negative effects on local businesses due to extended street closures.

The need for these additional sewers, including the longer subaqueous crossing of Quincy Bay, weighs heavily

against the Deer Island-Squantum alternative. In addition to construction impacts, additional energy is required on a continuous basis for wastewater pumping. It is estimated that the Deer Island-Squantum alternative would require about 5.9 million kilowatt hours per year of electricity over and above that required for the Deer Island-Broad Meadows alternative.

Given these facts, the Deer Island-Broad Meadows alternative emerges as the better of the two alternatives. The cost estimates for the two alterantives (see Table 1) show that the Deer Island-Squantum alternative involves approximately $3,500,000 per year additional cost (amortized capital cost and operation and maintenance cost).

When comparing the Deer Island-Broad Meadows and the All Deer Island alternatives, an immediate difference arises in the number of sites which are required. The Deer Island-Broad Meadows alternative requires three sites while the All Deer Island alternative requires only two. The Broad Meadows site is not needed for the latter alternative. The price which must be paid to eliminate one site is that a major harbor crossing is required. This component of the project also involves significant environmental impacts.

With all the treatment facilities on Deer Island, further advantages in routine operation and maintenance activities can be realized. That is, a more efficient operation, in terms of manpower and costs, will be realized. Energy costs also favor the All Deer Island system. It is estimated that this alternative would use about 7.5 million kilowatt hours less electric power annually than the Deer Island-Broad Meadows alternative.

With respect to outfall considerations, the All Deer Island system would require the construction of an additional outfall into President Roads to handle peak flows. This is comparably offset (in terms of construction) by the extension of the Nut Island outfall system required under the Deer Island-Broad Meadows alternative. An important difference, however, is that the All Deer Island system would completely remove all sewage discharges from Quincy Bay and would add additional effluent flow into President Roads. However, the Deer Island outfall would extend into 60 feet of water depth which would provide ample dilution.

Amendments to Public Law 92-500 in December, 1977 (PL95-217) allows the requirement for secondary treatment to be waived in certain coastal areas if eight specific statutory requirements are fulfilled. Should this occur in the Boston area, it is expected that some additional treatment beyond primary would be required (perhaps chemical treatment to reduce metal concentrations) and a longer ocean outfall would be needed to discharge the effluent out of the harbor. This modification would favor the All Deer Island alternative, since a single outfall to reach offshore waters would be more efficient

TABLE 1

COMPARISON OF COSTS[1]

	All Deer Island Plan	Deer Island-Broad Meadows Plan	Deer Island-Squantum Plan
Wastewater treatment Facilities[2]	404,291,000	425,755,000	420,509,000
Secondary Sludge Management	58,785,000	64,144,000	64,144,000
Interceptor System[3]	307,620,000	248,772,000	307,951,000
Total Capital Costs	770,696,000	738,671,000	792,604,000
Amortized Capital Costs[4]	59,783,000	57,299,000	61,482,000
Operation and Maintenance Costs	24,765,000	25,961,000	26,233,000
Total Annual Costs	84,548,000	83,260,000	87,150,000
Applicant's Share of Capital Cost (10%)	77,070,000	73,867,000	79,264,000
Applicant's Share of Amortized Capital Cost	5,978,000	5,730,000	8,772,000
Applicant's Share of O & M Costs	24,765,000	25,961,000	26,233,000
Applicant's Share of Total Annual Cost	30,743,000	31,691,000	35,005,000

(1) Engineering News Record Construction Index = 2654
(2) Includes work at Nut Island and Outfall
(3) Includes submerged pipelines, tunnel and related pumping stations
(4) Assume average life of facilities = 30 years; Interest rate = 6-5/8 percent.

than the extension of two outfalls, as would be necessary for the Deer Island-Broad Meadows alternative. Also, since secondary sludge would not be generated, there would be no need to utilize the Squantum site. This would reduce the number of sites used to one.

To summarize, the All Deer Island alternative is superior in terms of the number of sites required; operation and maintenance advantages; lower energy costs; and a more favorable outfall location. The Deer Island-Broad Meadows alternative is superior in terms of pipeline construction.

In terms of estimated total annual cost, the two alternatives are relatively similar - about $83,300,000 for the Deer Island-Broad Meadows alternative and about $84,500,000 for the All Deer Island alternative.

The All Deer Island alternative emerges as the better of the two alternatives and is the recommended system.

VI. OTHER OPTIONS

Three additional wastewater management option which must be considered prior to the selection of a Recommended Plan are: The EMMA Plan; the No Action Plan; and the Modified No Action Plan. These options are described below.

A. EMMA Plan

The MDC's proposed wastewater management plan, as presented in the EMMA Study, includes secondary treatment plants at Deer and Nut Islands and two advanced wastewater treatment plants (providing a higher degree of treatment than secondary) at inland locations.

The existing Deer Island Primary Treatment Plant would be expanded and upgraded to provide secondary treatment to the wastewater from the northern MSD service area. The proposed facilities would be constructed to the north of the existing facilities, and would require removing the prison and filling about 14 acres of Boston Harbor.

The wastewater from the southern MSD service area would receive treatment at three treatment plants. One of these plants would be located on Nut Island. The existing Nut Island Primary Treatment Plant would be expanded and upgraded to provide secondary treatment. Nut Island is presently almost completely occupied by the existing treatment plant, and the additional facilities would be constructed on an area of fill of about 28 acres in Quincy Bay.

The remaining wastewater from the southern service area would receive treatment at two inland satellite advanced

wastewater treatment plants. One of these plants would be located along the Charles River and the other satellite plant would be located along the Neponset River.

The sludge produced at the Nut Island plant would be pumped through a force main across Boston Harbor to Deer Island, where it would be dewatered and incinerated with the sludge produced at the Deer Island plant. The resulting ash from the incinerators would be disposed of in an ash landfill. The sludge produced at the satellite plants would undergo incineration at each plant.

Under this plan, modifications and additions would be made to the existing interceptor sewer system. About 32 miles of sewers ranging in size from 12 to 66 inches in diameter would be added to the northern interceptor sewer system, and about 36 miles of sewers, from 21 to 78 inches in diameter, would be added to the southern interceptor sewer system. In addition, each of the ten pumping stations which are located along the interceptor system would be renovated or replaced in order to provide efficient operation and adequate capacity for future flows.

The EMMA Plan also includes several combined sewer overflow regulation projects which would provide collection, treatment and disposal facilities to replace the numerous combined sewer overflows which presently discharge to Boston Harbor and its tributaries.

B. No Action Plan

The No Action Plan assumes that no capital improvements will be made to the existing wastewater management system.

Within the MSD system there presently exists about 225 miles of trunk sewers, serving over 5,000 miles of local sewers; 12 pumping stations (including two at wastewater treatment plants); four headworks; and two primary treatment plants, one located at Nut Island and the other at Deer Island. Consideration of the No Action Plan implies the continued use of the present system's facilities with its present levels of effluent discharge. The No Action Plan would provide for operation and maintenance of the existing interceptors, pumping stations, headworks and treatment plants in the MSD service area. No additional towns would be added to the service area and no interceptor relief would be provided. Present pumping station, interceptor and treatment plant capacities would remain limited. Present excess flows and future additional flows would exceed the capabilities of the existing facilities.

The average daily flow presently entering the Nut Island Primary Treatment Plant is above the plant's average design capacity. Built in 1952, much of the original equipment is in need of repair or replacement. Assuming the plant is maintained at present levels, poorly treated wastewater will continue to be discharged into Boston Harbor. Following digestion of the plant's sludge, the unchlorinated sludge is disposed of through a pipeline extending into deep tidal water.

The Deer Island Primary Treatment Plant, constructed in 1968, is in relatively good condition. It is anticipated that the quantity of wastewater reaching the plant will exceed its design capacity in the near future. The discharge from the facility is a mixture of chlorinated effluent and digested sludge which is released from the plant into President Roads. Three emergency outfalls exist for high flow periods.

C. Modified No Action Plan

This Plan includes specific plans which have been made, but are yet to be implemented, or are presently in the process of being implemented. These include the regulation of combined sewer overflows and the treatment and disposal of the primary sludge generated at the wastewater treatment facilities. Present combined sewer overflow regulation facilities consist of the following:

1. The East Boston pumping stations and the North Metropolitan Trunk Sewer which have a capacity to divert about 120 mgd from upstream areas to Chelsea Creek or to the Deer Island Treatment Plant.

2. The Boston Calf Pasture pumping station which diverts about 155 mgd of flow during periods of wet weather to the holding tanks on Moon Island prior to overflowing to Boston Harbor.

3. The Cottage Farm Chlorination and Detention Station designed to treat up to 233 mgd prior to overflowing into the Charles River Basin.

4. The Somerville Marginal Conduit Project which is designed to treat about 160 mgd prior to overflowing into the Mystic River tidal waters.

5. The Charles River Marginal Conduit Project presently under construction, to treat about 323 mgd prior to discharge to the Harbor.

Approximately 125 combined sewer outlets presently discharge to Boston Harbor and its tributaries. The proposed

Combined Sewer Overflow Regulation Program will provide a system to eliminate these discharges by collecting the flows and providing treatment and disposal facilities. Treatment will consist of screening, skimming, sedimentation, and chlorination.

Under the primary sludge management plan, the sludge from the existing Nut Island Primary Treatment Plant will undergo digestion prior to being pumped through a force main across Boston Harbor to Deer Island. At Deer Island this digested sludge will be combined with the primary sludge from the Deer Island plant. The sludge will then be dewatered and incinerated at Deer Island.

VII. SELECTION OF THE RECOMMENDED PLAN

A comparison of the All Deer Island, EMMA, No Action and Modified No Action Plans was made so that a selection of a recommended plan could be made.

With respect to water quality considerations, the All Deer Island Plan is the only plan which will meet water quality standards. This system will not affect water quality in inland streams and will greatly improve the quality of the existing effluent discharges. The EMMA Plan will similarly improve the quality of the harbor discharges and will reduce their volumes somewhat. The EMMA Plan, however, will cause degradation of water quality in the Charles and Neponset Rivers. A Neponset River discharge will cause its dissolved oxygen standard to be violated, while the Charles River discharge will significantly increase the magnitude of projected water quality violations. The No Action Plan will result in the continued degradation of harbor waters. The Modified No Action Plan will cause an improvement in ambient water quality conditions, but degradation in the vicinity of the existing primary discharges will persist. Overall, the All Deer Island Plan is the best of the four systems with respect to water quality.

In terms of water quantity, the All Deer Island Plan and both No Action Plans will have a similar effect. That is, they will result in the export of water from the Charles and Neponset watersheds in the form of wastewater. For the Charles River watershed, this loss will be approximately offset by additional point source discharges to the river. For the Neponset River, an estimated export of 12 mgd has been projected. The EMMA Plan, since it will result in the discharge of treated effluent to the rivers, will result in substantially higher dry weather river flows than have occurred in the past, but at the expense of water quality.

The effects of the No Action Plan on the area's biotic communities will represent a continuation of present trends. That is, organisms associated with polluted waters will re-

main. Increased degradation of water quality as a result of increased pollutant loads will continue to damage the harbor's flora and fauna as well as the public's use of them. The Modified No Action Plan will improve the situation except in the vicinity of the existing primary treatment plant outfalls. Both the EMMA Plan and the All Deer Island Plan will further improve biotic conditions.

The EMMA Plan will require the use of two addtional sites for facilities construction and specifies the filling of Quincy Bay to expand the Nut Island plant and the filling of Boston Harbor to expand the Deer Island plant. This is considered to be a major impact. The All Deer Island Plan avoids filling the harbor but requires the complete use of Deer Island plus a major harbor crossing. Also, additional interceptor relief is required for the All Deer Island Plan.

In terms of construction-related impacts, both the All Deer Island Plan and the EMMA Plan will cause more disturbance than either of the No Action Plans. Each of these systems will produce its own set of characteristic construction impacts, which cannot be easily separated.

As far as air quality characteristics are concerned, the No Action Plan would result in the least air emissions followed by the Modified No Action Plan. The Modified No Action Plan represents an increase in emissions to the ambient air due to the incineration of the primary sludge. Comparisons of the emissions from primary and secondary sludge incineration for the All Deer Island Plan and EMMA Plan indicates the All Deer Island Plan would have less of an air quality impact. This is based upon the lower quantities of emissions and the site location of the All Deer Island Plan. This differential is offset, however, by the need to establish a landfill for disposal of digested sludge under the All Deer Island Plan.

The No Action Plan, while it is the least expensive and has the least impact on air quality, is not considered feasible. Existing primary sludge discharges to Boston Harbor, poor efficiency of existing facilities, gross and visible pollution from the Nut Island facility, and persistent bacterial contamination of the harbor render this plan untenable

The Modified No Action Plan will improve water quality conditions and benefit the harbor's biota in a general sense, but the gross pollution from the existing primary outfalls and by-passes will persist. Pollution from primary sludge discharges will be abated, however. This plan is significantly less expensive than either the All Deer Island Plan or the EMMA Plan and will be more favorable in terms of air quality impacts and primary construction-related impacts. This plan is rejected, however, on the basis of permitting unacceptable water quality conditions to persist.

The EMMA Plan and the All Deer Island Plan both further improve water quality conditions in Boston Harbor. As described previously, these alternatives vary in terms of their specific impacts, but they can be separated on the basis of several significant parameters. These include:

1. The violation of water quality standards in the Neponset River and a further deterioration of the Charles River under the EMMA Plan.

2. The need for 42 acres of fill in Boston Harbor under the EMMA Plan.

3. The need for a major harbor crossing, additional interceptor relief and drumlin removal under the All Deer Island Plan.

Beside these factors,the other levels of impact are generally similar, with some trade-offs existing between the plans. Costs are approximately equal (see Table 2). While item #3 above represents significant impacts, they can be justified in light of the magnitude of the problem and it solution. Except for the drumlin removal, these effects are short term. Items #1 and #2 however, represent long term impacts which are considered unacceptable. The solution of a wastewater management problem should not create other water quality problems, and the loss of 42 acres of Boston Harbor represents an irreversible impact which should not be accepted if a feasible alternative exists. Therefore, the All Deer Island Plan was selected as the best of the four systems.

VIII. DESCRIPTION OF THE RECOMMENDED PLAN

The wastewaters from the member communities of the MDC's Metropolitan Sewerage District will be treated at a secondary wastewater treatment plant at Deer Island. The existing interceptor system and related pumping stations will be expanded and modified as required to handle peak flows. The wastewater from the southern interceptor system will recieve preliminary treatment at a headworks at Nut Island and be transported to Deer Island through a pipeline-tunnel system under Boston Harbor. The secondary sludge produced at the Deer Island Treatment Plant will be dewatered and disposed of by a combination of incineration, composting, and direct landfilling. The ash disposal and composting operations will take place at Squantum Point. (See figures 5,6,7 and 8)

Prior to and during facilities planning special consideration should be given to the effect of flow and waste reduction measures on the flows used in the design of facilities. At present,excessive infiltration/inflow conditions exist in both the local sewer systems and in the MDC's interceptors. A thorough analysis of this condition is necessary to determine how much of this excess flow can be removed cost effectively.

TABLE 2

COMPARISON OF COSTS[1]

	All Deer Island Plan	EMMA Plan
Wastewater Treatment Facilities[2]	404,291,000	503,400,000[4,5]
Secondary Sludge Management	58,785,000	33,892,000[4]
Interceptor System[3]	307,620,000	132,532,000[4]
Total Capital Costs	770,696,000	669,824,000
Amortized Capital Costs[6]	59,783,000	51,958,000
Operation and Maintenance Costs	24,765,000	30,447,000
Total Annual Costs	84,548,000	82,405,000
Applicant's Share of Capital Costs (10%)	77,070,000	66,982,000
Applicant's Share of Amortized Capital Cost	5,978,000	5,196,000
Applicant's Share of O & M Costs	24,765,000	30,447,000
Applicnat's Share of Total Annual Cost	30,743,000	35,643,000

(1) Engineering News Record Construction Index = 2654.
(2) Includes work at Nut Island and outfall.
(3) Includes submerged pipelines, tunnel and related pumping stations.
(4) From EMMA Study, adjusted to ENR CI of 2654.
(5) Includes satellite treatment plants,and satellite sludge management. Adjusted to account for primary sludge.
(6) Assume average life of facilities = 30 years; Interest rate = 6-5/8 percent.

A recently completed tide gate rehabilitation program should result in a reduction in the amount of seawater that enters the interceptor system. The effects of that program should be evaluated to determine the extent of its success.

Water conservation is another source of flow reduction that should be employed. Through a conscientious area wide water conservation program significant wastewater flow reduction is possible. While it is recognized that such a program will take several years to gain momentum, it could have a substantial effect in reducing the impact of projected future flow increases.

The interceptor system presently serving the MSD is overloaded in some sections and in need of relief. The determination of which sections require relief and the size of the relief structures was accomplished by matching the hydraulic capacities of the existing facilities with present and future flow rates. The amount of excess flow determined the amount of relief required. The interceptor modifications are designed for a 50 year design life.

About 32 miles of interceptor relief are required in the northern service area. The southern service area requires about 56 miles of interceptor relief. Space constraints in the Houghs Neck area necessitate that the sewer required to relieve the High Level Sewer be placed under Quincy Bay. This relief sewer requires a pumping station at its termination at Nut Island to lift its flow to the same level as the wastewater in the High Level Sewer.

The wastewater from the southern service area will be transported from Nut Island to Deer Island via a submarine pipeline and tunnel system across Boston Harbor. Before entering this pipeline-tunnel system, the wastewater should receive preliminary treatment to remove large objects and grit. Therefore, a headworks is provided at Nut Island.

The Boston Harbor crossing consists of two 108 inch diameter pipes installed under the bottom of the harbor between Nut Island and the northern tip of Long Island, and a 150 inch diameter deep rock tunnel under the President Roads Channel between Long Island and Deer Island.

In order to meet NPDES permit requirements for wastewater treatment plant discharges, secondary treatment is required. This level of treatment will provide monthly average concentrations of BOD and suspended solids which are no more than 30 mg/l. This level of effluent discharge requires removal of approximately 85 percent of incoming wastewater pollutants. The air activated sludge process was selected to achieve this level of effluent quality. The method of sludge disposal selected requires that the wastewater streams from the northern and southern service areas be kept separate.

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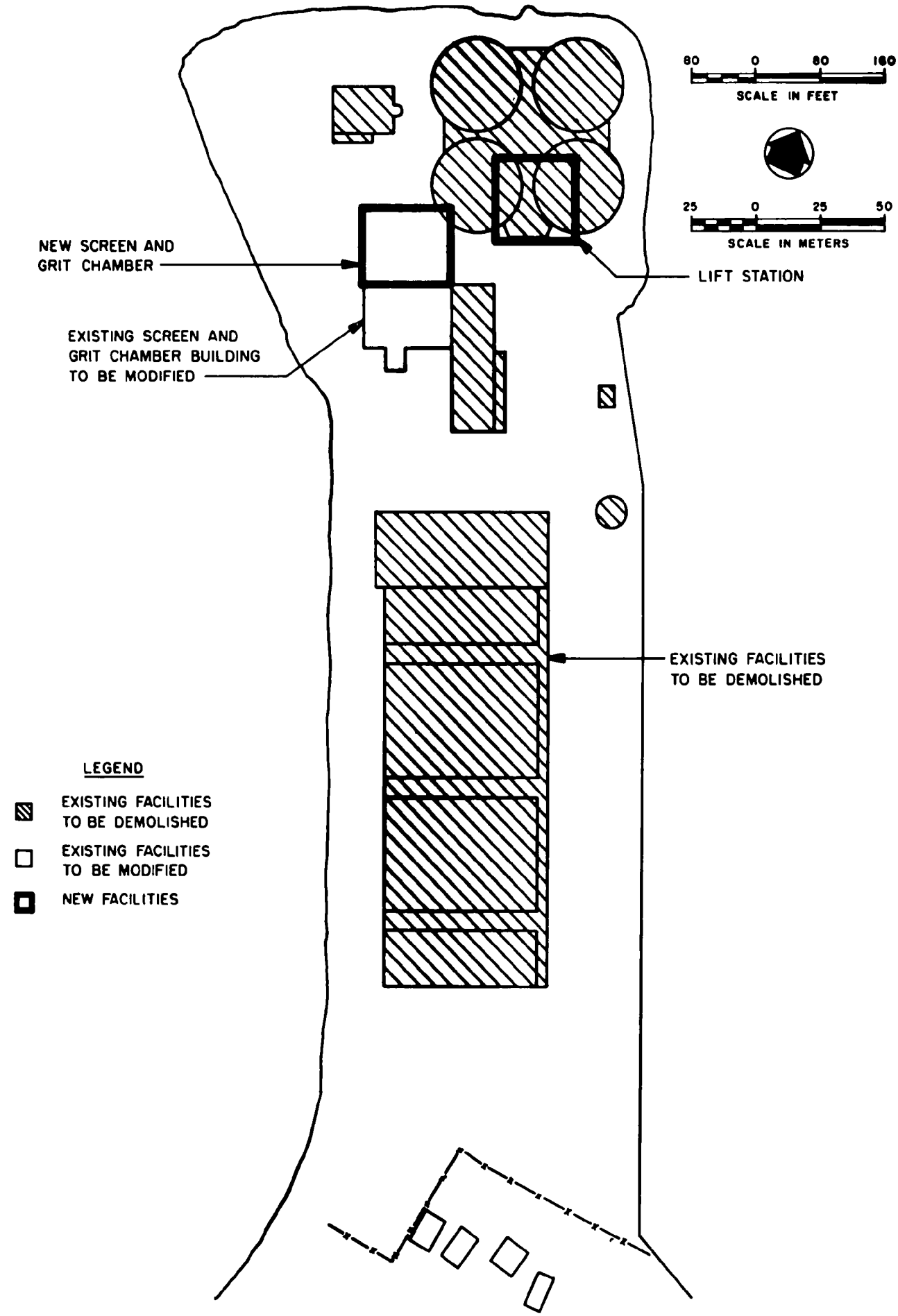

FIGURE 6 NUT ISLAND FACILITIES REQUIRED FOR RECOMMENDED PLAN

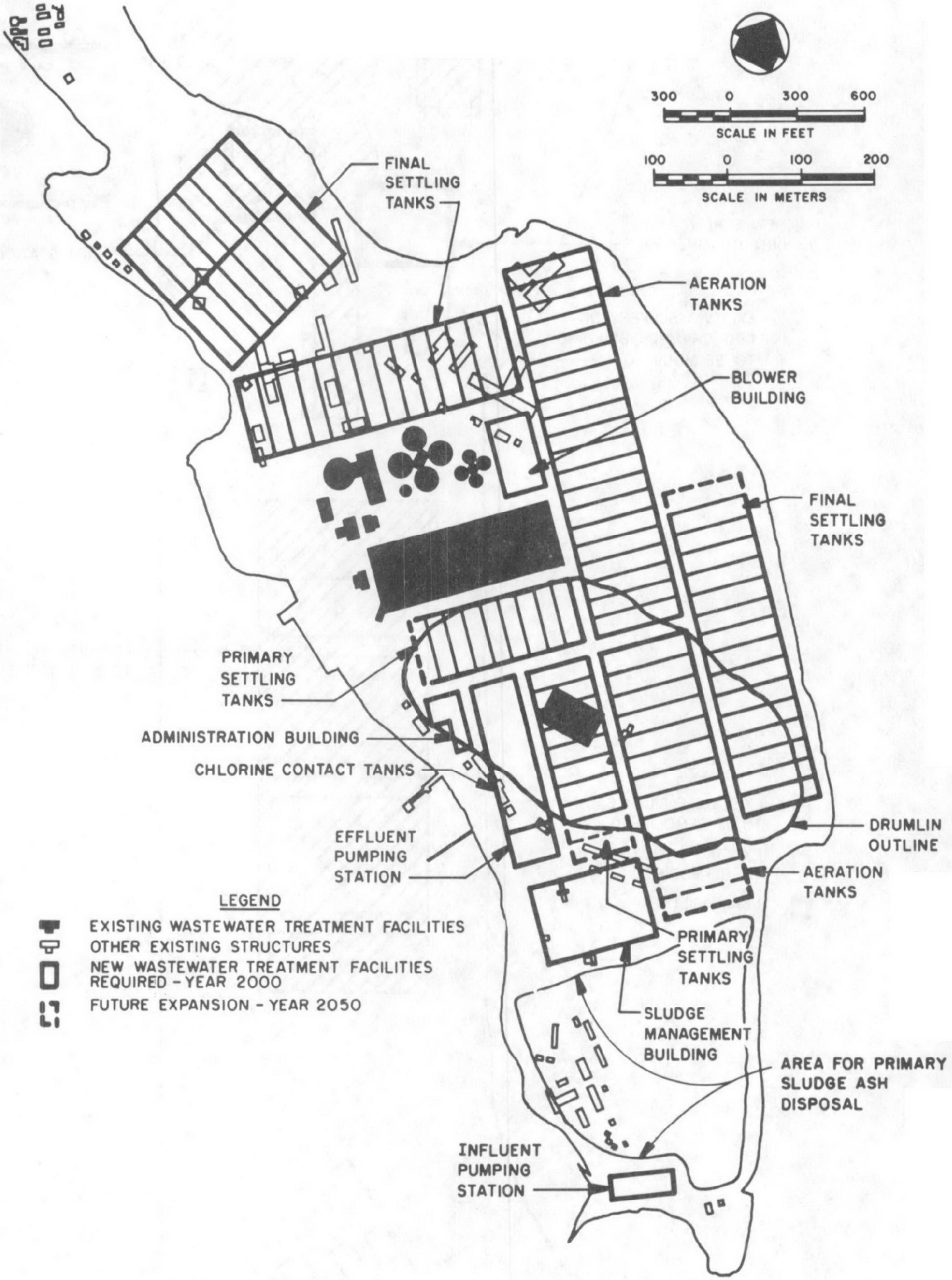

FIGURE 7 RECOMMENDED PLAN DEER ISLAND FACILITIES

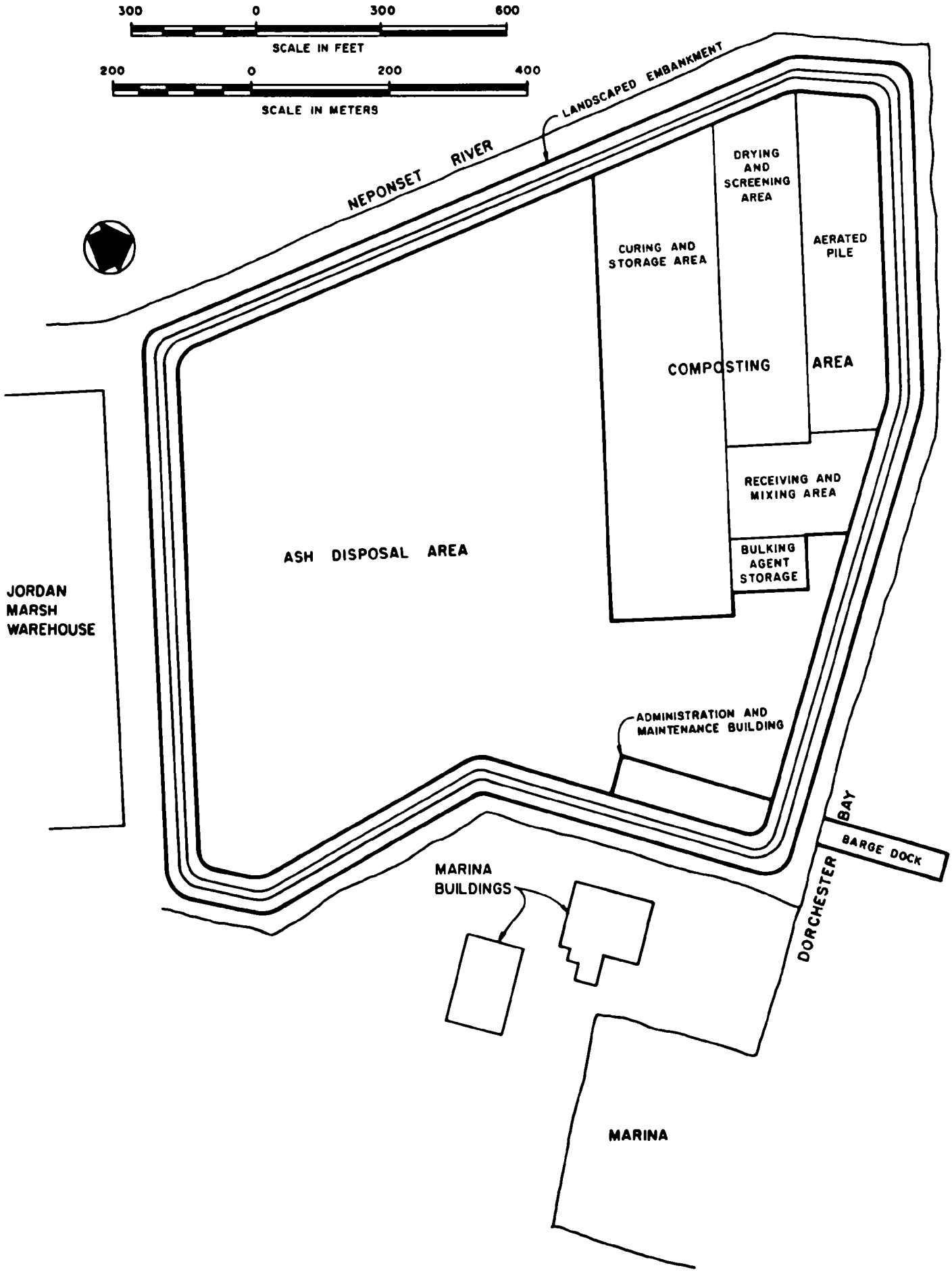

FIGURE 8 SQUANTUM POINT ASH LANDFILL AND SLUDGE COMPOSTING AREA

Preliminary treatment of the northern service area wastewaters will continue to be provided by the Ward Street, Columbus Park and Chelsea Creek Headworks and the Winthrop Terminal Facility on Deer Island. Wastewater from the southern service area will receive preliminary treatment at a new headworks at Nut Island. This new headworks will include the existing Nut Island plant's screening and grit removal facilities, which will be renovated and modernized, with additional facilities added to accommodate the increased flows expected.

A pumping station located near the southern end of Deer Island will lift the wastewater from the southern service area into primary treatment facilities. The existing primary treatment facilities on Deer Island will be expanded with the addition of eight primary settling tanks for the northern flow, and eight primary settling tanks will be provided for the southern flow. Provision is made for additional primary treatment facilities which will be required for future flows.

Secondary treatment will be accomplished through the use of twenty aeration tanks for the northern wastewater flow and eleven aeration tanks for the southern wastewater flow. Although the flows will be kept separate, a common air supply will be used for both facilities. Provision is also made for future expansion for this phase of treatment.

Final sedimentation tanks provide the other half of secondary treatment at Deer Island. Thirty-two tanks will be provided for the northern wastewater flow, and fifteen tanks will be provided for the southern wastewater flow, with provision made for the addition of facilities for future flows.

Sludge collected from the northern flow final sedimentation tanks will be either returned to the northern flow aeration tanks for process control or wasted to the sludge management facility for dewatering and incineration. Sludge collected from the southern flow final sedimentation tanks will be either returned to the southern flow aeration tanks for process control or wasted to the sludge management facility for conditioning and dewatering prior to composting or landfilling operations.

Disinfection will be accomplished through the use of chlorine and a chlorine contact basin. Provision will be made for a 15 minute detention time at periods of peak flow. This is the first place in the treatment process where the wastewaters from the northern and southern service areas are combined. Effluent discharge is accomplished with an effluent pumping station and a modified outfall structure.

Secondary sludge disposal will be accomplished using three methods; incineration, landfill and composting. The selection of the methods used was based on the characteristics

of the sludge and the desire to provide an acceptable alternative to incineration of all the sludge.

The sludge that is wasted to the sludge management facility will be thickened using air flotation thickeners, with separate thickeners used for the northern and southern sludges. After thickening, the southern sludge to be composted is conditioned with ferric chloride and lime and is then dewatered in a filter press. The resulting sludge cake is then loaded into containers for shipment to Squantum Point by barge. The portion of the southern sludge to be composted is approximately 23 percent of the total secondary sludge produced, or about 50 percent of the southern secondary sludge. The remaining southern sludge will be taken to anaerobic digesters after thickening, where, in the absence of oxygen, microbial activity produces a stable end product. The fuel value of the gas produced in this process will be utilized to maintain an adequate digestion temperature. After digestion, this sludge will be chemically conditioned with ferric chloride and lime, dewatered using pressure filtration, and barged in containers to Squantum Point. From Squantum Point the sludge will be trucked to an MDC operated sludge landfill.

The secondary sludge produced in the treatment of the northern service area wastewaters will be chemically conditioned with lime and ferric chloride following air flotation thickening. The resulting material will then be dewatered in a pressure filter. The resulting sludge cake will be burned in multiple hearth incinerators. The ash, and particulate matter from the air pollution control equipment, will then be loaded into containers for barge shipment to the Squantum Point ash landfill. Storage space for ash and sludge will be provided at Deer Island for inclement weather periods when daily barge shipments may not be possible.

Composting and ash landfill operations at Squantum will occur within the confines of a landscaped earth embankment. The area will be lined with an impermeable liner to prevent leachate from mixing with local groundwater. A leachate collection system will be constructed to collect all rainfall in the landfill area and discharge it to the MDC interceptor in Squantum for return to the treatment plant. Sufficient area will be provided at Squantum Point for twenty years of ash storage. After several years of operation it may be necessary to compost sludge on top of completed ash landfill areas. When the landfill reaches its design height, it will be covered with topsoil and may be converted to a recreational area. Approximately 125 cubic yards of ash material will be landfilled at Squantum Point each day. Compost production will vary from 70 to 98 cubic yards per day depending on the type of bulking agent used. The sludge volume which will be directly landfilled will be approximately 227 cubic yards per day.

IX. IMPACTS OF THE RECOMMENDED PLAN

A. Water Quality

Implementation of the Recommended Plan will eliminate the discharge of primary effluent and sewage overflows into the southern portion of Boston Harbor. Cessation of the Nut Island treatment plant operation should yield an immediate aesthetic improvement in Quincy Bay due to the elimination of wet weather plant bypasses which discharge floating debris and solids to near shore areas. Elimination of the continuous primary effluent discharge removes significant pollutant inputs from the southern portion of the Harbor and thus will have a long term positive impact upon its water quality. Productive shellfish beds, presently adversely influenced by these bypasses should, over time, become useable.

Pretreatment removal of heavy metals, as well as removal by the secondary facility, cannot be quantified at this time. Actual removals will depend upon the success of the MDC in implementing and enforcing its pretreatment program and the ability of the secondary facility to remove the toxic materials. Unless inputs are reduced, high concentrations of toxic metals in northern Boston Harbor can be expected to continue.

Analysis has indicated a properly diffused discharge to President Roads will not violate water quality criteria. All outfalls must include diffusers to ensure proper near field dilution of the wastewater. Water quality impacts can be minimized if the outfall system is designed to achieve the greatest dilution, in excess of 50:1, that the hydrodynamics of President Roads will permit.

The discharge of chlorinated secondary effluent into Boston Harbor can have significant water quality impacts. The recommended water quality criteria to protect marine organisms is 10 mg/l of total residual chlorine. In addition to toxicity effects, residual chlorine has been reported as impairing fish flavor. Chlorination of wastewater also results in the formation of chlorinated organics. Alternative disinfection processes or disinfecting only during the summer may be utilized to mitigate these impacts.

Dredging operations for the required harbor crossings will have a temporary negative impact upon water quality. Excavation of bottom materials can cause increased water column turbidity and suspended solids levels. Depending upon prevailing currents, these effects may not be localized in the vicinity of the dredge site. However, construction techniques are available to minimize these impacts.

Disposal of dredge material will also present problems. Increased suspended solids and turbidity will occur at the disposal site. Disposal of this material at an approved dumpsite will not

eliminate these impacts; however, the use of an approved dredge spoils disposal site will confine the impacts to an acceptable area. The "foul area" of Massachusetts Bay appears to be an environmentally acceptable disposal site due to the existing degradation of the area caused by previous dumping. Disposal of dredge spoils back into the harbor for backfilling the trench following construction of the harbor crossing will cause additional water quality impacts. Only material which is substantially free of colloidal particles should be used for backfill.

Potential exists for long term adverse water quality impacts from landfilling of sludge and incineration ash. Leaching of toxic metals poses a potential threat to surface and groundwaters proximate to the disposal sites. Disposal of these materials by landfilling in a "secured landfill" (one from which all leachate and surface drainage is collected for treatment) will prevent these impacts.

Interceptor relief programs will have a positive impact upon water quality by eliminating overflows to the rivers from hydraulically overloaded sewers during wet periods.

In summary, the following water quality impacts are associated with the recommended wastewater management plan. Positive impacts resulting from the upgrading to secondary treatment and consolidation of all treatment on Deer Island include improved quality in southern harbor waters, reduced discharge of pollutants to President Roads, and the elimination of sludge discharges and interceptor overflows. Dredging activities will cause temporary negative impacts. In addition, potential negative water quality impacts are associated with landfilling of incinerator ash and secondary sludge as well as wastewater chlorination, Negative impacts may be reduced and deemed acceptable through institution of proper mitigating procedures.

B. Water Quantity

The Recommended Plan will result in the export of about 57.5 mgd of water to Boston Harbor from local watersheds. This export represents a negative impact upon those watersheds. Infiltration/Inflow (I/I) represents a significant potential loss of local water, especially from the Charles and Neponset Rivers where interceptors run through sand and gravel deposits adjacent to the rivers. These potential impacts may be mitigated through effective water conservation and a vigorous program to correct excessive I/I.

C. Air Quality

The effects of the Recommended Plan on air quality will be primarily due to the incineration of sludge, with transportation related sources providing a secondary, and relatively minor, addition to pollutant emmissions. On the basis of air quality

modelling it was determined that Prevention of Significant Deterioration Standards (PSD) would not be violated. With the exception of the 24 hour maximum emmissions for sulfur dioxide, which uses 38 percent of the allowable PSD increment, 28 percent or less of the allowable increment is used by sources from the Recommended Plan. However, it is projected that National Ambient Air Quality Standards (NAAQS) will be violated, for the 24-hour secondary particulate standard only, due to background concentrations at certain monitoring stations. Therefore, emission offsets may be required.

Examination of the annual sulfur dioxide projections shows that the levels expected at Deer Island are well below the primary and secondary air standards. The addition of sulfur dioxide concentrations from the Recommended Plan, as indicated by the air model, would not cause a violation of any standard.

Transportation related emissions are a second source of air pollutants resulting from the Recommended Plan. The sources of these emissions are heavy duty vehicles, barge traffic and worker related automobile traffic.

The annual number of miles traveled during construction for heavy duty diesel trucks was estimated to be 39,000 miles (worst case condition). This mileage was multiplied by emission factors obtained from Supplement No. 5 for Compilation of Air Pollution Emission Factors (USEPA, 1975). During the operation and maintenance (O&M) phase of the project the number of vehicle miles traveled increases greatly due to the landfilling of sludge and removal of compost. It is estimated over 1.5 million miles of travel will occur annually. This includes about 1.2 million miles of travel due to the removal of compost.

There would be a substantial increase in barge traffic due to the Recommended Plan. Emissions were calculated for both the construction and O & M phases of the project for barge related emissions. Emissions were based upon the estimated number of miles traveled and the emission factors from Compilation of Air Pollutant Emission Factors, AP-42 (USEPA 1975).

Automobile emissions were calculated based upon vehicle miles traveled by workers to and from work during the construction and O & M phases. It was assumed, as a worst case, that each worker would drive to work alone and have a 30 mile round trip. Emission factors were obtained from Supplement No. 5.

As a result of the above mentioned calculations, it was determined that transportation related emissions would cause an insignificant addition of pollutants to the ambient air concentrations.

D. Noise

Three sites were examined for noise related impacts; Deer Island, Nut Island and Squantum. The State of Massachusetts has no noise standards indicating specific noise levels, in decibels which are acceptable or unacceptable. Therefore, the City of Boston's Noise Control Regulations were used as a guideline for acceptable noise levels.

Winthrop is the nearest community with residences that may be affected by noise from Deer Island. The nearest residence is about 700 feet from the closest portion of the proposed plant. Assuming that the highest noise level emanating from the completed plant is 88 decibels, which has been measured and originates at the main pumping station, a level of 50 dBA may be expected in the vicinity of the nearest residence. This level is acceptable for residential areas and therefore, it is not expected that noise levels during the operation of the Deer Island Treatment Plant would impact on local residences.

Noise levels at the Squantum site, due to facility operations, should not impact any local residences. At present, the nearest property to be impacted would be commerical in nature. The use of equipment on site during operation is not expected to cause any detrimental noise impacts. On Nut Island a lift station and headworks are to be constructed. Noise levels during operation should not impact upon adjacent residences.

The noise levels generated by construction equipment would not have any significant impact at the Squantum site. On Deer Island, noise levels should meet the City of Boston's Construction Noise Regulations at the Winthrop boundary. During the demolition of existing facilities at Nut Island, impact noise may frequently approach the maximum level specified in the Construction Noise Regulations at the nearest property line.

At Squantum, approximately 125 vehicle round trips per day would be made, removing compost and digested sludge and bringing in treatment plant supplies for use at the Deer Island Treatment Plant. The impact on surrounding areas should be minimal at Squantum due to the existing commercial nature of the area and the proximity to major transportation arteries. However, with the possible residential use of the adjacent parcel, the potential for nuisance effects may increase.

Assuming all workers were to drive to the Deer Island site, the roadways through Winthrop would become extremely congested since the carrying capacity of the roads would be exceeded. Noise levels through the community would be increased due to construction worker traffic.

Noise levels would increase near Quincy Great Hill (Sea Avenue) due to the increase in traffic to Nut Island. However, this should occur only during periods of peak traffic flow. Sea Street should not experience any noticeable increase in traffic or noise levels due to construction at Nut Island, since it would produce a minimal increase relative to the existing traffic volume.

The raised noise levels at Deer and Nut Islands due to construction would be temporary in nature and would not pose a significant noise impact. Transportation noise may be perceived as a nuisance during construction at the two island facilities. However, this noise would also be temporary. Squantum truck traffic would produce a long term addition to noise levels. Nonetheless, the impact on the surrounding area would be minimal due to the easy access to major roads and the relative isolation of the site as it now exists.

E. Biota

The Recommended Plan will impact upon existing biotic communities in several ways. First, upgrading the existing primary discharges into Boston Harbor and eliminating the sludge discharges will significantly improve water quality conditions and thereby positively affect estuarine biota. The elimination of a Quincy Bay effluent discharge and the sludge discharges will positively affect the bay by an immediate improvement in water quality. The localized water quality improvements which are realized may eventually open areas which are presently closed to shellfish harvest.

In general, water quality improvements should improve the diversity of species found within the harbor. Similarly, aquatic biota should be benefited to some degree by the relief of inland interceptors, which would minimize polluting overflows within the river systems.

Another impact of the Recommended Plan is the displacement (and loss) of biota due to the construction of sewerage facilities.

The entirety of Deer Island will be used for the development of treatment plant facilities. In addition to the areas now occupied by the prison and the treatment plant, Deer Island contains a grassy drumlin and the highly disturbed Fort Dawes area at the southern tip of the island. Some sections of the Fort Dawes area are bare and rocky. A low, marshy area exists adjacent to the rocky area.

The land adjacent to the existing treatment plant contains large grassy expanses which roll over the area with small forbs appearing occasionally. Young stands of trees exist, but they are not important ecologically. Development on Deer Island will not destroy any valuable biota.

Approximately 70 acres of land at Squantum Point will be affected by the proposed project. The vegetation on the site is composed of a mixture of grasses with a variety of other annuals, shrubs and trees being found scattered throughout. Meadow areas, both wet and dry, are present. The wet areas are dominated by expanses of grass. Large patches of bayberry shrubs are also found in this area.

A small salt marsh exists around the perimeter of the Squantum site (water boundaries). While the complete loss of this marsh would probably be insignificant surficially, too many acres of marshland have already been lost. By careful planning during the construction and operation phases of the project, this marsh can be protected from loss.

Overall, development of the Squantum site will have a minimal effect upon biotic communities. Provided that an effective barrier is used to contain leachate from the ash landfill, adjacent aquatic biota will be unaffected.

Approximately 10 acres of land on Long Island will be needed as a staging area during the construction phase only. While areas south of the State mental hospital are available, they are not suitable due to the steep slopes which parallel the water/land interface. The area north of the hospital is topographically more suitable. Biotic impacts will not be significant and will be short-term (the area will be restored following staging operations). However, land ownership problems may be restrictive because the land is under the jurisdiction of the hospital. If access to a site north of the hospital cannot be gained, then staging operations will have to be restricted to the other construction areas (Deer Island and Nut Island).

Another component of the project which will cause significant biotic impacts is the dredging of the harbor associated with the construction of the harbor crossing and outfall pipelines. In terms of displacing the benthic biotic community, approximately 80 acres of harbor bottom (hence benthic organisms) lie in the direct path of the pipelines and would be lost along with the dredge spoils. An even greater area of harbor bottom would be affected by sedimentation. Many forms will be smothered while other forms will adjust to the level of the sediment. While the short-term effects would be significant, benthic recovery would occur over several seasons. The placement of clean backfill over the pipes may result in an ultimate improvement over existing conditions.

Other biotic impacts would result from the construction of relief sewers and a landfill for digested sludge. While the location and magnitude of these effects cannot be accurately determined at this point, they are expected to represent significant displacements. In the case of relief sewers, construction rights-of-way will be restored following construction, but significant losses of mature vegetation would occur.

F. Socio-Economic

Implementation of the Recommended Plan can be expected to have significant socio-economic impacts, both positive and negative. The positive impacts will be primarily associated with construction employment and increased commerical activity in the vicinity of the staging areas.

Construction of the recommended project will require approximately 4,400 man-years of construction labor. At an average wage rate of $25,000 per man year, this amounts to approximately $110 million in wages that would be dispersed over a two to four year period. Substantial portions of this money would be spent locally, thereby increasing employment in other sectors of the economy.

In addition, sustained employment of 385 persons for operation and maintenance of the facilities would account for about $5,000,000 in regional income per year.

Other positive impacts of the proposed project result from the availability of Nut Island for recreational purposes. This, plus the elimination of a Quincy Bay discharge will greatly increase the attractiveness of the Quincy Bay area for revenue-generating recreational uses.

Negative impacts associated with the Recommended Plan include the removal of land from municipal tax rolls and possible devaluation of property value or usefulness of the areas adjacent to the Squantum site. Specifically, implementation of the Recommended Plan would result in the removal of 70 acres of land from the tax rolls of the City of Quincy. The loss of future taxes could be even greater than present losses, not only because the Plan precludes future residential development on the site, but also because the location of facilities at Squantum could diminish the attractiveness of adjacent land for residential development. This adjacent land is now zoned for Planned Unit Development. It is not possible to quantify these potential losses accurately at this time, but they could be significant. The specific reasons for this impact relate to the operation of the site as a landfill (visual impact); the increased vehicle traffic which will be involved in transporting chemicals, sludge, and compost; and the possible nuisance conditions (mainly odors) from the composting activity. The proposed project, by the inclusion of a berm in its design, will minimize visual impacts. However, the placement of high rise residential structures on the adjacent parcel would negate the shielding effect of a berm for upper story residents.

Another potential negative impact is the localized effect of street closures on local businesses in the vicinity of sewer line construction. For the areas surrounding Boston Harbor, this does

not seem to be a problem since very little construction will occur in or near streets. However, for inland interceptor relief projects, the potential for impact is significantly greater.

G. Recreational and Scenic Areas

The Recommended Plan will have both positive and negative effects on recreational sites and recreation in the study area. Negative effects can be attributed to the total loss of Deer Island for recreational use. The Boston Harbor Islands Comprehensive Plan (MAPC, 1972) proposed recreational uses for those portions of the Island not used by the EMMA Study's recommended expansion. Specifically, the drumlin was suggested as a vantage point from which the harbor can be viewed. The Fort Dawes area was recommended for use as a passive recreational area. However, the presence of a large treatment facility at the northern end of the Island is considered to diminish somewhat the value of an immediately adjacent recreational area.

Positive recreational impacts will result from the demolition of most of the Nut Island treatment facilities and the availability of this area for recreational use. Also, in the future, the Squantum site will be available for reversion to recreational use when the design capacity of the ash landfill has been reached (about 20 years).

In a general sense, the recreational use of the harbor and the inland rivers will be enhanced by the reduction in pollutant loads, elimination of sludge discharges and the reduction in wastewater overflows and bypasses.

On balance, the construction of the Recommended Plan would appear to positively affect the status of recreational sites and recreation in the study area. Although the future construction of relief sewers may cause specific local adverse effects, these can be mitigated through careful facilities planning.

H. Sites of Special Significance

Included under sites of special significance are designated historic preservation areas, pre-historic aboriginal sites and significant natural areas.

The construction of harbor-based facilities (treatment facilities, bay crossings, outfalls) will not affect any documented or recorded historic sites. Similarly, no known aboriginal sites are recorded on either Deer Island or Squantum. However, a detailed field survey of these areas, especially Deer Island, should be conducted during facilities planning to determine if any unrecorded aboriginal sites are present. While this is unlikely due to the extremely disturbed nature of both areas, the discovery of such a site would require removal of artifacts or recording of data.

With respect to significant natural areas, no sites on the National Registry of Natural Landmarks will be impacted by the proposed action. One site (Deer Island) on the Massachusetts Landscape and Natural Areas Survey will be impacted as discussed previously.

I. Significant Environmentally Sensitive Areas

Significant and/or sensitive components of the environment and the impacts of the Recommended Plan on these features are summarized below:

Geology - Over one hundred drumlins have been identified as distinctive geologic features in the Boston area. The Recommended Plan impacts the two drumlins present on Deer Island. The Boston Harbor Islands Plan will serve to protect the remaining drumlins which form most of the Harbor's Islands.

Surface Waters - Water quality will be positively impacted by the Recommended Plan. In addition to water quality improvements, no water areas will be lost by filling any harbor areas.

Recharge Areas - The proposed project will not involve the permanent construction of any facilities on recharge areas.

Wetlands - Construction at Deer Island and Squantum will not result in the displacement of any salt marsh areas. Wetlands are found on the perimeter of both sites but should be minimally affected by facilities construction. A small wetland area exists within the Squantum site but is not flushed by the tide. Hence, it makes no contribution to the bay ecosystem. During relief sewer construction, some inland freshwater wetlands may be temporarily disturbed. However, proper facilities planning should minimize these disturbances and mitigate any long term effects.

Steeply Sloped Areas - It is not anticipated that any facilities (except for minor segments of relief sewers) will be constructed on steeply sloped areas.

Forests and Woodlands - Harbor facilities will not affect forests and woodlands. Relief sewers will traverse wooded areas to a significant degree and will impose significant effects.

Air Quality - Since Boston is designated as a non-attainment area, every effort has been made to reduce air emissions from the Recommended Plan. However, incineration still represents a major method of sludge disposal, and it is possible that emission offsets will be required.

Habitat of Rare or Endangered Species - The Recommended Plan will not result in the loss of any significant habitat for rare or endangered species in the harbor area. Caution during facilities planning can also eliminate this condition during relief sewer construction.

Public Use/Cultural Resource Sites - Cultural resource sites will not be affected by the construction of harbor facilities. Public use sites will be both negatively affected (Deer Island) and positively affected (Nut Island).

X. MEASURES TO MITIGATE ADVERSE IMPACTS

The Recommended Plan is expected to result in a number of adverse environmental impacts. Feasible recommendations which can significantly minimize these impacts are listed below:

1. The possible adverse effects of wastewater chlorination were presented earlier. Several alternatives exist which can serve to both disinfect the effluent from the treatment plant and minimize the adverse effects of chlorine. The simplest option is to eliminate the chlorination step during that period of the year when the harbor is little used for water-contact recreation, Labor Day to Memorial Day. During the summer season, effluent could be both chlorinated and then dechlorinated (using sulfur dioxide). Because seawater has been demonstrated to be a hostile environment for sewage bacteria, the practice of chlorination only when human contact with the diluted effluent may occur quickly has received ever-increasing support. The additional cost of dechlorination would be more than offset by the savings realized from the elimination of chlorination for nine months each year.

Other options include year round chlorination and dechlorination; the use of an alternative disinfectant during summer months (such as permanganate or ozone); and the use of a low-level chlorine dose (which could be quickly diffused to a sub-toxic level).

These alternatives should be examined with respect to cost and feasibility during facilities planning. Environmental considerations would seem to favor the first approach (chlorination and dechlorination during the summer season only). In addition to the water quality and biotic benefits, a savings in resources (chemicals) and transport requirements will be realized. This should be coupled with a coliform monitoring program to test the efficacy of this approach and to safeguard the public health.

2. The Recommended Plan will continue the present practice of exporting water from inland river basins to the harbor. An analysis of water losses indicated that losses due to inflow and infiltration (I/I) greatly exceed net water export quantities. Hence, efforts which will reduce I/I will tend to mitigate the effect of water export.

Water conservation programs (both voluntary and involuntary) should be promoted. The MDC, acting as both sewer and water authority, is in an ideal position to advance this concept. The MDC should actively campaign toward the education of the public concerning the need for water conservation and what steps can be economically and easily taken to save water.

3. This project attempts to mitigate air quality impacts by maximizing the disposal of sludge by marketing or giving away a composted product. Therefore, the success of the composting operation is important in ultimately keeping air emissions as low as possible. In order to enhance the feasibility of this program, the MDC should actively publicize the availability and virtues of composted sludge. This includes providing leaflets instructing the public in its proper use and contacting other institutions, agencies, and commercial organizations concerning the use of composted sludge. Since the use of composted sludge is a relatively new idea on this scale, the program must be actively promoted. In order to enhance the quality (hence, the usefulness and market potential) of the composted sludge, the MDC should investigate additional methods of reducing its metal content.

In addition to providing composted sludge for public pick-up at Squantum, the MDC should truck compost to dispersed distribution sheds located through the study area. These sheds could be located on MDC parkland or other public land. This will greatly reduce traffic into Squantum; reduce total travel and air emissions; and increase the market for compost.

4. In order to mitigate the effects of dredging in the harbor, the use of a specially designed dredging barge should be investigated. The barge would be equipped with legs which are lowered to stabilize the barge once it is properly positioned. Steel sheeting is then driven around the front and sides of the barge and the trench section within the sheeting is excavated. This method will reduce the volume of material excavated, decreasing the number of barge trips necessary for disposal and the cost of the harbor crossing. The volume of backfill required also will be reduced, as well as the cost of this operation. In addition, localized sedimentation and siltation impacts will be limited to the area within the sheeting. Under actual operating conditions elsewhere, the cost of this method has been shown to be competitive with other, more conventional dredging techniques.

5. To further mitigate impacts on the adjacent PUD zone at Squantum, composting operations should be conducted on that part of the site farthest from the PUD zone. Also, the berm nearest the PUD zone should be well screened with vegetation to shield the site to a maximum extent possible. Ash placed in the landfill should be wetted and covered as needed to prevent dust and wind erosion. Optimum operating procedures can be developed using the successful techniques used at other ash landfill sites already in operation. Compost piles should not be broken down for movement to curing areas when the prevailing wind is in the direction of the PUD zone.

6. In order to minimize the effect of increased traffic through Winthrop to Deer Island, the maximum use of water transportation to move materials and machinery is recommended. The feasibility of

bringing construction workers to the site via shuttle bus should also be investigated. If workers can be brought in from outlying parking areas, daily traffic could potentially be reduced from 2000 vehicle round trips to 50 vehicle round trips (at 40 workers per bus).

7. To mitigate impacts upon the seasonal recreational use of the harbor, construction activities should be scheduled to avoid intensively used recreational areas during the peak-use season.

8. To minimize the loss of terrestrial biota during the construction of relief sewers, every effort should be made to minimize the right-of-way used, particularly in heavily vegetated areas.

9. To ensure that the sludge landfill does not contaminate underlying groundwaters, a series of monitoring wells should be installed around the landfill site. A water quality sampling program should be maintained to guard against the degradation of groundwater.

10. Current construction contracting procedures used by the MDC, and the size of the proposed construction project, preclude the award of a single contract for the construction of the treatment plant at Deer Island. There is a need for centralized control of all construction activity in order to reduce the impacts of construction on nearby communities, particularly through the use of barges for delivery of mechanical equipment and construction materials. It is recommended that a construction managment consultant be engaged throughout the design and construction periods to schedule and enforce timely completion of each phase of work. Cooperation between contractors is necessary in order to make barging an economical method of transporting equipment and materials.

XI. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

It is recognized that the Recommended Plan will result in some adverse impacts on the environment which cannot be mitigated or avoided. These are summarized below in qualitative terms.

While water quality conditions are expected to generally improve, the proposed effluent discharge will still introduce organic and inorganic pollutants to Boston Harbor. Specifically, the total loading of cadmium, mercury and nickel into President Roads from the effluent discharge will increase marginally over present conditions. (This ignores the present sludge discharge). However, these metals should be quickly diluted to acceptable levels.

Other unavoidable water quality effects include the introduction of silt, organics and metals to the harbor from the disturbed bottom muds during dredging operations.

The increased export of water from inland river basins to the harbor can be viewed as an adverse effect. Strictly speaking, this effect is avoidable through water conservation measures and through the reduction of inflow and infiltration. However, it is not likely that this effect will be completely mitigated by these measures. Hence, net water export will probably represent an adverse effect. This impact should be manageable and, if sincere efforts are made by the MDC and the public, it should be minimal. In any event, severe impacts on local water supplies and river flows are not foreseen.

The Recommended Plan attempts to minimize air quality impacts through the use of alternate sludge disposal methods, thereby relying on sludge incineration to the least degree feasible. However, air emissions from sludge incineration will be significant and will represent an unavoidable adverse effect. Similarly, air emissions resulting from additional barge, truck and automobile traffic are unavoidable.

Noise impacts during construction (especially along interceptor sewers) are unavoidable. However, during facilities operation, noise impacts should be minimal.

Unavoidable adverse impacts on the area's biota will result from the permanent displacement of existing biotic communities at Deer Island, Squantum and the sludge landfill. Unavoidable short-term impacts will result from dredging the harbor and the construction of relief sewers through vegetated areas. Additional short-term effects may result from the use of a Long Island site for staging operations.

With respect to socio-economic effects, the negative fiscal impact of taking the Squantum site for a tax exempt use is unavoidable. Also, the recommended use of the Squantum site may hamper a developer in marketing units in the adjacent PUD zone. At such time when residents occupy the PUD zone, high-rise residents will be affected by the visual impact of the ash landfill and compost operation.

In terms of recreational and secenic areas, the loss of Deer Island (particularly the drumlins) for recreational purposes represents an unavoidable adverse impact.

XII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The construction, operation and maintenance of the Recommended Plan is expected to result in the irreversible and irretrievable commitments of certain resources. The major resources include land, energy, chemicals, dollars and labor. In addition to these

items, other resources which are difficult to quantify will also be committed. These include such things as cement, aggregate, backfill, etc. They are, however, reflected as costs.

Labor - Labor is considered a resource whose commitment to this project is irreversible. That is, once labor (which could be spent in other ways) is committed to this project, it is a resource that has been expended in an irretrievable manner. This project will require approximately 4,400 person-years for the construction of the proposed facilities (this does not include inland relief sewers). For operation and maintenance, a permanent staff of about 384 persons will be needed.

Energy - The energy requirement of the proposed facilities during the operational phase is approximately 224 million kilowatt hours per year. In addition, about 930,000 gallons of fuel oil will be needed annually for the proposed plan.

Land - Approximately 210 acres of land at Deer Island will be permanently committed to wastewater treatment use. Seventy acres at Squantum will be reversibly committed. That is, when the ash landfill reaches its design capacity, it will be restored and can revert to an alternate use, such as recreational development.

The construction of relief sewers will require permanent easements which can restrict the use of land through which the rights-of-way pass.

Chemical Resources - For operational purposes, chemicals are required, in bulk, for disinfection and treatment. These commitments are quantified below. The estimate for chlorine is not adjusted in accordance with a seasonal chlorination program.

Chlorine, tons/year	7,135
Lime, tons/year	14,600
Ferric Chloride, tons/year	3,500
Polymer, tons/year	113

Dollars - Dollars are included here in the sense that once money is appropriated, it can be considered a resource with alternative uses. Dollars also represent a common basis with which other resources can be quantified. In this sense, the cost of a project represents the sum total of all resources committed to a project. The total capital cost of the Recommended Plan is estimated at $771 million, with annual operation and maintenance costs estimated at $24.8 million.